Tax revenue instability and tax revenue in developed and developing countries

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Abstract

Purpose – This paper aims to explore the effect of non-resource tax revenue instability on non-resource tax revenue in developed and developing countries.

Design/methodology/approach – The analysis has used an unbalanced panel data set of 146 countries over the period 1981–2016, as well as the two-step system generalized methods of moment approach.

Findings – The empirical analysis has suggested that non-resource tax revenue instability influences negatively non-resource tax revenue share of gross domestic product. The magnitude of this negative effect is higher in less developed countries than in relatively advanced countries. This negative effect materializes through public expenditure instability: non-resource tax revenue instability exerts a higher effect on non-resource tax revenue share as the degree of public expenditure instability increases. Finally, non-resource tax revenue instability exerts a higher negative effect on non-resource tax revenue share as economic growth volatility rises, inflation volatility increases and terms of trade instability increases.

Research limitations/implications – The main policy implication of this analysis is that policies that help ensure the stability of non-resource tax revenue also contribute to improving countries' non-resource tax revenue share. For example, governments' measures that help cope with or prevent the severe adverse effects of shocks on economies (shocks that could translate into higher tax revenue instability) would ultimately help enhance countries' tax revenue performance.

Practical implications – The severity of the current COVID-19 pandemic shock (which is a supply and demand shock) and the macroeconomic uncertainty that it has generated – inter alia, in terms of economic growth instability, terms of trade instability, inflation volatility and public expenditure instability – are likely to result in severe tax revenue losses. Governments in both developed and developing countries would surely learn from the management of this crisis so as to prepare for possible future economic, financial and health crises with a view to dampening their adverse macroeconomic effects, including here their negative tax revenue effects.

Originality/value – To the best of the author's knowledge, this topic is being addressed in the empirical literature for the first time.

Keywords Tax revenue, Tax revenue instability

Paper type Research paper

JEL classification – H1, H2

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1. Introduction

The instability of tax revenue has been a major concern for policymakers in both developed and developing countries as it can translate into a higher instability of public expenditure (Lim, 1983; Bleaney *et al.*, 1995; Ebeke and Ehrhart, 2012), greater instability of public investment and lower levels of public investment (Ebeke and Ehrhart, 2012), which all can hamper economic growth[1]. In turn, factors of economic growth play an essential role in determining the breadth of a country's tax base (Besley and Persson, 2014), and hence its public revenue performance, including tax revenue performance (also referred to as tax revenue share, measured by the share of tax revenue in gross domestic product [GDP]). At the same time, governments in both advanced and developing countries need to mobilize higher public revenue to finance their development needs. Much work [2] has been conducted on the determinants of countries' public revenue, in particular their tax revenue performance. However, to the best of our knowledge, little attention has been paid to the relationship between tax revenue instability and tax revenue performance. The relevance of this topic lies in the fact that through its adverse effect on public expenditure instability, tax revenue instability can influence the elements of the tax base, as those elements (consumption, investment, etc.) ultimately determine a country's tax revenue performance ("tax revenue performance" can also be referred to as "tax revenue share of GDP," or "tax revenue share"). The present study aims to fill this gap in the literature by investigating the effect of tax revenue instability on tax revenue performance.

We postulate that tax revenue instability would negatively affect tax revenue performance through the public expenditure instability channel. As noted above, Lim (1983); Bleaney *et al.* (1995); and Ebeke and Ehrhart (2012) have reported that tax revenue instability results in higher public expenditure instability. As the rise in public expenditure instability can be associated with lower economic growth (Afonso and Furceri, 2010; Bernanke, 1983; Brunetti, 1998; Gong and Zou, 2002; Pindyck and Solimano, 1993), we expect tax revenue instability to be associated with lower tax revenue performance. This is because economic growth is an essential ingredient for widening the tax net and the expansion of the tax base and thus, for greater tax revenue performance (Besley and Persson, 2014; Tosun and Abizadeh, 2007).

The analysis has been conducted on a sample of 146 countries over the period 1981–2016, using the two-step system generalized methods of moments (GMM). It has suggested that tax revenue instability leads to lower tax revenue share, and this negative effect is higher in less advanced countries than in relatively advanced economies. The analysis has been deepened by investigating whether the effect of tax revenue instability on tax revenue share depends on the prevailing economic conditions, measured by the volatility of economic growth rate, the inflation rate volatility and terms of trade instability. As these three factors are important sources of tax revenue instability (Lim, 1983; Bleaney *et al.*, 1995; Ebeke and Ehrhart, 2012; Brun and Gnangnon, 2019), we expect all of them to enhance the negative effect of tax revenue instability on tax revenue performance. The empirical analysis has supported this hypothesis, given that the negative effect of tax revenue instability on tax revenue performance is higher in countries with a higher economic growth volatility, greater inflation volatility and an increase in terms of trade instability.

The rest of the paper is organized as follows. Section 2 presents the model specification for the analysis, and Section 3 discusses the econometric method to estimate this model. Section 4 presents some data analysis, in particular for key variables under analysis. Section 5 interprets empirical outcomes, and Section 6 concludes.

2. Model specification

There is a voluminous literature on the determinants of tax revenue (Agbeyegbe *et al.*, 2006; Baunsgaard and Keen, 2010; Bird *et al.*, 2008; Brun *et al.*, 2015; Clist, 2016; Clist and Morrissey, 2011; Crivelli, 2016; Crivelli and Gupta, 2014; Ghura, 1998; Gnangnon and Brun, 2017, 2018, 2019; Khattry and Rao, 2002; Morrissey *et al.*, 2016; Yohou *et al.*, 2016). This literature has shown the existence of structural factors that influence countries' tax revenue performance. These include the real per capita income ("GDPC"), which measures countries' level of economic development; the inflation rate, whose transformation to reduce its skewness is denoted "INFL" (Appendix 1); countries' structure of output measured by the share of the value added in the agricultural sector in the total output (denoted "SHAGRI"); the level of trade openness, denoted "OPEN"; the degree of democratization, which acts as a proxy for the institutional quality (denoted "POLITY2"); the terms of trade, denoted "TERMS"; and the demographic characteristics of the country, proxied by the population size, denoted "POP."

In light of the foregoing, we postulate the following model:

$$\begin{aligned} Log(TAX)_{it} = {} & \alpha_1 \mathrm{Log}(\mathrm{TAX})_{it-1} + \alpha_2 \ \mathrm{Log}(\mathrm{TAXINST})_{it} + \alpha_3 \mathrm{Log}(\mathrm{GDPC})_{it} \\ & + \alpha_4 \ \mathrm{Log}(\mathrm{OPEN})_{it} + \alpha_5 \ \mathrm{Log}(\mathrm{SHAGRI})_{it} + \alpha_6 \mathrm{INFL}_{it} + \alpha_7 \mathrm{POLITY2}_{it} \\ & + \alpha_8 \mathrm{Log}(\mathrm{TERMS})_{it} + \alpha_9 \mathrm{Log}(\mathrm{POP})_{it} + \mu_i + \gamma_t + \omega_{it} \end{aligned} \tag{1}$$

i and t stand, respectively, for a country and the time period. The dependent variable "TAX" is the share of a country's total non-resource tax revenue in percentage of GDP, and the regressor of key interest, namely, "TAXINST" is the measure of total non-resource tax revenue instability. Non-resource tax revenue (% GDP) is calculated as the difference between total tax revenue excluding grants and social contributions (in % GDP) and the resource tax revenue (in % GDP), the latter being the tax revenue collected on natural resources. In fact, the reliance on non-resource tax revenue (% GDP) – rather than on total tax revenue (which includes resource tax revenue) – arises from the fact that resource tax revenue is not significantly affected by economic policies. Additionally, using non-resource tax revenue over a large set of countries helps achieve a greater homogeneity in terms of the revenue components across countries in the sample[3] (Brun *et al.*, 2015; Gnangnon and Brun, 2017, 2018).

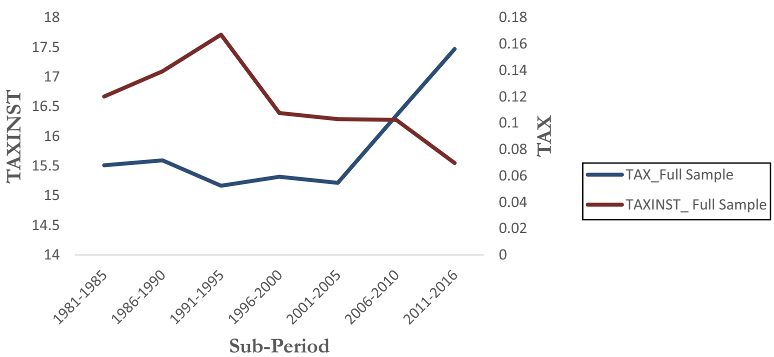
Based on data available, model (1) has been estimated using an unbalanced panel data set of 146 countries (including developed and developing countries) over the period 1981–2016. In light of the practice in the literature, we have used non-overlapping sub-periods of five-year data so as to limit the impact of business cycles on variables in model (1). Thus, the variable measuring tax revenue instability has been computed as the standard deviation of annual growth rate of non-resource tax revenue (% GDP) over non-overlapping sub-periods of five-year data. The sub-periods are: 1981–1985; 1986–1990; 1991–1995; 1996–2000; 2001–2005; 2006–2010; and 2011–2016. α_1–α_9 are parameters to be estimated. μ_i are countries' time invariant specific effects; γ_t are time dummies that act as global shocks that influence together all countries' tax revenue share. ω_{it} is a well-behaving error term. Note that the natural logarithm has been applied to all variables (except "POLITY2" – which contains negative values, but does not exhibit a high skewness) so as to reduce the skewness of variables such as "TAXINST," "GDPC," "OPEN" and "POP," but also to obtain coefficients in terms of elasticity.

By reflecting an improvement in the level of economic and institutional sophistication, the rise in the real per capita income can be positively associated with tax revenue

(Crivelli and Gupta, 2014). Nevertheless, it is possible that an increase in the real per capita income would be associated with lower tax revenue share of GDP. This could be explained by the fact that less developed countries make much more effort (in relation to their GDP) than relatively advanced economies in the mobilization of tax revenue. On another note, the majority of studies highlighted above have shown that an output structure featured by the rise in the share of value added in the agriculture sector in total output is negatively associated with the tax revenue-to-GDP ratio. This is because of the difficulties of countries to tax agricultural sector (Balh, 2003; Bird *et al.*, 2008), in particular for political reasons. The effect of trade openness on tax revenue is ambiguous, as it can be positive, including through the productivity channel (Edwards, 1998; Föllmi *et al.*, 2018; Melitz, 2003) or negative (Cagé and Gadenne, 2018; Khattry, 2003). Incidentally, an improvement in institutional quality is positively associated with tax revenue (Ghura, 1998; Bird *et al.*, 2008). A rise in the population size can be negatively associated with tax revenue because in countries with faster growing populations, the tax system may lag behind in the ability to capture new taxpayers (Bahl, 2003). Terms of trade improvements can positively affect tax revenue, including through the rise in the related trading corporate tax revenue (owing to the increase in the profitability of exporting firms) (Agbeyegbe *et al.*, 2006). However, governments may be less incentivized to collect tax revenue when countries experience terms of trade improvements, thereby leading to a negative relationship between terms of trade improvements and tax revenue. Finally, a higher inflation rate reduces tax revenue as the lags in tax payments reduce the real amount of tax collected by the inflation rate (Tanzi, 1977).

3. Data analysis

We present in Figure 1 the evolution of tax revenue instability and tax revenue over the full sample and the period 1981–2016 (using non-overlapping sub-periods data set). Figure 2 does the same for the sub-samples considered in the analysis. These sub-samples are derived from the World Bank classification of countries, and include low-income countries



Note: The variable "TAX" is the ratio of non-resource tax revenue to GDP, whereas the variable "TAXINST" is the indicator of instability of the ratio of non-resource tax revenue to GDP

Source: Author

Figure 1.
Evolution of TAX and TAXINST_Over full sample

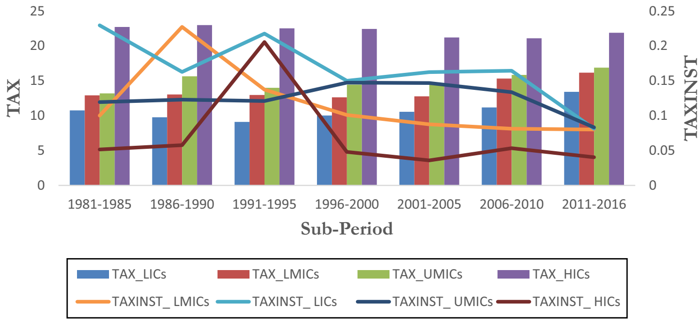


Figure 2.
Evolution of TAX and TAXINST_Over sub-samples

Note: The variable "TAX" is the ratio of non-resource tax revenue to GDP, whereas the variable "TAXINST" is the indicator of instability of the ratio of non-resource tax revenue to GDP

Source: Author

(LICs), lower-middle income countries (LMICs), upper-middle income countries (UMICs) and high-income countries (HICs). Figures 3 and 4 show the cross-plot between tax revenue instability and tax revenue, respectively, over the full sample and over the sub-samples (using non-overlapping data set).

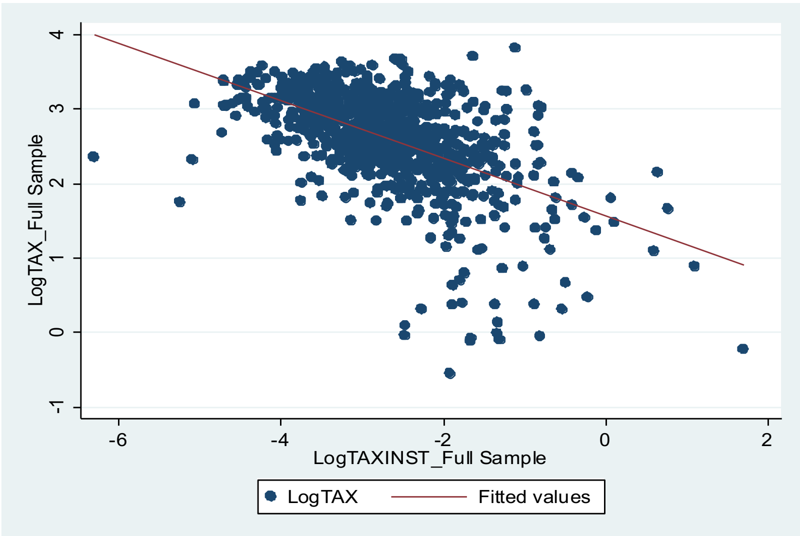
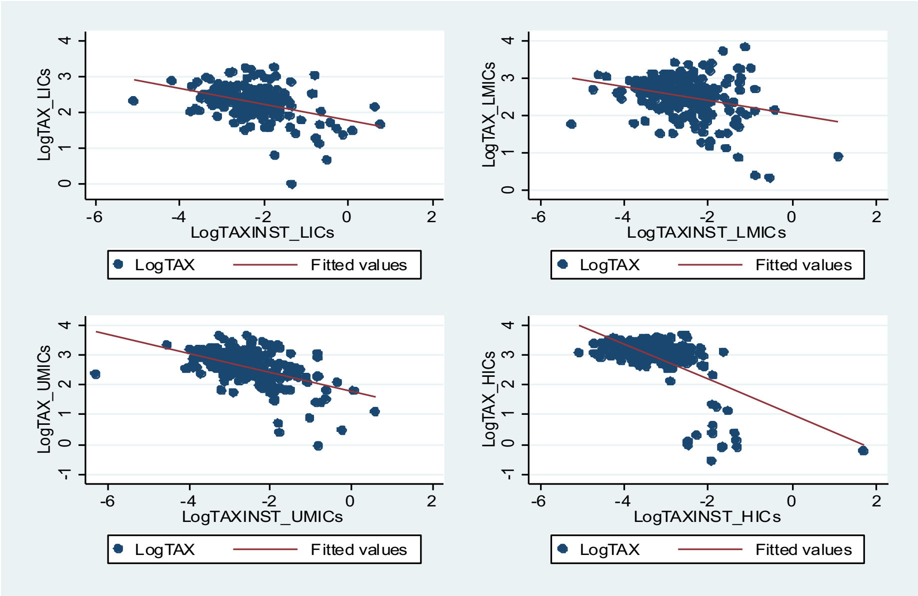


Figure 3.
Correlation pattern between TAX and TAXINST_Over full sample

Note: The variable "TAX" is the ratio of non-resource tax revenue to GDP, whereas the variable "TAXINST" is the indicator of instability of the ratio of non-resource tax revenue to GDP

Source: Author



Note: The variable "TAX" is the ratio of non-resource tax revenue to GDP, whereas the variable "TAXINST" is the indicator of instability of the ratio of non-resource tax revenue to GDP

Source: Author

Figure 4. Correlation pattern between TAX and TAXINST_Over sub-samples

Figure 1 indicates that tax revenue instability and tax revenue tended not to move in the same direction over the period under analysis. In particular, during the last sub-periods 2006–2010 and 2011–2016, there was a clear divergence between tax revenue instability and tax revenue. Figure 2 shows, as expected, that HICs experience the highest level of tax revenue, followed in the descending order by UMICs, LMICs and LICs. In the meantime, tax revenue has fluctuated strongly in the four sub-samples. Specially, from 1991 to 1994 onwards, HICs represent the group of countries that experienced the lowest degree of tax revenue instability. This group is followed by LMICs and UMICs. The level of tax revenue instability has been the highest in LICs, when compared to other sub-groups of countries. Figure 3 indicates a negative correlation between tax revenue instability and tax revenue over the full sample, and this pattern is observed in Figure 4 for each of the four sub-samples, although HICs experienced the steepest negative slope of the negative correlation pattern.

4. Empirical methodology

Many of the studies on the determinants of tax revenue share (Agbeyegbe *et al.*, 2006; Baunsgaard and Keen, 2010; Crivelli and Gupta, 2014; Crivelli, 2016; Gnangnon and Brun, 2018, 2019) have used the GMM system approach, including the two-step system GMM estimator proposed by Arellano and Bover (1995) and Blundell and Bond (1998) to estimate the dynamic relationship between tax revenue and its determinants. The present analysis follows this practice, and estimates the dynamic model (1) using the two-step system GMM estimator. It is more efficient than the first-differenced GMM estimator developed by Arellano and Bond (1991), in particular when there is persistence in variables over time, and in the presence of weak instruments for first differences.

The two-step system GMM estimator helps to deal with the endogeneity issue related to the reverse causality from the dependent variable to some regressors, notably tax revenue instability, trade openness, the real per capita income and the institutional quality. Additionally, this estimator allows for addressing the likely endogeneity problem induced by the correlation between the one-period lag of the non-resource tax revenue variable (as a regressor) and countries' time invariant specific effects. Such a correlation leads to biased estimates when the panel dataset features a short time dimension and a relatively larger cross-section (Nickell, 1981). The consistency of the two-step system GMM estimator rests on three tests, including the Arellano-Bond (AB) test of the presence of first-order serial correlation in the error term (denoted AR(1)), the Arellano Bond test of the absence of second-order autocorrelation in the residuals (denoted AR(2)), and the Sargan test of over-identifying restrictions (OID). The estimator would be consistent if the null hypotheses of the tests were not rejected. Finally, the diagnostic tests are powerful if the number of instruments used in the regressions are lower than the number of countries (Bowsher, 2002; Roodman, 2009). For this reason, in addition to reporting the outcomes of the diagnostic tests mentioned above, we also present the number of instruments used in the regressions. The latter have used a maximum of three lags of the dependent variables as instruments, and three lags of endogenous variables as instruments.

While the two-step system GMM approach is pour preferred estimator in this analysis, we also present the outcomes of the estimation of a variant of model (1) using two standard econometric estimators. These include the within fixed effects estimator (denoted "FE") along with the Driscoll and Kraay (1998) technique to correct standard errors of the estimates of serial correlation, heteroscedasticity and cross-sectional dependence; and the feasible generalized least squares (denoted "FGLS"). The variant of model (1) estimated by means of these two estimators is model (1) without the one period lag of the dependent variable (i.e. a static version of model (1)). We have used the one-period lag of the variables capturing the real per capita income, trade openness and the proxy for the institutional quality so as to mitigate the endogeneity problem associated with simultaneity bias, i.e. the reverse causality from the dependent variable to each of these regressors. The outcomes of these estimations are provided in Table 1.

The regressions based on the two-step system GMM approach are as follows. Column (1) of Table 2 contains the results of the estimation of model (1). Columns (2)–(5) contain the outcomes of the estimation of different variants of model (1) that allow obtaining the net effect of non-resource tax revenue instability on non-resource tax revenue, respectively, on LICs, LMICs, UMICs and HICs. These variants are model (1) in which we introduce (separately) a dummy capturing each category of countries (or each sub-sample) as well as its interaction with the variable "TAXINST." As the categorization of countries in each of these groups (sub-samples) by the World Bank may vary from one year to another year, we adopt a more general approach that entails estimating another specification of model (1). The latter includes the interaction between the variables "TAXINST" and "GDPC," and thus help to assess how the effect of tax revenue instability on tax revenue varies across countries in the full sample. The result of the estimation of this model specification is provided in Column (6) of Table 2.

Estimates presented in Table 3 aim to help examine the channel through which tax revenue instability affects tax revenue. As noted in Section 2, the present study has considered that the effect of non-resource tax revenue instability on non-resource tax

Variables	FE Log(TAX) (1)	FGLS with panel-specific AR(1) Log(TAX) (2)
Log(TAXINST)$_{t-1}$	−0.0281*** (0.00628)	−0.0848*** (0.00737)
Log(GDPC)$_{t-1}$	0.0677 (0.0562)	0.0919*** (0.0131)
Log(OPEN)$_{t-1}$	0.0660*** (0.0143)	0.0996*** (0.00999)
Log(SHVAAGRI)	0.0645 (0.0461)	0.151*** (0.0120)
INFL	−0.0601*** (0.00928)	−0.0483*** (0.00773)
POLITY2$_{t-1}$	0.000434 (0.00120)	0.0171*** (0.00145)
Log(TERMS)	−0.0497** (0.0218)	−0.0163 (0.0174)
Log(POP)	0.365*** (0.0298)	−0.0707*** (0.00697)
Constant	−7.527*** (0.282)	MMMMM (0.270)
Observations – Countries	654 – 144	650 – 140
Within R-squared	0.2494	
Pseudo R-squared		0.6238

Notes: *p-value < 0.1; **p-value < 0.05; ***p-value < 0.01. Robust standard errors are in parenthesis. The pseudo R^2 has been computed for the regression based on the FGLS estimator as the correlation coefficient between the dependent variable and its predicted values. *Estimators*: FE and FGLS

Table 1. Impact of tax revenue instability on tax revenue

revenue can materialize through the instability of government expenditure (denoted “EXPINST”). Thus, we estimate a variant of model (1) that includes both the variable “EXPINST” and its interaction with the variable “TAXINST.” The instability of public expenditure has been calculated as the standard deviation of the growth rate of the general government total expenditure (% GDP), over each of the above-mentioned non-overlapping sub-periods of five years.

Finally, we investigate whether the effect of non-resource tax revenue instability on tax revenue depends on countries’ prevailing economic conditions. These conditions are measured by three factors, including the economic growth volatility, inflation volatility and terms of trade instability. Thus, we estimate three other variants of model (1) that include, respectively, each of these three variables, and the interaction between the relevant variable and the variable “TAXINST.” Economic growth volatility (denoted “GRVOL”) is measured by the standard deviation of annual economic growth rate (growth rate of real GDP) over non-overlapping sub-periods of five years. Similarly, inflation volatility (denoted “INFLVOL”) is computed as the standard deviation of inflation rate over five-year non-overlapping sub-periods. Terms of trade instability (denoted “TERMSINST”) is the standard deviation of annual terms of trade growth over five-year non-overlapping sub-periods. The terms of trade indicator is measured by the ratio of the export price index to import price index.

5. Empirical results

At the outset, we would like to note that for the sake of simplicity, we henceforth refer to “non-resource tax revenue share of GDP” as “tax revenue share,” and the “instability of non-resource tax revenue share of GDP” as “tax revenue instability.”

Results in Columns (1) and (2) of Table 1 show that tax revenue instability influences negatively and significantly the tax revenue share. In fact, the coefficients of the variable “TAXINST” in these two columns of Table 1 are negative and significant at the 1% level. However, the coefficient obtained based on the FGLS approach is almost four times the one obtained from the FE regression. As for control variables, results in Column (1) (i.e. the one

Table 2.
Effect of tax revenue instability on tax revenue across sub-samples

Variables	Log(TAX)	Log(TAX)	Log(TAX)	Log(TAX)	Log(TAX)	Log(TAX)
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
$Log(TAX)_{t-1}$	0.735*** (0.0160)	0.748*** (0.0172)	0.765*** (0.0169)	0.768*** (0.0178)	0.796*** (0.0146)	0.728*** (0.0152)
Log(TAXINST)	−0.107*** (0.0106)	−0.100*** (0.0124)	−0.128*** (0.0138)	−0.0896*** (0.0112)	−0.0749*** (0.0145)	0.0213 (0.0401)
[Log(TAXINST)]*LIC		−0.0329* (0.0173)				
[Log(TAXINST)]*LMIC			MM (0.0220)			
[Log(TAXINST)]*UMIC				0.00140 (0.0209)		
[Log(TAXINST)]*HIC					−0.0625*** (0.0229)	
[Log(TAXINST)]*[Log(GDPC)]						−0.0181*** (0.00460)
LIC		−0.0779 (0.0564)				
LMIC			0.280*** (0.0689)			
UMIC				0.0632 (0.0571)		
HIC					−0.287*** (0.0890)	
Log(GDPC)	−0.0637*** (0.0179)	−0.0884*** (0.0196)	−0.0941*** (0.0170)	−0.0894*** (0.0193)	−0.0832*** (0.0214)	−0.170*** (0.0256)
MM	−0.0156* (0.00938)	0.00140 (0.0140)	0.0187 (0.0118)	−0.00697 (0.0139)	0.0100 (0.0120)	0.0251** (0.0125)
Log(SHAGRI)	−0.0765*** (0.0202)	−0.0754*** (0.0179)	−0.0489** (0.0242)	−0.0983*** (0.0186)	−0.0637*** (0.0232)	−0.0684*** (0.0199)
INFL	−0.0165*** (0.00622)	−0.0132* (0.00675)	−0.0123 (0.00761)	−0.0214*** (0.00629)	−0.0226*** (0.00766)	−0.0137* (0.00741)
POLITY2	0.0107*** (0.00179)	0.0108*** (0.00179)	0.00937*** (0.00172)	0.0121*** (0.00212)	0.0114*** (0.00250)	0.00903*** (0.00187)
Log(TERMS)	−0.0536*** (0.0194)	−0.0804*** (0.0142)	−0.0864*** (0.0217)	−0.0591*** (0.0170)	−0.0768*** (0.0194)	−0.0699*** (0.0176)
Log(POP)	−0.00577 (0.0111)	−0.00256 (0.0144)	−0.0246* (0.0138)	−0.00960 (0.0145)	−0.00627 (0.0128)	−0.0274** (0.0121)
Observations – Countries	688 – 146	688 – 146	688 – 146	688 – 146	688 – 146	688 – 146
Number of Instruments	97	97	97	97	97	97
AR1 (*p*-value)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AR2 (*p*-value)	0.2189	0.1933	0.2149	0.2205	0.1887	0.2331
OID (*p*-value)	0.2252	0.2986	0.1451	0.1787	0.2523	0.2612

Notes: *p-value < 0.1; **p-value < 0.05; ***p-value < 0.01. Robust standard errors are in parenthesis. In the two-step system GMM estimations, the variables "TAXINST," "OPEN," "GDPC," "POLITY2" and the interaction variables have been considered as endogenous. The other variables have been considered as exogenous. Time dummies have been included in the regressions. The latter have used a maximum of three lags of the dependent variables as instruments and three lags of endogenous variables as instruments. *Estimator*: Two-step system GMM

Variables	Log(TAX) (1)
$Log(TAX)_{t-1}$	0.737*** (0.0125)
Log(TAXINST)	−0.205*** (0.0139)
[Log(TAXINST)]*[Log(EXPINST)]	−0.0721*** (0.00467)
Log(EXPINST)	−0.265*** (0.0164)
Log(GDPC)	−0.0492*** (0.0145)
Log(OPEN)	−0.0148 (0.0136)
Log(SHAGRI)	−0.0829*** (0.0133)
INFL	−0.0124** (0.00495)
POLITY2	0.0143*** (0.00162)
Log(TERMS)	−0.112*** (0.0180)
Log(POP)	0.00990 (0.0125)
Observations – Countries	661 – 144
Number of instruments	111
AR1 (*p*-value)	0.0000
AR2 (*p*-value)	0.5442
OID (*p*-value)	0.4653

Notes: **p*-value < 0.1; ***p*-value < 0.05; ****p*-value < 0.01. Robust standard errors are in parenthesis. In the two-step system GMM estimations, the variables "TAXINST," "OPEN," "GDPC," "POLITY2" and the interaction variables have been considered as endogenous. The other variables have been considered as exogenous. Time dummies have been included in the regressions. The latter have used a maximum of three lags of the dependent variables as instruments and three lags of endogenous variables as instruments. *Estimator*: Two-step system GMM

Table 3. Impact of tax revenue instability on tax revenue for varying levels of public expenditure variability and economic growth rate

based on the FE approach) show that trade openness and the population size exert a positive and significant effect on the tax revenue share at the 1% level, while inflation and terms of trade influences it negatively and significantly (at least at the 5% level). The other regressors do not appear to influence significantly the tax revenue share. The outcomes based on the FGLS approach reveal that tax revenue share is positively and significantly (at the 1% level) driven by higher real per capita income, greater trade openness, a lower share of value added in agriculture in total output, lower inflation rates, a better institutional quality and a lower population size. Terms of trade do not influence significantly the tax revenue share.

Let us now turn to outcomes contained in the other tables. The estimations' outcomes presented in Tables 2–4 show that all the conditions required to ensure the consistency of the two-step system GMM estimator are met, thereby confirming the appropriateness of this estimator for the empirical analysis. In fact, as shown by results presented at the bottom of the three tables, the null hypothesis of the presence of the first-order serial correlation in the error term (denoted AR(1)) and the absence of the second-order autocorrelation in the error term (denoted AR(2)) are not rejected. Additionally, the *p*-values of the OID test are higher than 0.10, and thus confirm the validity of the instruments used in the regressions. Incidentally, the number of instruments is always lower than the number of countries. Finally, as observed in many other studies that have used the two-step system GMM estimator, the one-period lag of the dependent variable shows positive and significant coefficients at the 1% level across all columns of the three tables, thereby showing the state dependence nature of non-resource tax revenue share of GDP.

Results in Column (1) of Table 2 show a negative and significant coefficient (at the 1% level) of the variable "TAXINST." This suggests that tax revenue instability is associated with lower tax revenue share. A 1 percentage increase in the degree of tax revenue instability is associated with a 0.107 percentage decrease in tax revenue share[4]. Results in Columns (2)–(5) suggest that at the 5% level, the net effect of tax revenue instability on tax revenue share in LICs, LMICs, UMICs and HICs amounts, respectively, to −0.100; −0.011 (= −0.128 + 0.117); −0.0896; and −0.137 (= −0.0749−0.0625). It, therefore, appears that a 1 percentage rise in tax revenue instability is associated with a 0.1 percentage fall in tax revenue share in LICs, a 0.011 percentage decline in tax revenue share in LMICs, a 0.09 percentage decrease in tax revenue share in UMICs and a 0.137 percentage fall in HICs. Thus, HICs appear to be the group of countries that experiences the highest negative effect of tax revenue instability on tax revenue. This group is followed (in the descending order) by LICs, UMICs and finally LMICs. Results in Column (6) of Table 2 show a negative and significant (at the 1% level) coefficient of the interaction variable "[Log(TAXINST)]*[Log (GDPC)]," while the coefficient of the variable "[Log(TAXINST)]" is not significant at the conventional levels. We conclude that the magnitude of the negative effect of tax revenue instability on tax revenue share increases as countries experience a rise in their real per capita income. In other words, less developed countries experience a higher magnitude of the negative effect of tax revenue instability on tax revenue share than do relatively advanced economies. This means that relatively advanced economies managed relatively well the adverse effect of tax revenue instability on tax revenue share, compared to less developed countries.

Turning to control variables, we obtain (in particular from Column (1) of Table 2, although similar outcomes are more or less observed in other columns of the table) that at the 5% level, an improvement in tax revenue share is positively driven by a fall in the real per capita income, lower share of value added in agriculture in total output, lower inflation rate, an improvement in the institutional quality and a deterioration in terms of trade. The negative effect of the real per capita income on non-resource tax revenue runs in contrast with the theoretical expectation of a positive effect of real per capita income on tax revenue found in many studies in the literature. This peculiar outcome may be because of the inclusion of tax revenue instability in the model specification (which has not been the case in previous empirical studies). This may, therefore, signify that the effect of the real per capita income on non-resource tax revenue is dependent on the level of non-resource tax revenue instability. This was, indeed, what we found above.

The population size does not influence the tax revenue share. Finally, at the 5% level, there is no significant effect of trade openness on tax revenue share. Similar results on the control variables are obtained in Tables 2 and 3.

Turning to the results reported in Table 3, we find that the interaction term associated with the variable "[Log(TAXINST)]*[Log(EXPINST)]" and the coefficient of the variable "[Log(TAXINST)]" are both negative and significant at the 1% level. Based on these results, we draw the following conclusions: tax revenue instability is consistently associated with a fall in tax revenue share as the level of instability of public expenditure rises, and the higher this level, the greater is the magnitude of the negative effect of tax revenue instability on the tax revenue share.

Results in Column (1) of Table 4 suggest a negative and significant coefficient (at the 1% level) of the interaction variable "[Log(TAXINST)]*[Log(GRVOL)]," while the coefficient of the variable "[Log(TAXINST)]" is positive and significant at the 1% level. These two results indicate that there is a turning point of the economic growth volatility below which tax revenue instability is positively associated with the tax revenue share; above this threshold, the relationship between tax revenue instability and tax revenue share becomes negative. This turning point amounts to 1.468 [= exponential (0.0346/0.0902)]. Given that in the data

Variables	Log(TAX) **(1)**	Log(TAX) **(2)**	Log(TAX) **(3)**
$Log(TAX)_{t-1}$	0.760*** (0.0131)	0.734*** (0.0130)	0.808*** (0.0104)
Log(TAXINST)	0.0346*** (0.0122)	−0.0714*** (0.0122)	−0.183*** (0.00999)
[Log(TAXINST)]*[Log(GRVOL)]	−0.0902*** (0.00570)		
Log(GRVOL)	−0.302*** (0.0151)		
[Log(TAXINST)]*[Log(INFLVOL)]		−0.0139*** (0.00439)	
Log(INFLVOL)		−0.0979*** (0.0112)	
[Log(TAXINST)]*[Log(TERMSINST)]			−0.0637*** (0.00441)
Log(TERMSINST)			−0.234*** (0.0145)
Log(GDPC)	−0.0892*** (0.0174)	−0.0865*** (0.0157)	−0.103*** (0.0146)
Log(OPEN)	−0.0165* (0.00951)	0.0106 (0.0107)	−0.00414 (0.00922)
Log(SHAGRI)	−0.130*** (0.0144)	−0.0566*** (0.0142)	−0.105*** (0.0176)
INFL	−0.00215 (0.00599)	0.0519*** (0.00728)	−0.0112** (0.00455)
POLITY2	0.00952*** (0.00113)	0.00308** (0.00138)	0.00255** (0.00118)
Log(TERMS)	−0.0676*** (0.0129)	−0.0461*** (0.0161)	−0.0812*** (0.0143)
Log(POP)	0.00308 (0.00905)	−0.0131 (0.0135)	−0.0122 (0.00986)
Observations – Countries	687 – 146	688 – 146	662 – 146
Number of instruments	111	111	111
AR1 (*p*-value)	0.0009	0.0003	0.0001
AR2 (*p*-value)	0.3141	0.1388	0.1017
OID (*p*-value)	0.2795	0.2515	0.2869

Notes: *p-value < 0.1; **p-value < 0.05; ***p-value < 0.01. Robust standard errors are in parenthesis. In the two-step system GMM estimations, the variables "TAXINST," "OPEN," "GDPC," "POLITY2," "GRVOL" and the interaction variables have been considered as endogenous. The other variables have been considered as exogenous. Time dummies have been included in the regressions. The latter have used a maximum of three lags of the dependent variables as instruments and three lags of endogenous variables as instruments. *Estimator*: Two-step system GMM

Table 4. Impact of tax revenue instability on tax revenue taking into account the prevailing economic conditions (economic volatility, inflation volatility, terms of trade instability)

set considered in the analysis, values of economic growth volatility range between 0.14 and 63, we conclude that it is only for very small degrees of economic growth (comprising between 0.14 and 1.47) that tax revenue instability results in higher tax revenue share (the lower the degree of economic growth volatility, the greater is the positive effect of tax revenue instability on tax revenue share). For levels of economic growth volatility higher than the threshold 1.47, tax revenue instability leads to lower tax revenue share and the higher the level of economic volatility, the greater is the magnitude of the negative effect of tax revenue instability on the tax revenue share.

We also obtain from Columns (2) and (3) of Table 4 that not only are the coefficients of the variable "[Log(TAXINST)]" negative and significant at the 1% level, but the interaction terms related to the interactions variables "[Log(TAXINST)]*[Log(INFLVOL)]" and "[Log (TAXINST)]*[Log(TERMSINST)]" are also negative and significant at the 1% level. Therefore, we deduce that tax revenue instability consistently leads to lower tax revenue share in the context of rising inflation volatility or terms of trade instability. The higher the inflation volatility, the greater is the magnitude of the negative effect of tax revenue instability on the tax revenue share. Additionally, the magnitude of the reducing effect of tax revenue instability on tax revenue share rises as countries experience an increase in the degree of terms of trade instability.

6. Conclusion

This analysis has investigated the effect of tax revenue instability on non-resource tax revenue share in a set of 146 countries over the period 1981–2016. It has suggested that tax revenue instability affects negatively non-resource tax revenue share, with the magnitude of this negative effect declining as countries enjoy a rise in the real per capita income. This negative effect of tax revenue instability on non-resource tax revenue share translates through the channel of public expenditure instability. Specially, countries experience a higher negative effect of non-resource tax revenue instability on non-resource tax revenue share when their public expenditure instability increases. Finally, the magnitude of the negative effect of non-resource tax revenue instability on non-resource tax revenue share increases as countries experience higher economic volatility, higher inflation volatility and a rise in terms of trade instability.

The mobilization of tax revenue is essential to, *inter alia*, supply public services, and prevent or cope with economic, financial and health shocks that developed and developing countries may face. The main policy implication of this analysis is that policies that help ensure the stability of non-resource tax revenue also contribute to improving countries' non-resource tax revenue share. For example, governments' measures that help cope with or prevent the severe adverse effects of shocks on economies (shocks that could translate into higher tax revenue instability) would ultimately help enhance countries' tax revenue performance. The current COVID-19 pandemic, which has the specific feature to be simultaneously both a demand shock and a supply shock is a case in point. The severity of these negative shocks and the subsequent macroeconomic uncertainty that it has generated – *inter alia*, in terms of economic growth instability, terms of trade instability, inflation volatility and public expenditure instability – are likely to result in severe tax revenue losses. Governments in both developed and developing countries would surely learn from the management of this crisis so as to prepare for possible future economic, financial and health crises with a view to dampening their adverse macroeconomic effects, including here their negative tax revenue effects.

Notes

1. Studies in this regard include for example, Afonso and Furceri (2010); Aschauer (1989); Barro (1990); Bertola and Drazen (1993); Devarajan *et al.* (1996); Easterly and Rebelo (1993); Fischer (1993); Furceri (2007); Gali (1994); Gong and Zou (2002); and Kormendi and Meguire (1985).
2. These include, for example, Agbeyegbe *et al.* (2006); Baunsgaard and Keen (2010); Bird *et al.* (2008); Brun *et al.* (2015); Clist (2016); Clist and Morrissey (2011); Crivelli (2016); Crivelli and Gupta (2014); Ghura (1998); Gnangnon and Brun (2017, 2018, 2019); Khattry and Rao (2002); Morrissey *et al.* (2016); and Yohou *et al.* (2016).
3. It is important to underline that the UNU-WIDER data set (Appendix 1) can be considered as being the best source of information on government revenue at this moment, and one can argue that the distinction between resource and non-resource revenue is a tricky one and involves some choices, particularly regarding the poorer countries. To some extent, this choice can affect the estimations' outcomes. As noted in footnote 4 below, the inclusion of the variable capturing the resource revenue share of GDP does not alter qualitatively or quantitatively estimations' results, particularly the magnitude of the effect of tax revenue instability on tax revenue share.
4. It is worth noting at this stage of the analysis that we have also estimated a variant of model (1) (with the two-step system GMM approach) that included the variable capturing the "resource tax revenue share of GDP." We have observed that the results (notably the ones concerning the tax

revenue instability variable) are qualitatively and quantitatively similar to those presented in Column (1) of Table 2. Additionally, the coefficient of the "resource tax revenue share of GDP" variable is not statistically significant at the 10% level. On another note, the introduction of the variable "resource tax revenue share of GDP" in all other variants of model (1) described in the previous section does not alter qualitatively or quantitatively the estimations' outcomes.

References

Afonso, A. and Furceri, D. (2010), "Government size, composition, volatility and economic growth", *European Journal of Political Economy*, Vol. 26 No. 4, pp. 517-532.

Agbeyegbe, T.D., Stotsky, J. and WoldeMariam, A. (2006), "Trade liberalization, exchange rate changes, and tax revenue in Sub-Saharan Africa", *Journal of Asian Economics*, Vol. 17 No. 2, pp. 261-284.

Arellano, M. and Bond, S. (1991), "Some tests of specification for panel data: Monte carlo evidence and an application to employment equations", *The Review of Economic Studies*, Vol. 58 No. 2, pp. 277-297.

Arellano, M. and Bover, O. (1995), "Another look at the instrumental variable estimation of error-components models", *Journal of Econometrics*, Vol. 68 No. 1, pp. 29-51.

Aschauer, D. (1989), "Is government spending productive?", *Journal of Monetary Economics*, Vol. 23 No. 2, pp. 177-200.

Bahl, R.W. (2003), "Reaching the hardest to tax: consequences and possibilities", Paper presented at the 'Hard to Tax: An International Perspective' conference, Andrew Young School of Policy Studies, GA State University, May 15–16.

Barro, R. (1990), "Government spending in a simple model of endogenous growth", *Journal of Political Economy*, Vol. 98 No. 5, Part 2, pp. S103-S125.

Baunsgaard, T. and Keen, M. (2010), "Tax revenue and (or?) trade liberalization", *Journal of Public Economics*, Vol. 94 Nos 9/10, pp. 563-577.

Bernanke, B. (1983), "Irreversibility, uncertainty ad cyclical investments", *The Quarterly Journal of Economics*, Vol. 98 No. 1, pp. 85-106.

Bertola, G. and Drazen, A. (1993), "Trigger points and budget cuts: explaining the effects of fiscal austerity", *American Economic Review*, Vol. 83 No. 1, pp. 11-26.

Besley, T. and Persson, T. (2014), "Why do developing countries tax so little?", *Journal of Economic Perspectives*, Vol. 28 No. 4, pp. 99-120.

Bird, R.M., Martinez-Vazquez, J. and Torgler, B. (2008), "Tax effort in developing countries and high-income countries: the impact of corruption, voice and accountability", *Economic Analysis and Policy*, Vol. 38 No. 1, pp. 55-71.

Bleaney, M., Gemmell, N. and Greenaway, D. (1995), "Tax revenue instability, with particular reference to Sub-Saharan Africa", *Journal of Development Studies*, Vol. 31 No. 6, pp. 883-902.

Blundell, R. and Bond, S. (1998), "Initial conditions and moment restrictions in dynamic panel data models", *Journal of Econometrics*, Vol. 87 No. 1, pp. 115-143.

Bowsher, C.G. (2002), "On testing overidentifying restrictions in dynamic panel data models", *Economics Letters*, Vol. 77 No. 2, pp. 211-220.

Brun, J.F., Chambas, G., and Mansour, M. (2015), "Tax effort of developing countries: an alternative measure", in Boussichas, M. and Guillaumont, P. and Economica. F. (Eds), *Financing Sustainable Development Addressing Vulnerabilities, Chapter 11*.

Brun, J.-F. and Gnangnon, S.K. (2019), "Tax reforms, public revenue and public revenue instability in developing countries: does development aid matter?", *Journal of International Development*, Vol. 31 No. 8, pp. 764-785.

Brunetti, A. (1998), "Policy volatility and economic growth: a comparative empirical analysis", *European Journal of Political Economy*, Vol. 14 No. 1, pp. 35-52.

Cagé, J. and Gadenne, L. (2018), "Tax revenues and the fiscal cost of trade liberalization, 1792-2006, 1792-2006", *Explorations in Economic History*, Vol. 70, pp. 1-24.

Clist, P. (2016), "Foreign aid and domestic taxation: multiple sources, one conclusion", *Development Policy Review*, Vol. 34 No. 3, pp. 365-383.

Clist, P. and Morrissey, O. (2011), "Aid and tax revenue: signs of a positive effect since the 1980s", *Journal of International Development*, Vol. 23 No. 2, pp. 165-180.

Crivelli, E. (2016), "Trade liberalization and tax revenue in transition: an empirical analysis of the replacement strategy", *Eurasian Economic Review*, Vol. 6 No. 1, pp. 1-25.

Crivelli, E. and Gupta, S. (2014), "Resource blessing, revenue curse? Domestic revenue effort in resource-rich countries", *European Journal of Political Economy*, Vol. 35, pp. 88-101.

Devarajan, S., Swaroop, V. and Zou, H-F. (1996), "The composition of public expenditure and economic growth", *Journal of Monetary Economics*, Vol. 37 Nos 2/3, pp. 313-344.

Driscoll, J. and Kraay, A. (1998), "Consistent covariance matrix estimation with spatially dependent panel data", *Review of Economics and Statistics*, Vol. 80 No. 4, pp. 549-560.

Easterly, W. and Rebelo, S. (1993), "Fiscal policy and economic growth: an empirical investigation", *Journal of Monetary Economics*, Vol. 32 No. 3, pp. 417-458.

Ebeke, C. and Ehrhart, H. (2012), "Tax revenue instability in Sub-Saharan Africa: consequences and remedies", *Journal of African Economies*, Vol. 21 No. 1, pp. 1-27.

Edwards, S. (1998), "Openness, productivity, and growth: what do we really know?", *The Economic Journal*, Vol. 108 No. 447, pp. 383-398.

Föllmi, R., Fuest, A., An de Meulen, P., Micheli, M., Schmidt, T. and Zwick, L. (2018), "Openness and productivity of the swiss economy", *Swiss Journal of Economics and Statistics*, Vol. 154 No. 1, *Article number: 17*.

Furceri, D. (2007), "Is government expenditure volatility harmful for growth? A cross-country analysis", *Fiscal Studies*, Vol. 28 No. 1, pp. 103-120.

Gali, J. (1994), "Government size and macroeconomic stability", *European Economic Review*, Vol. 38 No. 1, pp. 117-132.

Ghura, H. (1998), "Tax revenue in Sub-Sahara Africa: effects of economic policies and corruption", International Monetary Fund (WP/98/135. Washington DC).

Gnangnon, S.K. and Brun, J.-F. (2017), "Impact of export upgrading on tax revenue in developing and high-income countries", *Oxford Development Studies*, Vol. 45 No. 4, pp. 542-561.

Gnangnon, S.K. and Brun, J.-F. (2018), "Impact of bridging the internet gap on public revenue mobilization", *Information Economics and Policy*, Vol. 43, pp. 23-33.

Gnangnon, S.K. and Brun, J.-F. (2019), "Trade openness, tax reform and tax revenue in developing countries", *The World Economy*, Vol. 42 No. 12, pp. 3515-3536.

Gong, L. and Zou, H.-F. (2002), "Effects of growth and volatility in public expenditures on economic growth: theory and evidence", *Annals of Economics and Finance*, Vol. 3, pp. 379-406.

Khattry, B. (2003), "Trade liberalization and the fiscal squeeze: implications for public investment", *Development and Change*, Vol. 34 No. 3, pp. 401-424.

Khattry, B. and Rao, J.M. (2002), "Fiscal faux pas? An analysis of the revenue implications of trade liberalization", *World Development*, Vol. 30 No. 8, pp. 1431-1444.

Kormendi, R. and Meguire, P. (1985), "Macroeconomic determinants of growth: cross-country evidence", *Journal of Monetary Economics*, Vol. 16 No. 2, pp. 141-164.

Lim, D. (1983), "Instability of government revenue and expenditure in less developed countries", *World Development*, Vol. 11 No. 5, pp. 447-450.

Marshall, M.G., Gurr, T.R., and Jaggers, K. (2018), *Polity IV Project: Political Regime Characteristics and Transitions, 1800-2017*, Centre for Systemic Peace, Vienna, VA.

Melitz, M.J. (2003), "The impact of trade on intra-industry reallocations and aggregate industry productivity", *Econometrica*, Vol. 71 No. 6, pp. 1695-1725.

Morrissey, O., Von Haldenwang, C., Von Schiller, A., Ivanyna, M. and Bordon, I. (2016), "Tax revenue performance and vulnerability in developing countries", *The Journal of Development Studies*, Vol. 52 No. 12, pp. 1689-1703.

Nickell, S. (1981), "Biases in dynamic models with fixed effects", *Econometrica*, Vol. 49 No. 6, pp. 1417-1426.

Pindyck, R. and Solimano, A. (1993), "Economic instability and aggregate investments", in Blanchard, O. and Fisher, S. (Eds), *NBER Macroeconomics Annual*, MIT Press, Cambridge.

Roodman, D.M. (2009), "A note on the theme of too many instruments", *Oxford Bulletin of Economics and Statistics*, Vol. 71 No. 1, pp. 135-158.

Squalli, J. and Wilson, K. (2011), "A new measure of trade openness", *The World Economy*, Vol. 34 No. 10, pp. 1745-1770.

Tanzi, V. (1977), "Inflation, lags in collection, and the real value of tax revenue", *IMF Staff Papers*, 26, 154-167, International Monetary Fund, Washington, DC.

Tosun, M.S. and Abizadeh, S. (2007), "Economic growth and tax components: an analysis of tax changes in OECD", *Applied Economics*, Vol. 37 No. 19, pp. 2251-2263.

Yeyati, E.L., Panizza, U. and Stein, E. (2007), "The cyclical nature of North-South FDI flows", *Journal of International Money and Finance*, Vol. 26 No. 1, pp. 104-130.

Yohou, H., Goujon, D., Michaël, M. and Ouattara, W. (2016), "Heterogeneous aid effects on tax revenues: accounting for government stability in WAEMU countries", *Journal of African Economies*, Vol. 25 No. 3, pp. 468-498.

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Appendix 1

Variables	Definition	Sources
TAX	This is the measure of the non-resource tax revenue as a share of GDP, which represents the difference between the variable the Total Tax Revenue excluding grants and social contributions as a share of GDP and the resource tax revenue as a share of GDP. The resource tax revenue represents the tax revenue collected on natural resources. Note that all ratios are not expressed in percentage.	Public Revenue Dataset developed by the United Nations University World Institute for Development Economics Research (UNU-WIDER). Available at: www.wider.unu.edu/project/government-revenue-dataset
TAXINST	This is the measure of the instability of non-resource tax revenue. It has been calculated as the standard deviation of annual growth rate of non-resource tax revenue (% GDP) over non-overlapping sub-periods of five-year data.	Authors' calculation based on data from the UNU-WIDER database
GDPC	GDP per capita (constant 2010 US$)	WDI
OPEN	This is the measure of trade openness suggested by Squalli and Wilson (2011). It is calculated as the ratio of exports and imports to GDP, adjusted by the proportion of a country's trade level relative to the average world trade (Wilson, 2011, p. 1758).	Authors' calculation based on data extracted from the WDI
SHAGRI	Share of value added in agriculture, in percentage of total output	WDI
POLITY2	This variable is an index extracted from Polity IV Database (Marshall et al., 2018). It represents the degree of democracy based on competitiveness of political participation, the openness and competitiveness of executive recruitment and constraints on the chief executive. Its values range between −10 and +10, with lower values reflecting autocratic regimes, and greater values indicating democratic regimes. Specifically, the value +10 for this index represents a strong democratic regime, while the value −10 stands for strong autocratic regime.	Polity IV Database (Marshall et al., 2018)
INFL	The variable "INFL" has been calculated using the following formula (Yeyati et al., 2007): INFL = *sign* (*INFLATION*)*log (1+|*INFLATION*|) (2), where |*INFLATION*| refers to the absolute value of the annual inflation rate (%), denoted "INFLATION." The annual inflation rate (%) is based on consumer price index (CPI) (annual %) where missing values have been replaced with values of the GDP Deflator (annual %).	Authors' calculation based on data from the WDI
TERMS	This is the measure of terms of trade. Terms of trade represent the ratio of the export price index to import price index.	Authors' calculation based on data from the World Development Indicators (WDI) of the World Bank
POP	Total population	WDI
EXPINST	This is the measure of the instability of total public expenditure. It has been calculated as the standard deviation of the growth rate of the general	Authors' calculation based on data on the general government total expenditure (percent of GDP) has

(*continued*)

Table A1.
Definition and source of variables

Appendix 2

Variables	Definition	Sources
	government total expenditure (percent of GDP), over non-overlapping sub-periods of five years.	been extracted from the International Monetary Fund Database
GRVOL	This is the measure of the volatility of economic growth rate. It has been calculated as the standard deviation of annual economic growth rate (growth rate of real GDP) over non-overlapping sub-periods of five years.	Authors' calculation based on economic growth rate data extracted from the WDI
INFLVOL	This is the measure of inflation volatility, calculated as the standard deviation of inflation rate over five-year non-overlapping sub-periods.	Authors' calculation based on inflation data extracted from the WDI
TERMSINST	This is the measure of terms of trade instability. Terms of trade represent the ratio of the export price index to import price index. Terms of trade volatility has been calculated as the standard deviation of annual terms of trade growth over five-year non-overlapping sub-periods.	Authors' calculation based on terms of trade data previously described

Table A1.

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
TAX	688	0.158	0.075	0.006	0.409
TAXINST	688	0.109	0.271	0.002	5.420
GRVOL	687	3.045	2.744	0.143	30.798
INFLATION	688	25.310	258.705	−5.111	6,517.110
INFLVOL	688	27.576	382.074	0.144	9,730.510
TERMS	688	103.112	49.040	16.781	750.973
TERMSINST	662	0.170	0.235	0.010	3.122
SHAGRI	688	15.081	13.485	0.033	71.779
POLITY2	688	3.536	6.304	−10.000	10.000
OPEN	688	0.0046	0.0105	0.0000000098	0.0875
GDPC	688	11,081.43	17,108.13	161.66	106,478.8
POP	688	44,100,000	148,000,000	295,163.4	1,360,000,000

Table A2. Standard descriptive statistics on the variables used in the analysis

Appendix 3

Full sample				
Albania	Republic of the Congo	Indonesia	Mongolia	Solomon Islands
Algeria	Costa Rica	Iran, Islamic Rep.	Morocco	South Africa
Angola	Croatia	Iraq	Mozambique	Spain
Argentina	Cuba	Ireland	Myanmar	Sri Lanka
Armenia	Cyprus	Israel	Namibia	Sudan
Australia	Czech Republic	Italy	Nepal	Eswatini
Austria	Cote d'Ivoire	Jamaica	Netherlands	Sweden
Azerbaijan	Dominican Republic	Japan	New Zealand	Switzerland
Bahrain	Ecuador	Jordan	Nicaragua	Tajikistan
Bangladesh	Egypt, Arab Rep.	Kazakhstan	Niger	Tanzania
Belgium	El Salvador	Kenya	Nigeria	Thailand
Benin	Equatorial Guinea	Korea, Rep.	Norway	Togo
Bhutan	Eritrea	Kuwait	Pakistan	Tunisia
Bolivia	Estonia	Kyrgyz Republic	Panama	Turkey
Botswana	Ethiopia	Lao PDR	Papua New Guinea	Turkmenistan
Brazil	Finland	Latvia	Paraguay	Uganda
Bulgaria	France	Lebanon	Peru	Ukraine
Burkina Faso	Gabon	Lesotho	Philippines	United Arab Emirates
Burundi	Gambia, The	Liberia	Poland	United Kingdom
Cabo Verde	Georgia	Libya	Portugal	United States
Cambodia	Germany	Lithuania	Romania	Uruguay
Cameroon	Greece	Luxembourg	Russian Federation	Uzbekistan
Canada	Guatemala	North Macedonia	Rwanda	Venezuela, RB
Central African Republic	Guinea	Madagascar	Saudi Arabia	Vietnam
Chad	Guinea-Bissau	Malawi	Senegal	Zambia
Chile	Guyana	Malaysia	Serbia	Zimbabwe
China	Haiti	Mauritania	Sierra Leone	
Colombia	Honduras	Mauritius	Singapore	
Comoros	Hungary	Mexico	Slovak Republic	
Congo, Dem. Rep.	India	Moldova	Slovenia	

Table A3.
List of countries of the full sample

Appendix 4

LICs	LMICs	UMICs	HICs
Benin	Armenia	Albania	Australia
Burkina Faso	Bangladesh	Algeria	Austria
Burundi	Bhutan	Angola	Bahrain
Central African Republic	Bolivia	Argentina	Belgium
Chad	Cabo Verde	Azerbaijan	Canada
Comoros	Cambodia	Botswana	Chile
Congo, Dem. Rep.	Cameroon	Brazil	Croatia
Eritrea	Congo, Rep.	Bulgaria	Cyprus
Ethiopia	Cote d'Ivoire	China	Czech Republic
Gambia, The	Egypt, Arab Rep.	Colombia	Estonia
Guinea	El Salvador	Costa Rica	Finland
Guinea-Bissau	Guatemala	Cuba	France
Haiti	Guyana	Dominican Republic	Germany
Liberia	Honduras	Ecuador	Greece
Madagascar	India	Equatorial Guinea	Hungary
Malawi	Indonesia	Gabon	Ireland
Mozambique	Kenya	Georgia	Israel
Nepal	Kyrgyz Republic	Iran, Islamic Rep.	Italy
Niger	Lao PDR	Iraq	Japan
Rwanda	Lebanon	Jamaica	Korea, Rep.
Senegal	Lesotho	Jordan	Kuwait
Sierra Leone	Mauritania	Kazakhstan	Latvia
Tanzania	Moldova	Libya	Lithuania
Togo	Mongolia	North Macedonia	Luxembourg
Uganda	Morocco	Malaysia	Netherlands
Zimbabwe	Myanmar	Mauritius	New Zealand
	Nicaragua	Mexico	Norway
	Nigeria	Namibia	Poland
	Pakistan	Panama	Portugal
	Papua New Guinea	Paraguay	Saudi Arabia
	Philippines	Peru	Singapore
	Solomon Islands	Romania	Slovak Republic
	Sri Lanka	Russian Federation	Slovenia
	Sudan	Serbia	Spain
	Eswatini	South Africa	Sweden
	Tajikistan	Thailand	Switzerland
	Tunisia	Turkey	United Arab Emirates
	Ukraine	Turkmenistan	United Kingdom
	Uzbekistan	Venezuela, RB	United States
	Vietnam		Uruguay
	Zambia		

Table A4. List of countries in the sub-samples