The dynamic effects of aid and taxes on government spending

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Abstract
This paper examines the impact of foreign aid and taxes on government spending for 67 developing countries during 1980–2013 using dynamic heterogeneous (panel) time-series techniques. We find that spending, aid and tax ratios comprise an equilibrium (cointegrated) relation. On average, the aid coefficients (and marginal impacts) are positive but smaller than the tax coefficients, indicating that in the long-run and short-run taxes have a stronger association with expenditures than aid. Central to this heterogeneous relationship is the political calculus between aid and tax—measured according to accountability and bureaucratic costs—whereby recipients offset the political costs of raising taxes against the political costs of receiving more aid. Once measures of political costs are incorporated into the analysis, we find the political costs of aid to be higher than those of tax, reinforcing the primary assertion that for spending, taxes are more important than aid. Countries with higher political costs of aid typically show no aid-spending relationship, while those with lower political costs of aid tend to show an aid-spending relationship. The findings are largely when replicated once we split total spending into capital and consumption spending.

Keywords Aid · Tax revenue · Political calculus · Nonstationary panel econometrics

JEL Classification C23 · E62 · F35

1 Introduction
Aid still represents a major source of revenue in most developing countries as the poorest of them do not have sufficient resources to finance their development needs (Herzer & Morrissey, 2013) and donors acknowledge that recipients spend more than they can finance domestically. As most aid given to a country goes to the
government, or finances services that would otherwise be a demand on the budget; it should impact on the level and composition of government spending. The amount of aid going through recipients’ budgets is substantial, which elicits direct fiscal effects on the level (relative to GDP) and composition (allocation to different expenditure headings) of government spending (Morrissey, 2015a). Aid, however, has been dwindling and will be insufficient to meet recipients’ financial needs and efforts have been directed towards recipient countries’ revenue-raising efforts (Morrissey, 2015b). Taxes are important and the major source of financing for spending across developing countries (Morrissey et al., 2011). This paper seeks to determine which source of finance, aid or taxes, is more important for government spending. This is the main question answered in this paper, employing methods in panel time-series econometrics on data for 67 countries over the period 1980 to 2013.

This paper seeks to uncover the ‘pass-through’ of aid and tax revenue to government spending, building on insights from the political calculus literature as an important (and unexplored) channel through which the marginal effects of taxes and aid on spending can be gauged. Aid—specifically the proportion that goes through the budget—and domestic taxes are two important sources of government expenditure, and we posit that the choice between both depends on the attendant political costs of aid and tax and how the costs offset each other (Morrissey & Torrance, 2015; Morrissey, 2015b). Collecting taxes is unpopular, and aid is viewed as a politically cheaper source of revenue to cover government spending. While aid does not cover all government spending, it may reduce the incentives to expend effort on collecting taxes. However, there are attendant political costs associated with aid, such as increased dependency and bureaucratic costs of administration. The choice between both costs depends on how they are perceived by recipient countries, and which revenue source best meets the recipients’ objectives. The political calculus dimension has not been explored in the aid-spending literature, but we posit that it is important in determining the marginal effects of aid and taxes on spending. We provide proxy measures for the various political costs of aid and tax and demonstrating—through formal econometric modelling—how they mediate the impact of aid and taxes on spending.

The literature on the effects of aid on spending is relatively scant, with a few cross-country studies (inter alia Kaya & Kaya, 2020; Marć, 2017). There are studies looking at the link between aid and total spending (inter alia Aworinde & Onakoya, 2016; Morrissey et al., 2011; Remmer, 2004) and some estimating the effects of aid on sector-specific spending such as health or education (Gomanee et al., 2005). Closely related to the above are fungibility studies which analyse the impact of aid on specific sectors stipulated by donors and usually test if spending in said sectors increases by the amount of aid: a concept known as “aid additionality”.1 Additionally, there are country-specific fiscal response models (FRMs hereafter) that draw

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1 Some fungibility studies include Lu et al., (2010) for health aid; Van de Sijpe (2013) for education aid; and Marć (2017) for total aid. The latter two studies also distinguish between on-budget and off-budget aid. The general pattern of findings is that over time aid increases spending in recipient countries, albeit the latter not increasing by the full amount of aid (Marc, 2017; Martins, 2011; Remmer, 2004).
heavily on the work of Heller (1975) and are used to estimate the dynamic impact of foreign aid on fiscal aggregates.

Empirical applications of early FRMs have limitations relating to the treatment of aid (whether it is exogenous or endogenous), the nature of the government’s utility function, the use and estimation of revenue and expenditure targets, the inherently static nature of the models, and the difficulty in obtaining consistent estimates of core parameters (Lloyd et al., 2009; Morrissey, 2015a). Due to these limitations, the FRM literature evolved through country-specific, time-series studies that apply the cointegrated vector autoregressive (CVAR) framework pioneered by Osei et al. (2005). The country-specific studies explicitly demonstrate heterogeneity with quantitative results differing across countries. Osei et al. (2005) show that there is no direct impact of aid on spending; increases in aid, alongside policies associated with increased taxes, is what lead to increased spending. Mascagni and Timmis (2017) find positive long-run associations between aid (and its components) and government spending.

While the above studies provide a useful backdrop for estimating the dynamics between aid, taxes and spending, they suffer from four crucial limitations. First, the cross-country methods do not explore the time-series properties of aid and domestic fiscal data: data characterised by inertia, resulting in non-stationarity. This inertia allows for a distinction between long-run (levels) and short-run (differences) relationships between aid and fiscal variables. Studies that include lagged dependent variables do so within fixed effects models (for example Marć, 2017; Van de Sijpe, 2013) and the temporal dimension of the data is not fully explored. Second, the studies overlook cross-country heterogeneity in fiscal effects. Institutional differences across countries are fundamental in estimating the impact of aid and taxes on spending (see Kaya & Kaya, 2020). Furthermore, the marginal effects of aid and tax ratios—the quantities linked to aid additionality—also differ across countries, depending on the political calculus between aid and tax. Third, potential reverse causality in aid disbursements. Conditional on the level of spending that can be domestically financed—the latter influenced by external or internal factors—aid can be disbursed to those countries with ex ante lower expenditure (hence greater need for aid). Alternatively, donors may be funding the provision of public goods in recipient countries that fail to provide them, resulting in the level of aid disbursement being responsive to recipient countries’ conditions. Fourth, the studies do not account for salient unobserved heterogeneity and the ensuing cross-section dependence that characterises macro-panel datasets. Accounting for cross-section dependence is important due to its distorting impact on empirical estimation and inference (Eberhardt & Teal, 2013, 2020).

This paper circumvents the above by analysing the effects of aid and taxes on spending for a panel of 67 low- and middle-income countries over 1980 to 2013. The empirical section proceeds in three steps. First, we estimate the impact of aid and tax ratios on government spending ratios within an error correction model (ECM) framework by employing the dynamic Common Correlated Effects Mean Group (CCEMG) estimator (Chudik & Pesaran, 2015). The method permits testing for the presence of a long-run (cointegrating) relationship between aid, taxes and spending, distinguishing between long-run and short-run relationships, and
allowing for these effects to differ substantially across countries. Additionally, the method is robust to unobserved recipient heterogeneity (latent trends) arising from omitted global variables and global shocks. Second, we invoke the political calculus argument in discussing results and test if the proxies for political costs of aid and taxation alter our main findings. This allows gauging which of the variables—aid or taxation—is more important for government spending, based on elasticities and marginal impacts. No previous studies have explicitly incorporated the political calculus argument into econometric specifications. Third, the direction of long-run causality across variables is addressed using novel methods in panel time-series econometrics. An advantage of panel time-series methods is allowing for agnosticism about the direction of long-run causality—cointegration between the variables implies there is long-run causality between them, the direction of which is unknown—and tests for the direction of long-run causality are applied (Canning & Pedroni, 2008; Eberhardt & Teal, 2013). The tests allow for cross-country heterogeneity and cross-section dependence.

Our main findings provide evidence of a long-run equilibrium (cointegrating) relationship between aid, taxes and spending ratios, akin to a domestic budget equilibrium. The average long-run effect of aid on spending (as well as the marginal effect) is positive and robust to variable and residual correlation, outliers and omitted global (latent) variables. This long-run impact is smaller than the long-run impact of taxes, suggesting that in the long-run expenditure levels are driven mainly by taxes, consistent with results in the fiscal effects literature. Once measures of political costs of aid and taxes are incorporated, our primary finding is reinforced: taxation is the main driver of domestic spending as the political costs of raising taxes are lower than the political costs of receiving aid. High political costs of aid dampen the positive effects of aid on spending. Furthermore, we find that aid is associated with higher capital spending but has no effect on recurrent spending, while domestic taxes influence both. The political calculus argument also applies here: the political costs of taxes are lower than those of aid, resulting in higher marginal effects of taxes on capital spending. Finally, we find that aid is weakly exogenous, suggesting that the disbursement of aid to recipients is independent of their fiscal situation.

The remainder of the paper is organised as follows. Section 2 provides a brief analytic framework from which hypotheses will be tested, and Sect. 3 introduces the data. Section 4 presents the empirical model specification. The main results and exploratory analysis are discussed in Sect. 5, and Sect. 6 concludes.

2 Conceptualising the dynamics between aid, taxes and spending ratios

2.1 Analytical framework

We provide a simple conceptual framework for the dynamics between aid, taxes and spending; based on a government budget constraint which could form the basis for testing hypotheses in the empirical model. The budget constraint states that all revenues and borrowing must equal all expenditures:
where revenue includes tax and non-tax revenues (such as from natural resources and resources from state-owned enterprises), borrowing includes domestic and foreign (non-concessional) borrowing, aid includes official development assistance (ODA) that goes through the budget. Government expenditures consist of government capital and recurrent expenditures. An increase in aid could lead to an increase or decrease in government spending (related to aid fungibility and additionality); a reduction in borrowing, or a combination of both (Dom & Roger, 2020; Lloyd et al., 2009; Marć, 2017; Morrissey, 2015a). Additionally, an increase in aid may lead to an adjustment in domestic revenue (see Clist & Morrissey, 2011; Gnangnon & Brun, 2018; Morrissey, 2015b). The precise direction of aid’s effects can be determined empirically, through a reduced form equation such as:

\[
\expit_{it} = \alpha_i + \beta_{1i} \text{aid}_{it} + \beta_{2i} \text{tax}_{it} + u_{it}
\]

where \(\expit_{it}\), \(\text{aid}_{it}\) and \(\text{tax}_{it}\) are, respectively, total government spending, net ODA and non-resource tax revenue – all as percentages of GDP. The vector of \(\beta_i\) coefficients in Eq. (2a) differ by country, and they represent the cross-country average effects of aid and taxes on spending, respectively. From Eq. (2a), we can explicitly test the hypotheses of aid leading to an increase or a reduction in spending, as well as the impact of tax revenue on spending. \(\beta_{1i}\) is the coefficient of primary theoretical interest in this paper: it depicts the cross-country average effect of aid, from which one can obtain the marginal impact of an extra dollar of aid, hence the extent of fungibility/additionality of aid on spending. \(\beta_{1i} = 1\) shows that government spending increases one-to-one with aid: an implausible scenario across developing countries. \(\beta_{1i} > 1\) shows that aid crowds in government spending and spending increases by more than the amount of aid (Pettersson, 2007). \(0 < \beta_{1i} < 1\) shows that aid is partially fungible and \(\beta_{1i} = 0\) depicts full fungibility of aid (a complete absence of additionality, also very implausible).4

Aid-to-GDP and aid-to-spending ratios are still high in developing countries, such that aid should have direct financing and indirect impacts on government spending: the former through its impact on the level and composition of government spending (Morrissey, 2015a) and the latter through donors’ policy conditionality (Williams, 1994). While a positive relationship between aid and spending is to be expected, there might be a negative relationship due to reverse causality (more aid going to

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2 We abstract from seigniorage in this analysis. While printing more money generates finance for domestic expenditures, some countries in the sample (for example, CFA Franc countries) have their exchange rates pegged to more developed countries, making them unable to print more money at will.

3 While there are substantial sources of domestic, foreign and total debt (also in net present value) for low-income countries, we omit borrowing from the analysis primarily due to data limitations for the pre-1990 period with most data available only from the 1990s and later. This makes borrowing unsuitable for the type of panel time-series estimation pursued in this paper.

4 Equation (2a) can be made to include dynamics (the inclusion of a lagged dependent variable, as well as lags of other explanatory variables) and common factor structures (created by common shocks which cause cross-section dependence), with implications for empirical estimation and inference.
countries with lower spending) and donor conditionality (retrenchment of the public sector as a prerequisite for increased aid). Taxes also impact directly on spending through changes in the tax base and tax rates (Lloyd et al., 2009).

Introducing dynamics (through a lagged dependent variable) into Eq. (2a) allows for inertia in government spending and feedback between variables in equilibrium with past fiscal imbalances (spending shortfalls) potentially determining the amount of aid recipient countries receive and the amount of tax revenue they raise. Including a lagged dependent variable, the reduced form equation becomes:

$$\exp(it) = \alpha_i + \rho_i \exp(it-1) + \beta_{1i} \text{aid}_it + \beta_{2i} \text{tax}_it + u_{it}$$  \hspace{1cm} (2b)$$

where $\rho_i$ is the country-specific coefficient on the lagged dependent variable. Including the lagged dependent variable changes how the marginal effects are estimated; the long-run marginal impact of aid on spending is now $\beta_{1i} / (1 - \rho_i)$, while $\beta_{1i}$ is the short-run effect (see Sect. 4).

The literature on fungibility and aid additionality is linked to the literature on aid and tax effort. If the marginal effect of aid on spending is small, it may indicate a high level of fungibility in the recipient country. Alternatively, it may also indicate that the impact of aid on spending is subsumed by the impact of aid on taxes. Aid, like other non-tax revenues, may dampen tax performance and collection capacity. The empirical literature is huge and conflicting, with no consensus view on the direction of effects (see Gnangnon & Brun, 2018 for a review). Some studies posit a crowding-out effect of aid (particularly grants) on taxation, while loans increase taxes (Benedek et al., 2012; Gupta et al., 2004). Relatively recent studies show these findings to be tenuous. Clist and Morrissey (2011) find a positive relationship between aid and taxation from the 1980s (perhaps reflecting the importance of donor conditionality). Carter (2013) applies panel time series and group fixed effects methods and find no robust evidence on the impact of aid on taxes. Furthermore, the amount of aid would realistically have no impact on tax since it is the nature of donor-recipient relationships, donor conditionality and technical assistance linked to tax reform that influence taxation (Morrissey & Torrance, 2015; Morrissey, 2015b).  

2.2 Political calculus

There is a political calculus between aid and tax as the major sources of finance for government spending. Domestic revenue is typically low in developing countries, reason why they receive aid. Given the narrow tax bases in these countries—influenced by economic, political, institutional and social factors—revenue mobilisation is as high as economically feasible but not enough to generate political gains. Aid plays a crucial role in assuaging these revenue constraints but that comes with a

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5 Aid is also expected to influence domestic borrowing when donor conditionality is fully applied (McGillivray & Morrissey, 2004; Osei et al., 2005). This can be achieved by increasing the capacity to service debt, thus, increasing borrowing. It can also be achieved by being substituted for borrowing in situations whereby dips in aid result in increased borrowing as governments seek alternative sources of finance for statutory expenditures (Dom & Roger, 2020).
cost: as aid provides revenue, recipient governments are less inclined to expend limited political and administrative effort on tax collection. This is plausible because increasing taxes is unpopular, and recipients may see aid as a politically less costly source of revenue to cover government spending, reducing the urgency of tax collection. However, there are attendant political costs associated with aid such as increased dependency, costs of accountability (donors account to their parliaments, while recipient governments account to their constituencies, and donors), as well as bureaucratic costs of administration. We posit that the choice between aid and tax—as the main driver of total government expenditure—depends on the respective political costs, and how they offset each other (Morrissey & Torrance, 2015; Morrissey, 2015b). The costs are evaluated according to accountability and bureaucratic costs, and these costs influence the marginal effects of aid and taxes on spending.

The costs of accountability refer to whom recipient governments have to account for their use of revenue, and the extent to which said governments have to account for the use of revenue (Morrissey, 2015b). Recipient countries have to account to their constituencies on how they spend generated tax revenue although accountability to domestic constituencies (and taxpayers) is weak in low-income countries, influenced by the institutional framework underpinning tax collection, as well as the broader institutional framework. Donors have to account to their governments and parliaments on how their aid is used so they implement strong monitoring mechanisms to minimise fungibility of their aid (Renzio, 2016). Furthermore, recipients must negotiate conditionality with donors and even in cases where the donors’ conditions are not fully met, considerable effort is expended in avoiding compliance.

Bureaucratic (administrative) costs of tax and aid also exist. The bureaucratic costs of tax refer to the costs of tax administration: with fiscal reform implemented in many developing countries over the years, the efficiency of tax mobilisation has increased, and the bureaucratic costs have reduced (Fossat & Bua, 2013; Moore, 2014). The bureaucratic costs of aid are a function of the number of donors: they refer to the costs of organising and attending meetings with different donor agencies. The bureaucratic costs of aid are likely to be high, exacerbated by donor proliferation, disbursement heterogeneity and the changing requirements on monitoring aid.

To measure accountability to domestic taxpayers, we use the vertical accountability index. The index measures the extent to which citizens—through formal political participation—hold their governments accountable and focuses on the relationship between citizens and their elected representatives (Lührmann et al., 2020). The variable ranges from −5 to 5, with higher values reflecting more accountability from the government to its citizens and vice versa. Data on the vertical accountability index is obtained from the Varieties of Democracy (V-Dem) database, covering the period 1980–2013. The data are averaged over the entire period, the median

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6 Dom (2018) uses a sample of 49 Sub-Saharan African (SSA) countries and shows that the links between accountability and taxation can be made only for vertical accountability, not for horizontal, diagonal or overall accountability.

7 The level of accountability to domestic taxpayers is low in low-income countries with weak political and tax systems (those that are major recipients of aid and have comparatively lower tax revenues), making the accountability costs of aid higher than the accountability costs of tax in these countries.
of which is used to distinguish between high vertical accountability and low vertical accountability countries. Countries with the vertical accountability index higher than the median are classified as those with high accountability costs of raising taxes and vice versa. This produces 25/40 high/low vertical accountability countries.\footnote{Belize and Dominica have no data on the vertical accountability index, reducing the sample to 65 countries.} We posit that for countries with high vertical accountability (thus, high costs), there is an insignificant relationship between aid and spending ratios, while for those with low vertical accountability, there is a significant positive relationship between aid and spending ratios.

To measure donors’ accountability costs, we resort to the OECD DAC’s Paris Declaration Monitoring Survey (PDMS) in 2011. The PDMS provides indicators which measure donors’ advancement towards the Paris Declaration’s (PD hereafter) goals of using recipients’ Public Financial Management (PFM) systems for aid disbursement. Our proxy for accountability costs is based on donors’ use of recipient countries’ PFM systems as a percentage of government sector aid (Knack, 2013, 2014). The indicator is an average of three sub-indicators from the survey: use of budget execution, financial reporting and PFM auditing procedures, each as a percentage of government sector aid. We posit that for countries where donors provide some of their aid through recipients’ country PFM systems the costs will be lower as it would imply more trust from the donor to the recipient. We thus split the sample into 32 countries with high donors’ accountability costs (countries whose PFM systems are bypassed) and 35 countries with low donors’ accountability costs (countries that receive aid through their PFM systems, no matter how small). We expect a stronger relationship (in terms of the sign, significance and/or estimated coefficient) for countries with low donors’ accountability costs than for those with high donors’ accountability costs.

To measure the bureaucratic costs of taxation, we use the presence of an operational Semi-Autonomous Revenue Authority (SARAs hereafter) in the recipient county. There is evidence on the positive effects of SARAs although the benefits are short-lived (Ahlerup et al., 2015), heterogeneous in terms of the de jure and de facto levels of autonomy across countries (Dom, 2019), and heterogeneous in terms of domestic political and economic events (Sarr, 2016). In principle, the effectiveness of SARAs in improving revenue performance should enhance revenue efficiency, hence performance, and thus reduce the bureaucratic costs of taxation. We thus posit that for countries with SARAs the bureaucratic costs of tax will be lower and vice versa. This allows comprises 24 SARA countries (perceived low bureaucratic costs) and 43 non-SARA countries (perceived high bureaucratic costs).

To measure the bureaucratic costs of aid, we construct a variable intended to capture donor proliferation. The absence of coordination across donors has adverse short-term and long-term effects on recipient countries (Knack & Rahman, 2007). We follow the literature and construct an Herfindahl index of aid disbursement by taking the share of a specific donor’s aid over all aid finance in a specific year, squaring this share and summing over all donors for the period 1980 to 2013 (Annen...
The index ranges from 0 to 1, with lower values indicating recipient countries with more donors (hence higher fragmentation) and vice versa. The donor fragmentation index is then obtained as one minus the Herfindahl index, averaged over the entire period and using the median as cut-off. Countries above the median are classified as high fragmentation countries and vice versa, producing 26/41 high/low donor fragmentation countries. Hence, we expect a weaker relationship (per the matrices described above) for countries with high donor fragmentation than for those with low donor fragmentation.

2.3 Linking theory to econometrics

Three econometric concepts are crucial to how we model the impact of aid and tax ratios on spending ratios. First, time-series properties and dynamics in aid and domestic fiscal data. Spending, tax and aid-to-GDP ratios display considerable persistence over time (albeit with positive and/or negative trends), implying they are nonstationary in at least some countries. The nonstationary properties of aid are of particular importance since aid plays two potentially distinct, but not mutually exclusive fiscal roles. Firstly, aid may form part of recipients’ domestic budget planning processes, in which case it will be nonstationary and enter the long-run I(1) relationship. Secondly, it may be used to cover short-term expenditures related to maintenance of infrastructure and other running costs related to wages and equipment, thus relaxing the current budget constraint. In this case, it will enter the I(0) short-run relationship (Lloyd et al., 2009). This distinction corresponds to the econometric notions of long-run equilibrium and short-run dynamic adjustments.

Second, analysing the relationship between aid, taxes and spending as different across countries (cross-country heterogeneity). Two kinds of heterogeneity characterise the data: heterogeneity in elasticities (the ratios of aid, tax and spending differing across countries) and heterogeneity in marginal effects (linked to aid additionality). Heterogeneity in elasticities emanates from differences in structural characteristics across countries—such as the level of economic development and natural resource endowment—as well as differences in countries’ revenue mobilisation priorities, spending levels (and composition) and spending priorities. The spending levels and priorities are inextricably linked to the administrative and implementation capabilities of the countries, which themselves differ across countries (Centeno et al., 2017; Ricciuti et al., 2019b). The heterogeneity in marginal effects—itself linked to heterogeneity in elasticities—is driven by the political

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9 For the analysis, we use the tab ‘Official Donors, Total’ from Table 2a of the OECD’s Development Assistance Committee (DAC) data Tables. The official donors include 28 DAC bilateral donors, multilaterals, non-DAC donors and private donors (most of which started disbursing only by 2009).

10 A linear combination of the fiscal variables is stationary if spending, taxes and aid are co-integrated (Engle & Granger, 1987; Granger & Newbold, 1974). That is, there is a long run equilibrium relationship between aid, taxes and spending and permanent changes in aid and taxes are associated with permanent changes in spending. The absence of co-integrating variables suggests any linear combination between them is spurious (Granger & Newbold, 1974).
The dynamic effects of aid and taxes on government spending measured according to accountability and bureaucratic costs. Firstly, the extent to which citizens hold their governments accountable—in addition to the political institutions that place constraints on the power of the executive—varies considerably across countries, depending on a constellation of country-specific characteristics that relate to the governance and institutional framework in the country (Ricciuti et al., 2019a). Secondly, the number of donors operating in a recipient country differs by country, and the level of competition (or absence of coordination) between them is country-specific.

Third, concerns about cross-sectional dependence induced by common shocks. Ignoring these concerns distorts empirical inference. Such global shocks affect donors’ disbursement capacities, hence influencing the domestic revenue mobilisation and expenditure allocation patterns of recipient countries. Alternatively, the unobserved factors may be influenced by spill-over effects through economic, policy and social ties. For example, tax revenue data tends to display cross-section correlation since tax systems are shaped by entrenched factors (including colonial heritage) and tax competition across countries also induces cross-section correlation.

3 Data

Annual data on 67 developing countries covering the period 1980 to 2013 are used in the empirical analysis: comprising 26 low-income countries (LICs) and 41 other low-income countries (non-LICs). This produces a balanced panel with 2,278 recipient-year observations. All variables are expressed as a percentage of current GDP, then in logarithms. Data sources and summary statistics are presented in Tables A1 and A2 in the Supplementary Materials. Descriptive plots depicting the distribution and evolution of the main variables are found in Figs. A1, A2 and A3 in the Supplementary Materials. Country composition—for the political costs analysis—is in Sect. 3 of the Supplementary Materials.

The aid variable—net aid from all official donors, in current prices—is taken from Table 2a of the OECD Development Assistance Committee (DAC), version 2016. Net aid disbursements differ from gross aid disbursements because the former reports negative values when repayment of loans exceed new loans for the specific year. In this sample, there are 11 countries with at least one negative net ODA observation, with a total of 22 negative observations across the sample.

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11 The list of countries included in this paper can be found in Appendix A.
12 Other low-income countries are a mixture of lower middle-income and upper middle-income countries, as classified by the World Bank.
13 The correlation between net ODA and gross ODA disbursements, however, is very high at 0.92. The correlation between the net aid-to-GDP and gross ODA-to-GDP ratios is 0.95.
14 The countries include Chile (1980–1982, 1986, 2002), China (2011–2013), Costa Rica (1996–97, 1999, 2002), Dominican Republic (1993), Gabon (2003), Iran (1982), Jamaica (1999), Mexico (2000), Mauritius (2003), Panama (2007), Peru (2010) and Philippines (2011, 2012).
aid-to-GDP since the countries with negative values are middle-income countries, most of whom receive very little aid (the average aid/GDP ratio is less than 2 per cent in each of these countries). In addition, 11 negative observations in 2,278 total observations (1.2 per cent of the total sample) is negligible and would not influence the analysis.

Total government spending data are obtained from the *World Development Indicators* database. As total government spending is the sum of government consumption (recurrent) expenditure and domestic public investment (capital expenditure), we also collect data for these two expenditure headings. The three aggregates are expressed as percentages of GDP.

Data on non-resource tax revenues, all excluding grants and social contributions, are obtained from the UNU-WIDER Government Revenue Dataset (GRD), version 2016. Non-resource tax revenue excludes royalties and natural resource taxes (Morrissey et al., 2014). Total tax revenue comprises all direct and indirect tax revenues while total government revenue is a composite of all tax and non-tax revenues (for instance, central bank receipts). The GRD data are compiled by combining data from the major international databases, individual country IMF Article IV reports and national budgets, as well as private tax datasets (for example, Keen & Mansour, 2009). The data distinguish between resource and non-resource components of each tax type, with the non-resource components of particular interest in econometric research (Morrissey et al., 2014).

Annual time-series data are of importance when interest is in obtaining the average effects of aid and taxes on spending ratios. Using annual data, however, raises concerns about the distorting influence of business cycles on empirical inference (Eberhardt & Teal, 2013; Temple, 1999), such that analysis can be carried out with time-averaged data (Morrissey & Torrance, 2015; Seelkopf & Bastiaens, 2020). In this paper, we argue that adopting a common factor approach is suitable to deal with any business cycle effects, whether they represent spill-over effects (idiiosyncratic to a small number of countries) or global shocks with more profound, albeit heterogeneous impacts (Eberhardt & Teal, 2013; Kim & Lin, 2017).

### 4 Empirical strategy

#### 4.1 Cross-section dependence

It is important to investigate for cross-section dependence in the data. This can be done by taking a variable series for country $i$ (or residuals from an estimating equation for country $i$) and correlating it with the variable series (or residual) for the other $N-1$ countries. Doing that for all countries in the sample, we end up with $N(N-1)$ correlation coefficients from which we can obtain the average correlation and the average absolute correlation coefficients. Alternatively, these $N(N-1)$ correlation coefficients can be used to obtain a more formal test statistic (for example, the Pesaran CD statistic). The Pesaran (2015) CD test is based on the pairwise correlations of variable series or residuals, and the statistic is approximately normally distributed.
as $N$ and $T$ get sufficiently large (De Hoyos & Sarafidis, 2006). For a balanced panel, the statistic can be defined as:

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left( \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \right)$$

(3)

where $\hat{\rho}_{ij}$ is the average pairwise correlation of the variable series (or residuals) and under null of weak cross-section independence, CD is normally distributed for sufficiently large $T$ and $N \to \infty$.15

4.2 Panel unit roots testing

Guided by insights from the conceptual framework, we aim to investigate the time-series properties of the data. Consider a $p^{th}$-order augmented Dickey-Fuller (ADF) regression of the form:

$$\Delta y_{it} = \mu_i + \beta_i t + (\rho_i - 1)y_{i,t-1} + \sum_{j=1}^{p} \delta_{ij} \Delta y_{i,t-j} + u_{it}$$

(4)

where $y_{it}$ can be the logarithm of total government spending, net aid, and tax revenue, or regression residuals. $t$ is the country-specific linear time trend.16 The null hypothesis for the unit root tests is:

$$H_0 : \rho_i - 1 = 0, i = 1, \ldots, N$$

(5)

Against the alternative that:

$$H_1 : \rho_i - 1 < 0, i = 1, \ldots, N; \rho_i - 1 = 0, i = N_1 + 1, \ldots, N$$

(6)

where $N$ is the number of countries in the sample, $N_1 < N$ and $N_{1/N}$ is nonzero and fixed as $N \to \infty$ (Baltagi and Moscone 2010). In words, the null hypothesis is the variable series (or regression residuals) is nonstationary for all countries in the sample, with the alternative of stationarity in at least some countries. Rejection of the panel unit root hypothesis does not imply panel stationarity, but rather rejection of non-stationarity in all countries (Eberhardt & Teal, 2011). In practice, we will most likely be faced with a mixture of countries in terms of the time-series properties

15 De Hoyos and Sarafidis (2006) describe, theoretically and empirically, the most commonly used tests of cross-sectional dependence.

16 Both ‘first generation’ and ‘second generation’ panel unit root tests can be applied to test for variable and residual (non)stationarity. ‘First generation’ tests assume cross-section independence, and the tests were developed to increase power from pooling low-powered country-specific unit root tests (Eberhardt & Teal, 2011). Time series unit roots tests have low power against I(0) alternatives that are close to I(1) and the tests cannot easily distinguish highly persistent stationary series from nonstationary processes. ‘Second generation’ tests, on the other hand, assume that the variable series or residual has a single factor creating the cross-section dependence.
of their variable series; hence estimation methods that accommodate this mixture should be used.

The first-generation test often considered is the Im, Pesaran and Shin (IPS, 2003) test. ADF tests akin to Eq. (4) are run separately for each country in the sample, and the panel ADF test statistic obtained is an average of the $t$-statistics from the $N$ country ADF regressions. As the distribution of the average $t$-statistic is non-standard; the critical values must be simulated. The main drawback of the IPS test is it does not allow for the impact of unobserved common factors. Pesaran (2007) proposes a test for Eq. (4), referred to as the ‘CIPS’ test, which includes cross-section averages of the dependent and independent variables to account for cross-section dependence. Hence, Eq. (4) augmented with cross-section averages of the observables will be:

$$
\Delta y_{it} = \mu_i + \beta_i t + (\rho_i - 1)y_{it-1} + \sum_{j=1}^{p} \delta_{ij}\Delta y_{it-j} + \theta_{1i}^C\Delta y_{it} + \theta_{2i}^C\Delta y_{it-1} + \theta_{3i}^C\Delta y_{it-p} + u_{it}
$$

(7)

where in addition to the terms in Eq. (4), cross-section averages of the dependent and independent variables are included. The ‘CIPS’ test can deal with a single common factor which affects countries to varying degrees.

4.3 Linear dynamic model

To estimate the effects of aid and tax ratios on spending ratios in country $i$ at time $t$, we employ a common factor approach of the form:

$$
\expit_{it} = \beta_{1i}aid_{it} + \beta_{2i}tax_{it} + \epsilon_{it}
$$

where $\expit_{it}$ is the total government spending-to-GDP ratio, $aid_{it}$ is the net ODA-to-GDP ratio and $tax_{it}$ is the non-resource tax-to-GDP ratio—all in logarithms. The vector of slope coefficients $\beta_i$ differs across countries but is constant over time.\(^\text{17}\)

Equation (8) also includes country-specific intercepts ($\alpha_i$) and a set of unobserved common factors $\Gamma_t$ with country-specific loadings ($\gamma_i$) to account for the levels and evolution of unobservables, respectively.\(^\text{18}\)

Given the importance of time-series properties and dynamics of the data, we employ an unconditional error correction model (ECM) representation of Eq. (8)

\(^\text{17}\) Eberhardt and Teal (2011) argue that neglecting parameter heterogeneity in econometric analysis has more severe implications if observable variables (in our case, aid, taxes and spending) and unobservable (time variant and/or time-invariant) variables are nonstationary, resulting in the breakdown of the cointegrating relationship between aid, taxes and spending. As shown in our analysis, a dynamic representation is a more accurate representation of the model as the residuals from the cointegrating relationship are both stationary and cross-sectionally independent.

\(^\text{18}\) The common factors can be a combination of ‘strong’ factors (for example, the recent coronavirus pandemic or the relatively recent global financial crisis) and ‘weak’ factors (for example, the devaluation of the CFA franc in 1994 or the Arab Spring in 2011). The former represents shocks which affect all countries irrespective of their location and level of development while the latter represents local spill-over effects (typically affecting neighbouring countries or those bound by socio-cultural ties). The impacts of these shocks and countries’ abilities to respond differ considerably across countries.
with three distinctive features. First, it easily encapsulates the inertia displayed by taxation and aid and the statutory nature of government spending in developing countries, ensuring that long-run and short-run effects differ.19 Second, the error correction term \( \rho_i \) and the long-run coefficients (\( \beta_i \)) are useful in determining the direction of causality between variables (Lloyd et al., 2009). Third, we can investigate and test for cointegration based on the statistical significance of the error correction term in the ECM (Eberhardt & Presbitero, 2015). A negative and significant error correction coefficient represents cointegration, indicating that the economy returns to its long-run equilibrium following a deviation from equilibrium. The ECM representation is of the form:

\[
\Delta \text{exp}_t = \alpha_i + \rho_i \left[ \text{exp}_{t-1} - \beta_{i1} \text{aid}_{t-1} - \beta_{i2} \text{tax}_{t-1} - \gamma_i \Gamma_{t-1} \right] + \psi_{i1} \Delta \text{aid}_t + \psi_{i2} \Delta \text{tax}_t + \psi_{i3} \Delta \Gamma_t + \epsilon_t
\]

(9)

where the \( \beta_i \)'s represent the long-run relationship between spending, aid and taxes in the model (the potential cointegrating relationship we seek to identify) and \( \psi_i \)'s represent the short-run relations. \( \rho_i \) represents the speed of convergence of the economy to its long-run equilibrium. We include the unobservable common factors \( \Gamma_t \) in the long-run equation as we posit that they are nonstationary, hence forming part of the cointegrating relationship (Banerjee & Carrion-i-Silvestre, 2017).20

To estimate the ECM in Eq. (9), we employ the Common Correlated Effects Mean Group (CCEMG) estimator which uses (weighted) cross-section averages of the dependent and independent variables constructed to filter out the unobserved common factors \( \Gamma_t \) and omitted elements of the cointegrating relationship (Coakley et al., 2006; Eberhardt, 2012; Pesaran, 2006). Chudik and Pesaran (2015) extend the standard CCEMG approach to accommodate feedback from weakly exogenous regressors and find that the standard CCEMG is subject to small sample bias, especially in samples of moderate time series. To deal with the bias, Chudik and Pesaran (2015) suggest including lags of cross-section averages in addition to the cross-section averages already included in the standard CCEMG model. In our setup:

\[
\Delta \text{exp}_t = \pi_{0i} + \pi_{EC} \text{exp}_{t-1} + \pi_{aid} \text{aid}_{t-1} + \pi_{tax} \text{tax}_{t-1} + \psi_{aid} \Delta \text{aid}_t + \psi_{tax} \Delta \text{tax}_t + \pi_{CA} \text{exp}_{t-1} - \pi_{CA} \text{aid}_{t-1} - \pi_{CA} \text{tax}_{t-1} + \sum_l \pi_{7l} \text{exp}_{t-p} + \sum_l \pi_{8l} \text{aid}_{t-p} + \sum_l \pi_{9l} \text{tax}_{t-p}
\]

(10)

19 Aid disbursements normally follow commitments, albeit with an undefined time lag.
20 The unobservable common factors are not restricted to be stationary. For example, a global shock like the coronavirus pandemic will have more long-lasting effects on recipients’ abilities to raise taxes, hence influencing their spending decisions. The shock will also influence the amount of aid bilateral donors disburse because of the ensuing fiscal austerity in their respective countries, impinging on their decisions to disburse to multilateral organizations. This ‘uncertainty’ regarding how much tax and foreign aid can be raised to meet spending requirements after the financial crisis is what potentially makes the unobservable common factors non-stationary.
where the $\pi_s$ and $\Psi_s$ represent the long-run and short-run coefficients respectively, and the $\pi_{CA}$s represent the coefficients on the cross-section averages of the dependent and independent variables. The $\sum_{i=1}^{p} \pi_{CA}$, represent the coefficients on the additional lags of cross-section averages. As a rule of thumb, the lags of the cross-section averages to be added to the standard model are chosen by $p = \sqrt{T}$ (Chudik & Pesaran, 2015). Chudik and Pesaran (2015) show that once the CCEMG estimator has been augmented with the sufficient number of lags, the estimator is unbiased in the presence of dynamics and weakly exogenous regressors.

We estimate Eq. (10) by relaxing the common factor restriction between the parameters $\rho_i$ and $\beta_i$ implicit in Eq. (9) and reparametrizing the model following Eberhardt and Presbitero (2015). From the levels terms ($\pi_i^{aid}$ and $\pi_i^{tax}$), we can obtain the long-run coefficients, $\rho_i^{aid} = -\frac{\pi_i^{aid}}{\pi_i^{EC}}$ and $\rho_i^{tax} = -\frac{\pi_i^{tax}}{\pi_i^{EC}}$, whereas the regression coefficients on the terms in first differences capture the short-run (transitory) effects, and can be read off directly from estimation. Inference on $\pi_i^{EC}$ provides insights into the presence of a long-run (cointegrating) relationship between aid, taxes and spending. If $\pi_i^{EC} = 0$, then there is no cointegration, and the model reduces to one with variables in first differences. If $\pi_i^{EC} \neq 0$, then there is ‘error correction’ in the model following a shock the economy returns to its long-run equilibrium path, and therefore there exists a cointegrating relationship between aid, taxes and spending.

This makes finding cointegration between spending, taxes and aid very important as it would imply no potentially important nonstationary variables have been omitted (Herzer & Donaubauer, 2018; Herzer & Morrissey, 2013; Herzer & Nagel, 2019). Lütkepohl (2007) shows that the cointegration property is invariant to model extensions. This means if other sources of finance (domestic/foreign borrowing) are included in the model, it may result in further cointegration relations but the initial long-run relationship between aid, taxes and spending will still hold. This raises the possibility that there may be more than one cointegrating relationship, as there are other sources of finance that influence recipients’ spending. Nevertheless, Lloyd et al. (2009) state that there is no economic justification for more than one long-run equilibrium relationship between aid and domestic fiscal variables. Hence, in this paper, we treat the sole long-run relationship as a statistical analogue to the domestic budgetary equilibrium. Moreover, including other nonstationary variables into the system may result in spurious relations (Herzer & Nagel, 2019). Specifically, including a nonstationary variable that is not cointegrated with the other variables—such as trade openness, the share of agriculture value added in GDP and the inflation rate—will lead to non-stationarity in the error term, hence a breakdown of the cointegrating relationship because the coefficient on the recently included variable will not converge to zero as expected of irrelevant variables in a standard regression. These considerations justify a parsimonious model such as Eq. (9).21

21 Data limitations also guide our choice of model. Given the data dimensions (on average, 30 years of data per country) and the econometric methods intended in the paper (dynamic analysis through an ECM), including other covariates will create dimensionality issues.
4.4 Long-run causality

Aid is allocated in a non-random manner so there is interest in investigating if donors respond to recipients’ fiscal imbalances when disbursing aid, or if disbursement is independent of the fiscal situation in recipient countries. Given the level of spending that can be financed domestically, aid goes to countries with *ex ante* lower total government spending, resulting in reverse causality. Another type of reverse causality ensues when donors may be directly funding public goods in recipient countries that fail to provide them (Marć, 2017). Furthermore, structural characteristics determine low (high) tax collection (hence spending) and high (aid), creating simultaneity issues in estimation. Reverse causality can be handled by averaging the aid and fiscal variables over time (Marć, 2017). Nonetheless, averaging the data reduces the long-run information inherent in the data, the properties of which are very salient for this paper. Additionally, the reduction in spending (that which elicits an increase in aid flows) may be a result of latent factors which affect both donors and recipients such that increased aid to the recipients would be uncorrelated with their reduction in spending.

Furthermore, aid disbursement is fragmented, and most recipients receive aid from many donors, reducing the possibility of endogeneity. Figure 1 shows within-donor and within-recipient Herfindahl indices of fragmentation (as calculated in Sect. 2). The lower and upper ends of each box plot show the 25th and 75th percentiles, respectively, with the horizontal line indicating the median donor and median recipient. The trend over time shows more fragmentation in the way aid is disbursed, with more donors providing aid to many different recipients.

Additionally, there is considerable fragmentation in disbursements to recipients, most of whom receive aid from many donors. For very few recipients, there is a huge reliance on few donors. Since aid looks fragmented, endogeneity will mean that multiple donors’ aid budgets respond simultaneously—and to a large degree—to a recipient’s domestic conditions (Temple & Van de Sijpe, 2017). Aid budgets, however, are determined by medium to long-term political processes, it is unlikely that the amount of aid a donor disburses to each recipient country will be reflective of the economic conditions in the recipient countries (Temple & Van de Sijpe, 2017). While endogeneity concerns cannot be completely invalidated by the descriptive analysis above, the analysis shows that there is at least much exogenous variation in aid disbursements across recipient countries.

In a (panel) time-series context, direction of causation and endogeneity can be dealt with differently. If the variables are nonstationary and cointegrated, then tests for weak exogeneity (i.e. the direction of long-run causality) are applicable (Canning & Pedroni, 2008). The tests are estimated in ECM form, controlling for the contemporaneous correlation between aid, taxes and spending while allowing for an agnostic, albeit long timeframe within which aid and taxes can influence spending. Furthermore, they incorporate cross-country heterogeneity and unobserved common

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22 The power of the weak exogeneity tests lies in their ability to fully explore the temporal dimension of the data.
factors which may otherwise plague findings using standard micro-econometric methods.

When weak exogeneity tests are applied to domestic fiscal variables, the tests indicate which of the fiscal variables adjust considering fiscal disequilibria (deficit/surplus) to restore equilibrium. When such tests are applied to the level of aid, they offer insights into the disbursement behaviour of donors. If donors respond to domestic fiscal imbalances when allocating aid, this will imply aid is endogenously determined. If on the other hand, donors do not respond to fiscal imbalances in their allocation decisions, but aid influences other aggregates in the system, aid is said to be weakly exogenous or ‘long-run forcing’ (Lloyd et al., 2009).

Provided there exists a cointegrated relationship between the aid, tax and spending ratios, the Granger Representation Theorem (Engle & Granger, 1987) states that at least one variable must adjust to maintain an equilibrium relation, and the variables can be represented in the form of a dynamic ECM. For a pair of cointegrated variables, we can then test for weak exogeneity in the following ECMs:

\[ \Delta \text{exp}_{it} = \rho_{1i} + \theta_{1i}\hat{e}_{it-1} + \sum_{j=1}^{K} \lambda_{11ij}\Delta \text{exp}_{it-j} + \sum_{j=1}^{K} \lambda_{12ij}\Delta \text{aid}_{it-j} + \sum_{j=1}^{K} \lambda_{13ij}\Delta \text{tax}_{it-j} + \epsilon_{it}^{\text{exp}} \]  

(11)

\[ \Delta \text{tax}_{it} = \rho_{2i} + \theta_{2i}\hat{e}_{it-1} + \sum_{j=1}^{K} \lambda_{21ij}\Delta \text{tax}_{it-j} + \sum_{j=1}^{K} \lambda_{22ij}\Delta \text{aid}_{it-j} + \sum_{j=1}^{K} \lambda_{23ij}\Delta \text{exp}_{it-j} + \epsilon_{it}^{\text{tax}} \]  

(12)

\[ \Delta \text{aid}_{it} = \rho_{3i} + \theta_{3i}\hat{e}_{it-1} + \sum_{j=1}^{K} \lambda_{31ij}\Delta \text{aid}_{it-j} + \sum_{j=1}^{K} \lambda_{32ij}\Delta \text{tax}_{it-j} + \sum_{j=1}^{K} \lambda_{33ij}\Delta \text{exp}_{it-j} + \epsilon_{it}^{\text{aid}} \]  

(13)

where \( \hat{e}_{it-1} \) is the disequilibrium term \( \hat{e} = y - \hat{\beta}x - \hat{d} \) constructed using the cointegrating relationship between the variables (\( d \) represents deterministic terms obtained after estimating Eqs. (11, 12 and 13)).\(^{23}\) The disequilibrium term represents how far the variables are from the equilibrium relationship, with the error correction mechanism indicating the speed of adjustment following a deviation from the long-run equilibrium (Canning & Pedroni, 2008). The Granger representation theorem implies that at least one of the adjustment coefficients \( \theta_{1i}, \theta_{2i}, \theta_{3i} \) must be nonzero if a cointegrating (equilibrium) relationship between the variables is to hold (Canning & Pedroni, 2008, p. 512). If \( \theta_{1i} \neq 0 \) then \( \text{aid}_{it} \) and \( \text{tax}_{it} \) have a long-run causal impact on \( \text{exp}_{it} \), if \( \theta_{2i} \neq 0 \) then \( \text{exp}_{it} \) and \( \text{aid}_{it} \) have a long-run causal impact on \( \text{tax}_{it} \) and if \( \theta_{3i} \neq 0 \) then \( \text{exp}_{it} \) and \( \text{tax}_{it} \) have a long-run causal impact on \( \text{aid}_{it} \). If \( \theta_{1i}, \theta_{2i} \) and \( \theta_{3i} \) are nonzero, then \( \text{aid}_{it}, \text{tax}_{it} \) and \( \text{exp}_{it} \) determine each other jointly.

The ECM regressions are estimated for each country and empirical estimates of \( \theta_i \) are investigated using standard \( t \)-ratios, given that all the variables in the ECM

\(^{23}\) Equations (11-13) also include cross-section averages of the non-error terms in the weak exogeneity regressions to control for common factors. Additionally, each variable may react to its lagged differences, as well as lagged differences of other variables in the co-integrating relationship.
The dynamic effects of aid and taxes on government spending regressions (11), (12) and (13) are stationary (Canning & Pedroni, 2008; Eberhardt & Teal, 2013). Following Canning and Pedroni (2008), we present the group-mean statistic (GM hereafter) which averages the $\theta_i$ from individual country estimations of Eqs. (11–13), and the test for the null of ‘no long-run causal impact’ is computed from the averaged $t$-ratio from country regressions ($t_{\theta_2} = N^{-1} \sum_{i=1}^{N} t_{\theta_2}$). The GM statistic follows a standard normal distribution under the null hypothesis of ‘no causal impact’, that is, $\theta_i = 0$. The test is a two-tailed test so can take on positive or negative values under the null and alternative hypothesis depending on whether is positive or negative.

5 Empirical results

We investigate the cross-section correlation properties of the data using the Pesaran (2015) CD test. Results are provided in the appendix (Table A@1) and indicate that the variable series are subject to considerable cross-section dependence. We also carry out panel unit root tests following Pesaran (2007), results for which are also reported in the appendix (Table A@2). The results indicate all the variables are non-stationary (of order 1) in levels and stationary in first differences.

5.1 Heterogeneous baseline estimates

The long-run average coefficient is obtained by averaging ECM coefficients, then computing the long-run coefficient, with standard errors computed through the Delta method.\(^{24}\) As the variables in the analysis are all I(1) we can test for cointegration by

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\(^{24}\) The average long-run coefficient can be obtained by computing the long run coefficient in each country, then taking the average across the 67 countries. Standard errors can be constructed following Pesaran and Smith (1995). The average long-run coefficients are similar to the long run average coefficients, albeit the former being more sensitive to outliers.
investigating the statistical significance of the lagged dependent variable as shown in Table 1.\textsuperscript{25} The coefficient on the lagged dependent variable is negative, statistically significant and different from zero, indicating that the system reverts to its equilibrium path following a shock.

Additionally, the $t$-statistic\textsuperscript{26} is sufficiently greater than 10 in the model, providing evidence of a long-run cointegrating relationship between aid, taxes and spending ratios. The results indicate that on average, there is a long-run budgetary equilibrium between fiscal variables, and aid is an important determinant of that equilibrium with increases in the level of spending sustained by the levels of taxes and aid.

The long-run average coefficients on aid are positive and statistically significant, consistent with the literature on fiscal effects (Bwire et al., 2017; Marć, 2017; Mascagni & Timmis, 2017). A positive relationship between aid and spending is to be expected, as aid still represents an important source of revenue for most developing countries. In the long-run, a one-percentage-point increase in the aid-to-GDP ratio is associated with a 0.066 per cent increase in spending. This average effect is small, given the perceived importance of aid to developing countries, but provides insight into the general tendency in the panel that on average, there is a positive association between aid and spending ratios. The marginal impact of aid is 0.052, implying that an extra dollar of aid increases domestic spending only by 0.052 dollars, a very negligible impact.

As regards taxes, higher levels of tax revenue are also associated with higher levels of spending in the long run. A one-percentage-point increase in the tax-GDP ratio is associated with a 0.338 per cent increase in the government spending ratio in the long run. The coefficient on taxes is large (and larger than that of aid) indicating that on average, long-run spending plans are driven mainly by tax revenue (or domestic revenue in general). The marginal impact of tax is 0.27, implying an extra dollar of tax increases spending by 0.27 dollars, a considerably large magnitude. While developing countries still maintain high shares of aid their spending patterns are dictated mainly by their domestic sources of revenue, as expected. This is plausible as spending driven by tax revenue reduces the risk of fiscal vulnerability resulting from aid unpredictability.

Turning to the short-run coefficients; again, aid and taxes are positively associated with spending. The short-run coefficient on aid is smaller than the long-run average, but still positive and significant. In the short-run, a one-percentage-point increase in aid/GDP ratio is associated with a 0.03 (this is exactly the same as the short-run marginal impact of aid) per cent increase in spending.

While aid contributes to the long-run equilibrium, the short-run impact shows that it also has its benefits in recipient countries. Not only is aid a component of the long-run budgetary equilibrium, on average, but it may also be used to cover

\textsuperscript{25} We employ the robust regression (see Hamilton, 1992)—which weighs down outliers in computing the averages—in all estimations. Relevant diagnostics which inform the fit of the model—the RMSE and \textit{CD} test statistic—are reported at the bottom of the Table.

\textsuperscript{26} The $t$-ratios on the error correction terms are not $t$-distributed and their critical values are likely to be significantly higher than in standard analysis. Though the $t$-statistic on the lagged dependent variable does not follow a $t$ distribution, a high value of, say 10, is ‘solid’ evidence of cointegration.
for costs of maintaining infrastructure and wages/equipment in recipient countries. Regarding taxes, a one-percentage-point increase in the tax/GDP ratio is associated with a 0.219 per cent increase in spending ratios in the short run.

Overall, the results suggest that aid is useful in the long run and short run but spending patterns are driven mainly taxes. We posit that the choice between aid and taxes as the primary source of funding for domestic spending—hence the marginal effects of both—is heterogeneous across countries, and it relates to the political calculus between aid and tax. In micro-econometric analysis, the measures of political costs could be incorporated by using interaction terms—between aid and taxes and the proxies for political costs—to gauge changes in the primary relationship. That approach cannot be applied in macro panels given that the variables are integrated and cointegrated (Eberhardt, 2019). Hence, sample splits based on high/low comparisons are logical. We present only the average long-run effects and long-run marginal impacts from each cell (the full ECM results are available upon request).

Panel A Table 2 shows that the accountability costs of aid are higher than those of tax. For donors’ accountability costs, countries with high costs have no significant relationship between aid and spending ratios, while those with low donors’ accountability costs show a strong positive relationship between aid and spending ratios. Thus, the marginal effects of aid are higher for countries with low donor accountability costs. Taxes have a strong significant relationship with spending across both groups of countries, and the marginal impact of taxes is also high for both sets of countries. For recipients’ accountability costs, countries with higher

| Table 1 Linear dynamic estimates |
|----------------------------------|
| **Dependent variable: total government spending** |
| **Long-Run** |
| Tax/GDP | 0.338*** [0.097] |
| Aid/GDP | 0.066*** [0.033] |
| **Short-Run** |
| Tax/GDP | 0.219*** [0.068] |
| Aid/GDP | 0.030* [0.017] |
| **EC Coefficient** |
| $\gamma_{i,t-1}$ | $-0.786*** [0.052]$ |
| $t$-statistic | $-15.05$ |
| **Diagnostics** |
| RMSE | 0.080 |
| CD test (p-value) | 1.54 (0.124) |
| Observations (N) | 1884 (67) |

The results are based on an ECM for all 67 countries in the sample with the first difference of log (spending/GDP) as dependent variable. The long-run and short-run averages are reported, with standard errors reported below the averages. RMSE is the root-mean-square error. CD test is the Pesaran (2015) test distributed $N(0,1)$ under the null of weak cross-section independence (p-value in parentheses below). *, ** and *** indicate significance at 10%, 5% and 1% respectively.
vertical accountability show no significant relationship between aid and spending ratios, while those with lower vertical accountability show a positive significant relationship between aid and spending ratios. The balance of evidence suggests that the accountability costs of aid are higher than those of taxes: the marginal impact of an extra dollar of aid is larger in countries with lower accountability costs, indicating that increasing accountability costs of aid reduces the positive impact of aid on spending. The marginal impact of taxes is consistently larger than that of aid, suggesting that the political costs of raising taxes is lower.

The bureaucratic costs of aid are also higher than those of tax (panel B). For the donor fragmentation index, there is a significant aid-spending relationship for countries with low donor fragmentation, while those with high fragmentation show no
significant relationship. Taxes are more important for spending across both sets of countries. The results show that higher donor competition (hence fragmentation) dampens the positive effect of aid on spending, and taxes are more important for spending (see marginal effects). For countries with SARAs (hence low administrative costs of tax), there is a positive relationship between aid and spending ratios, while for those without SARAs, there is no significant relationship. The evidence, based on the above analysis, suggests that the political costs of aid are higher than those of taxation.

5.2 Disaggregated expenditures

We model the disaggregated spending impact of aid and we re-estimate Eq. (10) with capital expenditures and recurrent expenditures as dependent variable, respectively. Results for the disaggregated spending impact are reported in Table 3. Investigation of the lagged dependent variable indicates that aid, capital expenditures and taxes form a cointegrating relationship with physical capital projects in recipient countries sustained by aid and taxes. On average, aid has a positive long-run impact on capital expenditures. A one-percentage-point increase in the aid/GDP ratio is associated with a 0.086 per cent increase in capital spending ratios. The marginal effect is 0.064, indicating that an extra dollar of aid leads to a 0.064 dollar increase in spending. This magnitude is small and is influenced by the productivity of investment in the recipient country. The productivity of investment, itself, depends inter alia on the institutional setup of the country (Herzer & Morrissey, 2013) and the political costs between aid and tax.

Taxes have a larger coefficient (and marginal impact) than aid which, again, may suggest that public sector decision makers in recipient countries rely more on their domestic sources of revenue for financing their development projects. A one-percentage-point increase in taxes is associated with a 0.313 per cent increase in capital spending ratios. The marginal impact of taxes is 0.233, suggesting that an extra dollar of tax leads to a 0.233 dollar increase in government spending. The absence of evidence of a short-run impact for aid on capital spending is intuitive. As capital expenditures consist mainly of projects that mature in the medium to long term, the observable impact of aid is restricted to the long run only. Short-term capital expenditures are financed mainly via tax revenue (as shown by the magnitude and significance of taxes) and possibly domestic borrowing.

Further heterogeneity is explored in two ways (Tables xA3 and xA4 in the Supplementary Materials). First, by splitting the sample by level of economic development. There is a strong long-run and short-run impact of aid on spending in low-income countries but no impact (neither long run nor short run) in other developing countries. This demonstrates the importance of aid to the poorest countries. Taxes are still the main driver of spending across both sets of countries. Second, we re-estimate Eq. (10) with different measures of domestic revenue; first, total tax revenue and then with total government revenue. The former comprises revenue resource and non-resource components of taxation while the latter is a composite of tax and nontax revenues. The results are broadly similar to our primary findings using non-resource taxes.
Aid does not have an observable impact on recurrent spending while taxes influence recurrent spending in both the long run and short run. We do not overstate this finding as the proportion of aid intended for different spending headings is not always known (Morrissey, 2015a). Increasing social sector spending—such as on health, education and social protection—is an explicit intention of donors, and the costs of maintenance for these social sector investments are usually classified as recurrent expenditures. Hence, our findings should not be treated as evidence of no aid fungibility, but as absence of evidence of aid fungibility. The results differ from Osei et al. (2005), who find that aid appeared to be associated with higher recurrent spending but not capital spending in Ghana. This was not due to a financing impact of aid per se as policy conditions attached to aid were associated with higher tax revenue (which implied higher recurrent spending) and lower domestic borrowing (which implied lower capital spending).

Table 4a discusses the political calculus with respect to capital spending. The results are remarkably similar to those when total spending is the dependent variable (see Table 2): the accountability costs of aid are higher than those of tax, while the bureaucratic costs are fairly balanced between both. Table 4b discusses the results with respect to consumption spending. The results are starker, showing a clear distinction between high and low-cost countries. Even after incorporating measures for political costs of aid and tax, there is no significant relationship between aid and consumption spending across different specifications. The results here ascertain that the political costs of aid are indeed higher than those of taxes, reason why taxes are the main driver of spending.

5.3 Direction of long-run causality

We present results for weak exogeneity tests in Table 5, using specifications of Eqs. (11, 12 and 13) with two lags. The results are based on the dynamic CCEMG model augmented with two lags of cross-section averages (this is the long-run relationship from which the disequilibrium term is constructed). ‘In each row with ‘equation’, the specified variable is used as dependent variable in the ECM regression. We also report the panel robust estimate and its associated t-statistic: we expect a high t-statistic on the average coefficients in the expenditure equation (which can be interpreted as evidence of a long-run causal relationship from aid and taxes to spending) and a low t-statistic (absolute value below 1.96) in the other equations (Eberhardt & Presbitero, 2015).

The results have three salient characteristics. First, the direction of causality is from aid and tax ratios to the spending ratio, meaning spending is endogenous. In the fiscal response context, this implies that expenditures adjust to maintain fiscal equilibrium. This is plausible in situations when government spending is planned based on the expected revenue packet but spending allocation is affected when the revenue outcome is realised. This pattern is replicated when expenditures are disaggregated into capital and consumption expenditures (the last two rows of Table 5). Second, taxes are weakly exogenous. Tax systems are statutory and are not easily changed once parliamentary bills have been ratified. Faced with
The dynamic effects of aid and taxes on government spending

A deficit, recipients cannot just increase tax rates as such bills usually need to be agreed upon and ratified by congress and that is a time-consuming process. Additionally, the behaviour of tax administration and policy makers is persistent and change only slowly. Aid may also impact tax policy and administration such that tax rates do not increase but the collection efficiency of taxes increases. Nonetheless, improvements in efficiency also take time, meaning taxes would not immediately adjust to fiscal imbalance. Third, aid is weakly exogenous: the finding is intuitive since it provides insights into the disbursement behaviour of donors. Aid plays an important role in determining the budget, but its level does not reflect budget imbalance in recipient countries. Nonetheless, as shown in Table 1, aid influences other variables in the system (it is \textit{long-run forcing}). While fiscal planners in recipient countries have a planned target for aid revenue (as portrayed by the long-run relationship), they take the aid as given. Donors do not adjust the level of aid to recipients, but possibly adjust how the aid is delivered (that is, the modality of aid) according to certain recipients’ characteristics.

Ultimately, given the data dimensions and characteristics, and given the all the problems and caveats of individual country and panel exogeneity tests, we

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**Table 3  Heterogeneity in expenditures**

**Panel A: Baseline Estimates**

| Long-Run | Capital expenditure | Recurrent expenditure |
|----------|---------------------|-----------------------|
| Tax/GDP  | 0.313** [0.122]     | 0.445*** [0.131]     |
| Aid/GDP  | 0.086** [0.037]     | 0.034 [0.033]        |

| Short-Run | Capital expenditure | Recurrent expenditure |
|-----------|---------------------|-----------------------|
| Tax/GDP  | 0.268*** [0.081]    | 0.178*** [0.063]     |
| Aid/GDP  | 0.024 [0.024]       | 0.015 [0.006]        |

**EC Coefficient**

| $y_{t-1}$ | Capital expenditure | Recurrent expenditure |
|-----------|---------------------|-----------------------|
| $t$-statistic | $-0.744$*** [0.054] | $-0.622$*** [0.033] |

**Diagnostics**

| RMSE | Capital expenditure | Recurrent expenditure |
|------|---------------------|-----------------------|
| CD test (p-value) | $-0.27$ (0.790) | $-0.79$ (0.429) |
| Observations (N) | 1870 (67) | 1876 (67) |

**Panel B: Marginal impacts**

| Long-run taxes | 0.233*** | 0.277*** |
| Long-run aid   | 0.064**  | 0.021   |
| Short-run taxes| 0.268*** | 0.178*** |
| Short-run aid  | 0.024    | 0.015   |

‘Capital Expenditure’ and ‘Recurrent Expenditure’ refer to error correction models for all 67 countries with the first difference of log (capital expenditure/GDP) and log (recurrent expenditure/GDP) as dependent variables, respectively. For all other details, see Table 1.

Bolded numbers show statistical significance.
Table 4 Political costs analysis, (a) Capital spending, (b) Consumption spending

|                      | Donors       | Recipients  |
|----------------------|--------------|-------------|
|                      | High         | Low         | High         | Low         |
| **Panel A: Accountability Costs** |              |             |              |             |
| Donors’ accountability costs |              |             |              |             |
| Tax/GDP              | 0.009 [0.186] | 0.582*** [0.143] | 0.616*** [0.195] | 0.140 [0.160] |
| Marginal impact of tax | 0.006       | 0.454***     | 0.474***     | 0.101       |
| Aid/GDP              | 0.013 [0.050] | 0.150*** [0.054] | 0.196*** [0.068] | 0.142***     |
| Marginal impact of aid | 0.009       | 0.117***     |             |             |
| **Vertical accountability index** |              |             |              |             |
| Tax/GDP              |              |             | 0.303** [0.139] | 0.300 [0.245] |
| Marginal impact of tax |             | 0.251 [0.171] | 0.239**     | 0.208       |
| Aid/GDP              | 0.083 [0.051] | 0.137** [0.060] | 0.178** [0.092] | 0.123**     |
| Marginal impact of aid | 0.056       | 0.109***     |             |             |
| **Panel B: Bureaucratic Costs** |              |             |              |             |
| Donor fragmentation index |              |             |              |             |
| Tax/GDP              | 0.410** [0.183] | 0.251 [0.171] | 0.303** [0.139] | 0.300 [0.245] |
| Marginal impact of tax | 0.276**     | 0.199       | 0.239**     | 0.208       |
| Aid/GDP              | 0.083 [0.051] | 0.137** [0.060] | 0.178** [0.092] | 0.123**     |
| Marginal impact of aid | 0.056       | 0.109***     |             |             |
| **Revenue Authority** |              |             |              |             |
| Tax/GDP              |              |             | 0.303** [0.139] | 0.300 [0.245] |
| Marginal impact of tax |             | 0.251 [0.171] | 0.239**     | 0.208       |
| Aid/GDP              | 0.083 [0.051] | 0.137** [0.060] | 0.178** [0.092] | 0.123**     |
| Marginal impact of aid | 0.056       | 0.109***     |             |             |
| **Panel A: Accountability Costs** |              |             |              |             |
| Donors’ accountability costs |              |             |              |             |
| Tax/GDP              | 0.387* [0.236] | 0.444*** [0.151] | 0.789*** [0.037] | 0.199* [0.120] |
| Marginal impact of tax | 0.217*     | 0.302***    | 0.503***    | 0.125*    |
| Aid/GDP              | 0.021 [0.060] | 0.046 [0.039] | 0.026 [0.037] | 0.040 [0.053] |
| Marginal impact of aid | 0.012       | 0.031       | 0.017       | 0.025       |
| **Vertical accountability index** |              |             |              |             |
| Tax/GDP              | 0.824*** [0.253] | 0.261* [0.145] | 0.789*** [0.037] | 0.199* [0.120] |
| Marginal impact of tax | 0.532***   | 0.154*     | 0.503***    | 0.125*    |
| Aid/GDP              | 0.139 [0.085] | 0.012 [0.034] | 0.026 [0.037] | 0.040 [0.053] |
| Marginal impact of aid | 0.054       | 0.007       | 0.017       | 0.025       |
The dynamic effects of aid and taxes on government spending suggest most conservatively that long-run causation runs mainly from aid and taxes to spending; with aid (and its components) being weakly exogenous. There is no ‘donor disbursement rule’ in which recipients’ budgetary performance influences the level of aid received.

### 6 Conclusion

This paper investigated the relationship between aid, taxes and spending using heterogeneous panel time-series techniques and provides new insights for the literature on fiscal effects of aid. The paper makes three contributions to the literature.

First, we investigated the relationship between the variables by applying a dynamic model which fully explores the temporal dimension of aid and domestic

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**Table 4** (continued)

|          | Donors       | Recipients  |
|----------|--------------|-------------|
|          | High         | Low         | High         | Low         |
| Revenue Authority |             |             |             |             |
| Tax/GDP  | 0.214* [0.124] | 0.642*** [0.243] |
| Marginal impact of tax | 0.128* | 0.433*** |
| Aid/GDP  | 0.044 [0.038] | 0.012 [0.061] |
| Marginal impact of aid | 0.026 | 0.008 |

Panel A shows the means of the long-run tax/GDP and aid/GDP coefficients when countries are split by their level of accountability costs, while Panel B shows a split by bureaucratic costs. The marginal impacts are strictly for the long-run relationships, with each marginal impact estimated at the mean. The emboldened statistics show statistical significance. *, ** and *** indicate significance at 10%, 5% and 1%, respectively. Bolded numbers show statistical significance.

**Table 5** Weak exogeneity tests

|                          | GM          | (p) | Mean $\hat{\theta}_i$ | t-stat |
|--------------------------|-------------|-----|------------------------|--------|
| Expenditure equation     | −2.037      | 0.04| −0.795                 | −13.835|
| Tax equation             | −0.068      | 0.95| −0.043                 | −0.959 |
| Aid equation             | 0.136       | 0.89| 0.271                  | 1.457  |
| Capital expenditure equation | −1.938 | 0.05| −0.851                 | −14.220|
| Consumption expenditure equation | −2.043 | 0.04| −0.740                 | 15.529 |

GM represents the group-mean statistic which is the average of country-specific $t$-ratios on the disequilibrium term which is distributed $N(0,1)$. The test statistic if for the null of ‘no causal impact’ which in our case can be interpreted as the variable not adjusting to maintain fiscal equilibrium. $p$-values of less than 0.1 imply that the null of ‘no causal impact’ can be rejected. We also report the robust $\hat{\theta}_i$, estimate, and its associated $t$-statistic.
fiscal data. The empirical specification also allows for heterogeneity in the long-run and short-run across countries. We establish that the variables comprise a long-run equilibrium (cointegrated) relation. This finding is largely consistent with the broader FRM literature (Bwire et al., 2017; Osei et al., 2005). Marginal effects estimates show that on average, aid has a positive long-run and short-run impact on spending. These positive effects are quite small, indicating that increases in aid are positively associated with marginal increases in spending. The average coefficients on tax revenue are consistently than those on aid (Bwire et al., 2017; Clist & Morrissey, 2011 have similar findings), suggesting that taxes are the main driver of expenditures, and aid is a source of complementary finance in both the long-run and short-run.

Second, we incorporated an important channel through which aid influences spending: the political calculus between tax and aid. The budgetary choice between tax and aid as alternative sources of revenue depends on attendant political costs of aid and taxes; and the exploratory evidence in the literature suggests that the political costs of tax have been reducing over the years, making taxes a more logical choice for financing spending. We explore the political costs argument by incorporating proxy measures for the costs into the econometric analysis, shedding more light on cross-country heterogeneity. We find that the marginal effects of aid and taxes on spending ratios—that is, the productivity of both in increasing the level of government spending—are influenced by the political costs of aid and tax. High accountability costs dampen the positive effects of aid on taxes and spending. For bureaucratic costs, the presence of an operational SARA is beneficial although just the presence may not necessarily translate to higher tax collection. The costs of donor fragmentation, however, are pervasive: less donor coordination dampens any positive impact of aid on spending.

While the importance of the political calculus dimension has been demonstrated, the precise measures for political costs of aid and tax may be crucial. There are many proxy variables which can be used to contextualise accountability and bureaucratic costs. An interesting avenue for future research would be to explore these various and see how primary aid/tax-spending regressions change once the variables are incorporated. Future research could also focus entirely on African countries with pegged exchange rates, for example, francophone African countries and the euro. Such countries are typically constrained in their ability to use seigniorage as alternative financing mechanism for spending. Estimating the aid/tax-spending relationship in these countries—factoring in the political costs dimension—can be explored in future research.
Appendix

List of countries

Algeria, Angola, Argentina, Bangladesh, Belize, Benin, Botswana, Burkina Faso, Burundi, Central African Republic, Chad, Chile, China (People’s Republic of), Colombia, Comoros, Congo (Republic of), Congo (Democratic Republic of), Costa Rica, Cote d’Ivoire, Dominica, Dominican Republic, Ecuador, Egypt (Arab Republic of), El Salvador, Equatorial Guinea, Eswatini, Fiji, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Guatemala, Honduras, India, Indonesia, Iran, Jamaica, Jordan, Kenya, Lesotho, Madagascar, Malawi, Mauritania, Mauritius, Mexico, Morocco, Mozambique, Nepal, Niger, Nicaragua, Pakistan, Panama, Peru, Philippines, Rwanda, Senegal, Seychelles, Sri Lanka, Sudan, Togo, Turkey (Republic of), Uganda, Uruguay, Vanuatu, Venezuela, Zimbabwe.

See Tables 6, 7.

| Table 6 | Cross-section dependence |
|---------|--------------------------|
|         | Exp$_{it}$ | Aid$_{it}$ | Tax$_{it}$ | Cap$_{it}$ | Cons$_{it}$ |
| Variables in Levels | | | | | |
| avg $\hat{\rho}_{ij}$ | 0.032 | 0.309 | 0.094 | 0.063 | 0.034 |
| avg $|\hat{\rho}_{ij}|$ | 0.329 | 0.423 | 0.403 | 0.298 | 0.352 |
| CD | 8.26 | 78.50 | 24.16 | 15.91 | 8.69 |
| p-value | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Variables in First Differences | | | | | |
| avg $\hat{\rho}_{ij}$ | 0.008 | 0.044 | 0.005 | 0.024 | 0.042 |
| avg $|\hat{\rho}_{ij}|$ | 0.170 | 0.166 | 0.174 | 0.171 | 0.169 |
| CD | 1.95 | 11.33 | 1.13 | 5.96 | 10.24 |
| p-value | 0.05 | 0.00 | 0.26 | 0.00 | 0.00 |

We use the stata routine ‘xtcd’ developed by Markus Eberhardt. We report the average correlation (avg $\hat{\rho}_{ij}$) and average absolute correlation (avg $|\hat{\rho}_{ij}|$) coefficients of the $N(N-1)$ sets of correlations. CD is the Pesaran (2015) test for weak cross-section dependence distributed N(0, 1) under the null of cross-section independence. Panels A and B test for cross-section dependence in the variable series for levels and first differences, respectively. Government expenditure (Exp), Net ODA (Aid), Tax revenue (Tax), Capital spending (Cap), Consumption spending (Cons). All as shares of GDP, and in logs.
Table 7  Panel unit roots test

| Lags | Exp Zbar | Exp p | Aid Zbar | Aid p | Tax Zbar | Tax p | Cap Zbar | Cap p | Cons Zbar | Cons p |
|------|----------|-------|----------|-------|----------|-------|----------|-------|----------|-------|
| 0    | −5.76    | 0.00  | −7.22    | 0.00  | −3.66    | 0.00  | −7.63    | 0.00  | −6.40    | 0.00  |
| 1    | −5.13    | 0.00  | −3.40    | 0.00  | −2.53    | 0.00  | −5.88    | 0.00  | −5.55    | 0.00  |
| 2    | −1.73    | 0.04  | −0.67    | 0.25  | −0.31    | 0.38  | −3.72    | 0.00  | −2.97    | 0.00  |
| 3    | −0.41    | 0.34  | 0.07     | 0.53  | 1.23     | 0.89  | −3.51    | 0.00  | −1.82    | 0.04  |
| 4    | 1.66     | 0.95  | 0.93     | 0.82  | 0.88     | 0.81  | −0.42    | 0.34  | −2.14    | 0.02  |

*Levels: CIPS with intercept only*

| Lags | Exp Zbar | Exp p | Aid Zbar | Aid p | Tax Zbar | Tax p | Cap Zbar | Cap p | Cons Zbar | Cons p |
|------|----------|-------|----------|-------|----------|-------|----------|-------|----------|-------|
| 0    | −5.96    | 0.00  | −5.51    | 0.00  | −7.27    | 0.00  | −5.72    | 0.00  | −2.14    | 0.02  |
| 1    | −5.31    | 0.00  | −1.12    | 0.13  | −6.30    | 0.00  | −3.73    | 0.00  | −3.47    | 0.00  |
| 2    | −2.35    | 0.01  | 2.42     | 0.99  | −2.61    | 0.00  | −1.50    | 0.07  | −0.55    | 0.29  |
| 3    | 0.03     | 0.51  | 3.59     | 1.00  | −0.29    | 0.39  | −0.48    | 0.32  | 1.10     | 0.86  |
| 4    | 2.29     | 0.99  | 5.77     | 1.00  | 2.17     | 0.99  | 2.58     | 1.00  | 0.48     | 0.68  |

*Levels: CIPS with intercept & trend*

| Lags | Exp Zbar | Exp p | Aid Zbar | Aid p | Tax Zbar | Tax p | Cap Zbar | Cap p | Cons Zbar | Cons p |
|------|----------|-------|----------|-------|----------|-------|----------|-------|----------|-------|
| 0    | −34.16   | 0.00  | −34.70   | 0.00  | −30.71   | 0.00  | −24.33   | 0.00  | −30.76   | 0.00  |
| 1    | −24.51   | 0.00  | −22.54   | 0.00  | −22.21   | 0.00  | −24.33   | 0.00  | −19.77   | 0.00  |
| 2    | −14.78   | 0.00  | −12.86   | 0.00  | −14.33   | 0.00  | −14.38   | 0.00  | −12.40   | 0.00  |
| 3    | −9.45    | 0.00  | −7.28    | 0.00  | −8.09    | 0.00  | −8.85    | 0.00  | −8.24    | 0.00  |
| 4    | −5.91    | 0.00  | −3.63    | 0.00  | −2.83    | 0.00  | −5.51    | 0.00  | −5.27    | 0.00  |

*Differences: CIPS test with drift*

**Variables defined and measured as in Table 1. ‘Lags’ denote the number of lags of the differenced dependent variable included to wipe out serial correlation. $H_0$ = nonstationarity in all countries’ variable series; $H_1$ = stationarity in some countries’ variable series**

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References

Ahlerup, P., Baskaran, T., & Bigsten, A. (2015). Tax innovations and public revenues in Sub-Saharan Africa. Journal of Development Studies, 51(6), 689–706.

Annen, K., & Moers, L. (2017). Donor competition for aid impact, and aid fragmentation. The World Bank Economic Review, 31(3), 708–729.

Aworinde, B., & Onakoya, A. (2016). Foreign aid and government expansion: Evidence from low and middle income countries. The Journal of Developing Areas, 50(3), 21–33.

Banerjee, A., & Carrion-i-Silvestre, J. (2017). Testing for panel cointegration using common correlated effects estimators. Journal of Time Series Analysis, 38(4), 610–636.

Benedek, D., Crivelli, E., Gupta, S., Muthoora, P. (2012) Foreign aid and revenue: Still a crowding out effect? IMF Working Paper WP/12/86, Washington DC: International Monetary Fund

Bwire, T., Lloyd, T., & Morrissey, O. (2017). Fiscal reforms and the fiscal effects of aid in Uganda. Journal of Development Studies, 53(7), 1019–1036.

Canning, P., & Pedroni, P. (2008). Infrastructure, long-run economic growth and causality tests for cointegrated panels. The Manchester School, 76(5), 504–527.

Carter, P. (2013). Does foreign aid displace domestic taxation? Journal of Globalization and Development, 4(1), 1–47.

Centeno, M., Kohli, A., Yashar, D. J., & Mistree, D. (2017). States in the developing world. Cambridge University Press.

Chudik, A., & Pesaran, M. H. (2015). Common correlated effects estimation of heterogeneous dynamic panel models with weakly exogenous regressors. J Econom, 188(2), 393–420.

Clist, P., & Morrissey, O. (2011). Aid and tax revenue: Signs of a positive effect since the 1980s. Journal of International Development, 23(2), 165–180.

Coakley, J., Fuertes, A. M., & Smith, R. (2006). Unobserved heterogeneity in panel time series models. Computational Statistics & Data Analysis, 50(9), 2361–2380.

De Hoyos, R. E., & Sarafidis, V. (2006). Testing for cross-sectional dependence in panel-data models. The Stata Journal, 6(4), 482–496.

Djankov, S., Montalvo, J. G., & Reynal-Querol, M. (2009). Aid with multiple personalities. Journal of Comparative Economics, 37(2), 217–229.

Dom, R. (2019). Semi-autonomous revenue authorities in Sub-Saharan Africa: Silver bullet or white elephant. Journal of Development Studies, 55(7), 1418–1435.

Dom, R., & Roger, L. (2020). Debt or alive: Burundi’s fiscal response to economic sanctions. International Studies Quarterly, 64(2), 369–379.

Eberhardt, M. (2012). Estimating panel time-series models with heterogeneous slopes. Symposium (international) on Combustion, 12(1), 61–71.

Eberhardt, M. (2019). Nonlinearities in the relationship between debt and growth: (no) evidence from over two centuries. Macro Dyn, 23(4), 1563–1585.
Eberhardt, M., & Presbitero, A. (2015). Public debt and growth: Heterogeneity and non-linearity. Journal of International Economics, 97(1), 45–58.

Eberhardt, M., & Teal, F. (2011). Econometrics for grumblers: A new look at the literature on cross-country growth empirics. Journal of Economic Surveys, 25(1), 109–155.

Eberhardt, M., & Teal, F. (2013). No mangoes in the tundra: Spatial heterogeneity in agricultural productivity analysis. Oxford Bulletin of Economics and Statistics, 75(6), 914–939.

Eberhardt, M., & Teal, F. (2020). The magnitude of the task ahead: Macro implications of heterogeneous technology. Review of Income and Wealth, 66(2), 334–360.

Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: Representation, estimation and testing. Econometrica, 55(2), 251–276.

Fossat, P., Bua, M. (2013) Tax administration reform in francophone countries of Sub-Saharan Africa. IMF Working Paper WP/13/173, Washington DC: International Monetary Fund

Gnangnon, S. K., & Brun, J. F. (2018). Is the impact of development aid on government revenue sustainable? An empirical assessment. The Quarterly Review of Economics and Finance, 67, 311–325.

Gomaneke, K., Morrissey, O., Mosley, P., & Verschoor, A. (2005). Aid, government expenditure and aggregate welfare. World Development, 33(3), 355–370.

Granger, C. W., & Newbold, P. (1974). Spurious regressions in econometrics. Journal of Econometrics, 2(2), 111–120.

Gupta, S., Clemens, B., Pivovarsky, A., & Tiongson, E. (2004). Foreign Aid and revenue response: does the composition of aid matter? Helping countries develop: the role of fiscal capacity (pp. 385–406). Washington: International Monetary Fund.

Hamilton, L. C. (1992). How robust is robust regression? Stata Technical Bulletin, 1(2).

Herzer, D., & Donaubauer, J. (2018). The long-run effect of foreign direct investment on total factor productivity in developing countries: A panel cointegration analysis. Empirical Economics, 54(2), 309–342.

Herzer, D., & Morrissey, O. (2013). Foreign aid and domestic output in the long run. Review of World Economics, 149(4), 723–748.

Herzer, D., & Nagel, K. (2019). The impact of adult and non-adult mortality on development: Two centuries evidence from a panel of industrial countries. Journal of Policy Modelling, 41(2), 352–371.

Kaya, I., & Kaya, O. (2020). Foreign aid, institutional quality and government fiscal behavior in emerging economies: An empirical investigation. The Quarterly Review of Economics and Finance, 76, 59–67.

Keen, M., Mansour, M. (2009) Revenue mobilization in sub-saharan africa: challenges from globalizatization. IMF Working Paper WP/09/157, Washington DC: International Monetary Fund

Kim, D. H., & Lin, S. C. (2017). Natural resources and economic development. Environmental and Resource Economics, 66(2), 363–391.

Knack, S. (2013). Aid and donor trust in recipient country systems. Journal of Development Economics, 101, 316–329.

Knack, S. (2014). Building or bypassing recipient country systems: are donors defying the paris declaration. Journal of Development Studies, 50(6), 839–854.

Knack, S., & Rahman, A. (2007). Donor fragmentation and bureaucratic quality in aid recipients. Journal of Development Economics, 83(1), 176–197.

Lloyd, T., McGillivray, M., Morrissey, O., Opoku-Afari, M. (2009) The fiscal effects of aid in developing countries: a comparative dynamic analysis. In: Development Aid: A Fresh Look. Palgrave Macmillan:158–179

Lu, C., Schneider, M. T., Gubbins, P., Leach-Kennon, K., Jamison, D., & Murray, C. J. (2010). Public financing of health in developing countries: A cross-national systematic analysis. Lancet, 375(9723), 1375–1387.

Lührmann, A., Marquardt, K. L., & Mechkova, V. (2020). Constraining governments: new indices on vertical, horizontal and diagonal accountability. American Political Science Review, 114(3), 811–820.

Marć, L. (2017). The impact of aid on total government. Review of Development Economics, 21(3), 627–663.

Martins, P. M. (2011). Aid absorption and spending in Africa: A panel cointegration approach. Journal of Development Studies, 47(12), 1925–1953.
Mascagni, G., & Timmis, E. (2017). The fiscal effects of aid in Ethiopia: evidence from CVAR applications. *Journal of Development Studies*, 53(7), 1037–1056.

McGillivray, M., & Morrissey, O. (2004). Fiscal Effects of aid. In T. Addison & A. Roe (Eds.), *Fiscal Policy for development: poverty, reconstruction and growth*. Basingstoke: Palgrave Macmillan, London.

Moore, M. (2014). Revenue reform and statebuilding in Anglophone Africa. *World Development*, 60, 99–112.

Morrissey, O., Isopi, A., Clist, P. (2011) Aid and government spending: Report A to agence francaise de developpement (Paris)

Morrissey, O., Prichard, W., Torrance, S. (2014) Aid and taxation: exploring the relationship with new data. Working paper 21. London: International Centre for Tax and Development

Morrissey, O. (2015a). Aid and government fiscal behavior: assessing recent evidence. *World Development*, 69, 98–105.

Morrissey, O. (2015b). Aid and domestic resource mobilization with a focus on Sub-Saharan Africa. *Oxford Review Economy Policy*, 31(3–4), 447–461.

Morrissey, O., & Torrance, S. (2015). Aid and taxation. *Handbook of foreign aid* (pp. 555–576). Cantwell: Edward Elgar.

Osei, R., Morrissey, O., & Lloyd, T. (2005). The fiscal effects of aid in Ghana. *Journal of International Development*, 17(8), 1037–1053.

Pesaran, M. H. (2006). Estimation and inference in large heterogeneous panels with a multifactor error structure. *Econometrica*, 74(4), 967–1012.

Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, 22(2), 261–312.

Pesaran, M. H. (2015). Testing weak cross-sectional dependence in large panels. *Econometric Reviews*, 34(6–10), 1089–1117.

Pesaran, M. H., & Smith, R. P. (1995). Estimating long-run relationships from dynamic heterogeneous panels. *Journal of Economics*, 68(1), 79–113.

Pettersson, J. (2007). Foreign sectoral aid fungibility, growth and poverty reduction. *Journal of International Development*, 19(8), 1074–1098.

Remmer, K. L. (2004). Does Foreign aid promote the expansion? *Am J Pol Sci*, 48(1), 77–92.

De Renzio, P. (2016) Accountability dilemmas in foreign aid. Published online

Ricciuti, R., Savoia, A., & Sen, K. (2019a). How do political institutions affect fiscal capacity? explaining taxation in developing economies. *J Institutional Econ*, 15(2), 351–380.

Ricciuti, R., Savoia, A., & Sen, K. (2019b). What determines administrative capacity in developing countries? *International Tax and Public Finance*, 26(5), 972–998.

Sarr, B. (2016). Assessing revenue authority performance in developing countries: A synthetic control approach. *International Journal of Public Administration*, 39(2), 146–156.

Seelkopf, L., & Bastaens, I. (2020). Achieving sustainable development goal 17? An empirical investigation of the effectiveness of aid given to boost developing countries’ tax revenue and capacity. *International Studies Quarterly*, 64(4), 991–1004.

Temple, J. (1999). The new growth evidence. *J Econ Lit*, 37(1), 112–156.

Temple, J., & Van de Sijpe, N. (2017). Foreign aid and domestic absorption. *Journal of International Economics*, 108, 431–443.

Van de Sijpe, N. (2013). Is foreign aid fungible? Evidence from the education and health sectors. *The World Bank Economic Review*, 27(2), 320–356.

Williams, G. (1994). Why structural adjustment is necessary and why it doesn’t work. *Review of African Political Economy*, 21(60), 214–225.

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