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Allocating budget in developing countries, the need to fight corruption: evidence from Sub-Saharan African countries

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Abstract

This paper highlights the need to fight corruption in developing economies to ensure a better allocation of public resources in a context of institutional failure with the discretionary power of budgetary authorities. The study uses a panel of 48 Sub-Saharan African countries by combining several databases (WDI, WGI, SPEED BASE DATA and PWT), estimate by generalized moment method in system, the bias-corrected estimation linear dynamic panel data [6] and the type of error correction (Driscoll–Kraay). The results indicate that the phenomenon of corruption in the form of rent capture has two effects on public resources. One effect is linked to the level of public spending and the other to the distribution of public resources. Thus, corruption leads to an increase in the overall level of public spending. Corruption reduces spending on education, mining and communications, but increases spending on the military, health and transport. The study recommends that political leaders in developing countries strengthen and rigorously enforce anti-corruption laws, and raise public awareness of the underground economy.

Keywords Public investment, Corruption, GMM in system, Africa

JEL Classification E22, D73, E24, N37

Introduction

The management of public resources is hampered by a series of institutional shortcomings that include not only corruption, but also a lack of transparency, a lack of accountability on the part of stakeholders, insufficient public participation and a lack of independence on the part of the bodies that oversee the preparation and execution of the state budget.

In this context of a market economy with competition in developing countries, the relationship between entrepreneurs and public authorities in terms of budget allocation is of particular importance. Insofar as economic actors (multinationals, medium-sized businesses, associations, etc.....) can exert pressure on a government through lobbying [33], policy-makers and bureaucrats can indulge in illicit practices since the latter have discretionary power. In this posture, they no longer act in the interests of society as a whole but capture rents like any other economic actor, which is a form of corruption. The result is preferential treatment linked to corruption and rent-seeking, which can introduce bias into the composition of public spending and the allocation of resources [11]. This rent becomes an issue in public decision-making, and anticipating it encourages interest groups to commit resources to public decision-makers to make it effective. In this sense, rent-seeking corresponds to "the set of activities consisting of the expenditure of scarce resources to capture an artificially created transfer" [32] and is, therefore, the source of a waste of resources, of a social loss, compared to profit-seeking activities which create value [7].

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Rent-seeking can be likened to corruption in that certain agents' appropriate rents, thereby transferring collective wealth to these same agents by tampering with the rules of economic activity. This idea, supported by Krueger [23], is generally found in the fraudulent awarding of contracts and the like to suppliers. In this sense, rent-seeking becomes a form of corruption (with or without theft), since the intervention of a corrupter makes it possible to pay a public official to misuse his power and exceed the rules of his office. In the same vein, Dridi [12] and De La Croix and Delavalade [9, 11] argue that corruption affects not only the level but also the distribution of public spending.

The previous work has illuminated the literature on corruption on the one hand and budget allocation on the other, but also on the effects of corruption on public spending. For example, Ngono [26] deals with the problem of corruption, specifically that of politicians seeking employment, and Azam [3] deals with corruption but focuses on its effect on growth in 14 Latin American and Caribbean countries. However, in developing countries, few studies have examined how government efficiency in budget allocation, and particularly rent capture, is perceived as corruption, especially in Sub-Saharan Africa. It should be noted that in Sub-Saharan Africa, corruption is a phenomenon that pervades all areas of the economy. Habib [17] shows that African countries are highly corrupt. In the same vein, Tanzi and Davoodi [31] argue that the total amount of expenditure is artificially inflated by the sums embezzled or bribed when public decision-makers are corrupt, particularly in a "bureaucratic" regime. In the case of corruption in the sense of embezzlement of public funds, the state budget includes not only actual public spending but also the sums embezzled. Moreover, Sahnoun and Abdennadher [29] and Jajkowicz and Droiszova [22] provide empirical evidence that corruption hurts public spending in developing countries.

According to the World Bank's governance index, the control of corruption is very weak, at around −0.25.

As an extension of rent-seeking theory in institutional economics, analyzing the efficiency of governments in allocating budgets and distributing public spending in Sub-Saharan African countries is of prime interest, since these countries are struggling to ensure their development efficiently in a context of transition economies with discretionary administrative power and institutional failure. A public expenditure model is, therefore, used while incorporating corruption as a rent capture phenomenon. A dynamic panel model of 48 Sub-Saharan African countries is estimated using efficient and robust methods, namely: the method of generalized moments in a system (GMM); bias-corrected estimation of linear dynamic panel data models of Breitung et al. [6] and regression with Driscoll–Kraay standard errors. The alternative use of these different dynamic panel methods makes it possible to resolve the problems of endogeneities, multicollinearities and omitted variables to obtain robust results. The study shows that corruption is detrimental to budget management. On the one hand, it inflates the overall level of public investment, and on the other, it affects the composition and allocation of public spending. The results indicate that corruption distorts budget allocation in favor of sectors where the risk of detecting corruption is very low, to the detriment of sectors where it is difficult to extract rent. The rest of the article is divided into three sections. The first section provides a brief review of the literature. The second section deals with the analysis methodology, while the third section presents the results of the estimations and the ensuing discussions.

Literature review

This heading first reviews the existing literature on the subjects of corruption and public investment.

Considered by the World Bank as the abuse of public service for personal enrichment, corruption is a relatively complex phenomenon that encompasses a range of human actions [8]. For Jain [21], corruption broadly refers to practices in which "public officials, legislators and politicians use the powers delegated to them by the community to pursue their economic interests." It includes embezzlement, influence peddling and bribery.

Corruption with and without theft can be clearly distinguished using the agency model developed by Shleifer and Vishny [30]. The model assumes a public good produced by the government and sold at price p. The agent can limit the supply of this good without risk of detection to maximize the sum of bribes resulting from this sale. When the revenue destined for the state ends up in the agent's pocket, there is bribery with theft, since there is theft of public resources. On the other hand, when the agent maximizes the bribes by adding a sum x to the price p of the good, there is corruption without theft. It is, therefore, the user who is subject to theft, not the state. For the user, it is always preferable to deal with bribery with theft, as the actual price may be lower than the price p of bribery without theft [11]. Consequently, corruption distorts not only the allocation of public investment but also the overall level of public spending.

By using their discretionary power in allocating the budget, public authorities can redirect resources toward sectors where they have greater scope for extracting rents. Similarly, Mauro [25] provides empirical evidence that for a high preference for bribes, public authorities are likely to invest in projects that offer the best rent-seeking

opportunities. Indeed, these types of expenditure may involve high-tech goods produced by oligopolistic markets, corruption being difficult to detect since the prices of high-tech products are not comparable to the prices of innovative products. In this respect, Gupta et al. [14] have recently shown that corruption reduces the amount spent on education and health, as it is difficult to obtain bribes compared to other sectors of activity. These situations offer politicians and bureaucrats more advantageous bribes thanks to higher profits. In addition, Bardhan [4] argues that rent-seeking by senior officials and policy-makers can lead to a redirection of resources toward spending on large projects. For him, project size is a bottom-up function of the cost of purchased goods. Furthermore, Tanzi and Davoodi [31] show that, given budgetary constraints, corruption redirects public investment toward large projects and effectively leads to an increase in project size and complexity, to the detriment of expenditure categories such as operation and maintenance, education and health. They base their analysis on the famous "golden rule." This idea is widely shared by Mauro [24]. Considering Barro's (1990) model, in which public spending includes public goods (services), Babar (2011) shows that in the presence of corruption, public goods are at a much lower level than in the absence of corruption. He shows that corrupt officials and bureaucrats steal part of the resources that would normally increase the supply of public goods.

For his part, Zohal (2010) uses an endogenous rent-seeking model to demonstrate that corruption has an impact on the distribution of public spending. At the equilibrium point, he finds that corruption increases the amount of public spending on health. In his view, corruption is, therefore, a factor that stimulates spending on human capital, particularly in the health sector. In the same vein, some authors have developed models to support the idea that corruption is a lubricant. These include Huntington (1668), Leff (1964) and Theobald (1990). They argue that, in the absence of institutional capital (effective institutions and systems of governance) with a high level of regulation, corruption compensates for institutional weaknesses and the effects of heavy bureaucracy while stimulating the economy. Beck and Maher (1986), in turn, argue that corruption can allocate investment at its most efficient level since the highest bribes are paid by the most efficient entrepreneurs. The latter find that corruption compensates for public rigidities.

Delavallade [10], De la Croix and Delavallade [9] and Mauro [25] have also demonstrated, using empirical data, that corruption negatively affects investment in public human capital (health and education), but positively affects certain expenditures, notably military expenses, fuel, energy, public transport and so on. Using a dynamical corruption model, De la Croix and Delavallade [10] show that corruption negatively affects government spending on human capital. Their study covered 63 countries observed over the period 1996–2004, using the triple least squares (3LS) method with instrumental variables.

Table 1 Statistiques descriptives des variables et sources

Variable	Obs	Mean	SD	Min	Max	Sources
tot_pctgdp	834	1827.957	29.00269	0.1585473	680879.4	Speed data
hl_pctgdp	638	2.338128	4.406928	1.06e−07	79.25687	Speed data
edu_pctgdp	638	4.281307	10.28393	1.83e−07	222.8377	Speed data
def_pctgdp	638	3.373837	9.362908	0.0000121	86.95763	Speed data
fuel_pctgdp	490	0.6007333	0.9519282	0	5.9509	Speed data
min_pctgdp	577	0.6707377	1.271738	0	12.59903	Speed data
trn_pctgdp	540	1.828563	2.740686	0	13.69197	Speed data
com_pctgdp	406	0.1581876	0.230025	0	1.624649	Speed data
Corrup	858	2.9705	0.8447715	0.0205322	4.326361	WGI
Pop_grow	836	2.554836	0.953668	−2.628656	8.117928	WDI
GDP_grow	836	4.330983	5.039559	−46.08212	26.41732	WDI
Infla	814	11.25802	34.99731	−60.4964	513.9068	WDI
Esp_vie	836	55.62496	6.995973	35.38	74.30976	WDI
Apd	836	64.16045	74.87305	0.4633441	691.9246	WDI
kh_BLE	770	3.844245	12.73896	1.053331	89.35313	PWT9, 1 (B-L)
rente_res	726	13.43915	12.58561	0.0658137	59.61957	WDI

Source: Author, based on WB data (WGI and WDI), PWT9, 1 (B-L) and SPEED DATA

Data and analysis methodology

Theoretical analytical approach

Justifying the theoretical background of the model is a prerequisite for specifying the empirical model.

Following Delavallade [9] and Hessami [18], we include the corruption parameter in public spending and consider the basic framework of an economy, i.e., a concentration of identical agents whose measure is unitary and whose have a lifetime between 0 and infinity. Given that utility is maximized, the agent has the choice of working (in the rentier sector or the productive sector). Thus, $1 - x_t$ is the number of people who have made a priesthood and decided to join the manufacturing sector. People looking for an annuity represent x_t

In the model, it is assumed that no sector is exempt from corruption as a result of over-invoicing and fraudulently obtaining public contracts.

To grasp the induced effect of corruption on public service, we analyze the lines of Hussain [20]. For him, as a corrupt bureaucrat takes a share of expenditure for a social cause, the level of service diminishes at the same time. Thus, when bureaucrats are all honest, no corruption exists, and the level of public service provided by the government is given by:

$$G_1 = ng \tag{1}$$

On the opposite, if a bureaucrat decides to take a share of public resources θ, the level of service provided is as follows:

$$G_2 = (1 - \vartheta\theta)ng \tag{2}$$

with $0 < \theta < 1$.

As we observe $G_1 > G_2$, means that the level of public service without corruption is much higher than the level without corruption.

Furthermore, if resources are diverted as a result of overcharging or rent-seeking, decision-makers anticipate an initial level G_1 high level of public spending which will be higher than the level invested $G2$. In this case, we always $G1 > G2$. Equation (2) also shows the effect of corruption on public spending.

Select variables, source and expected signs

Variables were selected mainly on a literature basis. The discretionary behavior of bureaucrats is a source of distortion in the production and provision of government agencies. In addition to influencing overall expenditure, corruption also affects the structure of public spending [11, 16, 25].

Beyond the corrupt phenomenon, certain variables are likely to influence the level of allocation of public spending. Such variables make it possible to better control the effects of the institutional environment on budget allocations. GDP per capita growth rate is used as a proxy to measure a country's level of economic development. The more resources a country has, all other things being equal, the more it can increase public investment in some sectors [11, 15, 24, 25].

The rate of population growth is likely to affect the level of public spending since it increases the demand for public services: Investment in health and education is expected to be influenced by the rate of population growth. This variable was also used by Delavallade [11] in his thesis. Mauro [25] also shows that educational expenditure is likely to increase with the share of the population aged less than 15. This is expected to have a positive sign. The level of public investment can be boosted by the level of inflation. This is because the high rising cost of living leads to an appreciation in the price of goods, which, in turn, increases the level of public investment. A positive effect is expected. The level of government spending in a past period is also used to explain the current level of government expenditures. The level of spending in year t-1 can explain the level of spending in year t.

Empirical data analysis

To carry out our estimations, we first carry out a variable descriptive analysis, then we specify the model to be estimated, and finally, we justify the estimation procedure.

Statistical analysis of model variables and variable sources

Table 1 provides a statistical description of the model variables. The analysis shows that in Sub-Saharan Africa, the average level of corruption is approaching 3, with little disparity between countries. Government spending on the health sector has an average of 2.3381, with little disparity between countries. In the cases of investment in education and defense, the median is higher than that for health, but the divergence is far from that of the health sector. As far as other expenditure is concerned, it should be noted that it varies widely. There is considerable variation between countries.

Econometric specification

As the allocation of public resources is left to the discretion of public decision-makers and bureaucrats, we estimate the effects of public action efficiency in this allocation of public resources. As we already know from the literature that public resource allocation is subject to a corruption bias, depending on the weight of rent, we estimate the effect of corruption in this allocation.

To achieve this, we specify a model inspired by [11]. The result is Eq. 3

Table 2 Results of corruption impact estimates in %GDP (GMM in system)

Variables	hl_ptgdp	ed_ptgdp	df_ptgdp	fuel_ptgdp	trn_ptgdp	com_pctgdp	min_ptgdp	tot_pctgdp
Corrup	0.386*	−1.222**	0.928***	0.1365*	0.0235**	−0.0377	−0.0894	2.349*
	(0.202)	(0.514)	(0.330)	(0.047)	(0.124)	(0.0278)	(0.0938)	(1.258)
Pop_grow	−0.628***	−0.385	−0.478*	−0.0262	−0.0163	0.00623		−3.027**
	(0.183)	(0.418)	(0.286)	(0.0376)	(0.0544)	(0.0119)		(1.181)
Gdp	0.0270	0.0103	0.0255	0.000950	−0.00488	−0.00181	−0.0132*	−503.7***
	(0.0328)	(0.0804)	(0.0539)	(0.00730)	(0.00888)	(0.00247)	(0.00749)	(190.3)
Infla	−0.00833	−0.00687	−0.00728	0.000770	−0.00282	0.000377	−0.00166	
	(0.00636)	(0.0148)	(0.00986)	(0.00197)	(0.00174)	(0.000863)	(0.00144)	
L.hl_ptgdp	0.390***							
	(0.0360)							
L.edu_ptgdp		0.180**						
		(0.0744)						
L.def_ptgdp			0.838***					
			(0.0263)					
L.fuel_ptgdp				0.872***				
				(0.0305)				
L.trn_ptgdp					0.970***			
					(0.0170)			
con_pouv					0.0256	0.0255	−0.0467	
					(0.111)	(0.0244)	(0.0938)	
L.com_ptgd						0.699***		
						(0.0465)		
L.min_ptgdp							0.769***	
							(0.0423)	
APD							0.000114	−4.095
							(0.000454)	(18.29)
rent_res							0.0107***	
							(0.00324)	
L.tot_ptgdp								0.652***
								(0.0256)
kh_BLE								−2.033
								(98.18)
Constant	1.861***	8.039***	−0.919	−0.0643	0.0301	0.0737*	0.454**	4.293
	(0.645)	(1.768)	(0.999)	(0.125)	(0.165)	(0.0402)	(0.211)	(4.375)
AR2	0.894	0.865	0.346	0.245	0.110	0.529	0.157	0.734
Sargan/Hansen	0.741	0.988	0.989	0.987	0.997	0.999	0.967	0.302
Observations	567	567	567	423	471	357	403	691
Number of ID	27	27	27	23	25	22	20	33

***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$. Standard errors in parentheses

Source: Author, using data from WDI, 2019 and SPEED data, 2019

, which is estimated by introducing sectoral expenses one by one.

$$\left(\frac{dep_{\sec_s}}{pib}\right)_{it} = \alpha_0 + \alpha_1\left(\frac{dep_{\sec_s}}{pib}\right)_{it-1} + \alpha_2 corrup_{it} + \theta X_{it} + \varepsilon_{\mathrm{it}} \quad (3)$$

In this equation, $(\frac{dep_{sec_s}}{pib})_{it}$, it is the amount of spending in a given sector as just one percentage of GDP. Sectors covered include health, education, defense, transport, communications, energy, fuels and mining. corrup_it is the level of corruption in each country. The share of spending in a given sector as a percentage of GDP lagged one period is denoted by the term $(\frac{dep_{secs}}{pib})_{it-1}$. The vector X_{it} denotes a set of control variables. As for the effect of corruption on resource allocation, it is captured by the coefficient α_2

Table 3 Estimating the effects of corruption on the share of expenditure as a % of GDP [6]

Variables	hl_pctgdp	edu_pctgdp	def_pctgdp	fuel_pctgdp	min_pctgdp	trn_pctgdp	com_pctgdp	oth_pctgdp
corrup	0.272**	−0.122**	1.508**	0.0263*	−0.0595*	0.0591**	−0.0217	1.985**
	(0.280)	(0.229)	(1.398)	(0.0293)	(0.0401)	(0.0415)	(0.0143) (1.989)	
Pop_grow	−0.149**	−0.0540	−0.288	−0.0103	0.0509	0.0133	−0.00982	−642.7
	(0.155)	(0.158)	(0.282)	(0.0255)	(0.0446)	(0.0191)	(0.00999)	(650.6)
GDP_grow	0.0683	0.0469	0.0971	0.00199	−0.00465	−0.00484	−0.00219	182.9
	(0.0565)	(0.0404)	(0.111)	(0.00407)	(0.00420)	(0.00456)	(0.00244)	(197.9)
infla	−0.00216	0.000910	0.00389	4.68e−05	−0.000179	−0.000798	0.00229	5.701
	(0.00204)	(0.00148)	(0.00357)	(0.000345)	(0.000386)	(0.00101)	(0.00186)	(7.353)
L.hl_pctgdp	0.350***							
	(0.0129)							
L.edu_pctgdp		0.465***						
		(0.00412)						
L.def_pctgdp			0.684***					
			(0.0313)					
L.fuel_pctgdp				0.566***				
				(0.0616)				
L.min_pctgdp					0.808***			
					(0.0740)			
L.trn_pctgdp						0.744***		
						(0.142)		
L.com_pctgdp							0.510*	
							(0.270)	
L.oth_pctgdp								0.966***
								(0.0117)
Constant	−1.909	−1.889	−6.132	0.260	−0.0854	0.553*	0.184	−14.63
	(2.499)	(3.809)	(6.062)	(0.192)	(0.191)	(0.302)	(0.193)	−1.543
Observations	441	441	441	317	382	365	251	596
Number of ID	21	21	21	17	19	19	16	29

Standard errors in parentheses

We can also analyze the effect of corruption on the level of public spending on human capital as a percentage of public spending. To do this, we try to capture the effect of corruption on the level of public expenditure as a percentage of GDP. We, therefore, obtain the following Eq. 4:

$$\left(\frac{dep_{tot}}{pib}\right)_{it} = \varphi_0 + \varphi_1\left(\frac{dep_{tot}}{pib}\right)_{it-1} + \varphi_2 corrup_{it} + \phi X_{it} + \varepsilon_{it} \tag{4}$$

with $(\frac{dep\_tot}{pib})_{it}$, total expenditure as a percentage of GDP.

It is recognized that:

$$\frac{dep\_\sec t_i}{pib} = \frac{dep - tot}{pib} * \frac{dep\_\sec_i}{dep\_tot} \tag{5}$$

From Eq. (5), we can determine the effect of corruption on the level of public spending as a percentage of total spending using the term α_2/φ_2.

We, therefore, analyze in greater detail the effects of corruption on the allocation of public resources.

To achieve this objective, an appropriate estimation strategy is needed to obtain better results.

Estimating strategy

The method used in this study is the generalized method of moments in a system (GMM system). This method was first proposed by Arellano and Bond [2] and Holtz-Eakin Newey and Rosen [19]. Two estimators are derived from this method: the difference MMG estimator or Arrellano and Bond [2] and the MMG estimator of Blundell and Bond [5] or system MMG estimator. This technique offers enormous advantages in terms of estimation, particularly for macroeconomic data, which are generally associated with endogeneity problems.

In this model, we include the lagged dependent variable as an explanatory variable. The introduction of this variable

Table 4 Results of estimates of the effects of corrupt practices on the share of expenditure in % of expenditure [6]

Variables	hl_pctexp	edu_pctexp	def_pctexp	min_pctexp	trn_pctexp	com_pctexp	oth_pctexp
Corrup	0.107*	−0.276	0.302**	−0.230	0.0395	−0.0766	2.262
	(0.105)	(0.287)	(0.166)	(0.200)	(0.122)	(0.0547)	(1.613)
Pop_grow	−0.0324**	−0.0174	−0.101*	0.155	0.0529**	−0.0376	−0.511
	(0.0538)	(0.0933)	(0.199)	(0.141)	(0.0602)	(0.0255)	(0.537)
GDP_grow	0.00661	0.0139	0.0596*	0.0144	−0.0105	−0.00247	0.106*
	(0.00599)	(0.0237)	(0.0334)	(0.0140)	(0.0141)	(0.00462)	(0.0592)
infla	−0.000485	−0.000638	0.00228	0.000328	−0.00171	0.00705	0.0100
	(0.000483)	(0.000864)	(0.00258)	(0.00108)	(0.00224)	(0.00456)	(0.00939)
L.hl_pctexp	0.685***						
	(0.0928)						
L.edu_pctexp		0.684***					
		(0.0724)					
L.def_pctexp			0.687***				
			(0.120)				
L.min_pctexp				0.746***			
				(0.140)			
L.trn_pctexp					0.740***		
					(0.129)		
L.com_pctexp						0.498**	
						(0.225)	
L.oth_pctexp							0.939***
							(0.0815)
Constant	1.289**	3.759**	2.380	0.356	0.849	0.589	13.55
	(0.520)	(1.495)	(2.317)	(0.728)	(0.587)	(0.532)	0
Observations	441	441	441	382	365	251	596
Number of ID	21	21	21	19	19	16	29

Standard errors in parentheses

creates an endogeneity problem. Moreover, the use of institutional variables is also a source of endogeneity, given how they are calculated. Institutional variables are produced from expert opinion and survey data, and are, therefore, potentially subject to measurement error [1, 34].

The first-difference model, or Arellano and Bond [2], involves taking the first-difference of the equation to be estimated for each period, in order to eliminate country-specific effects, and then instrumenting the explanatory variables of the first-difference equation with their level values lagged by at least one period or more. Although this method is more powerful than OLS, instrumenting with level-lagged variables does not seem appropriate and does not allow us to identify the influence of time-invariant factors. Blundell and Bond's system MMG estimator combines first-difference with at least one period lagged level equations. The latter are more appropriate than the former. Indeed, Monte Carlo simulations by Blundell and Bond [5] have shown that the system MMG compares favorably with the first-difference estimator. They argued that, when the instrumentation is small, the parameters are biased for small samples. But combining first-difference equations with level equations, and estimating them simultaneously, increases the importance of estimator precision when the explanatory variables are highly cross-correlated.

Several preconditions must, therefore, be met before MMG can be used in the system. For Roodman [27, 28], it makes sense for the study period (T) to be significantly reduced compared to the sample size of the study (N).

In this study, N is 48 and $T=23$. Two tests are associated with the MMG estimator in a dynamic system to ensure the robustness of the results. These are the Sargan/Hansen over-identification test, which verifies the validity of lagged variables as instruments, and the Arellano and Bond autocorrelation test, where the zero hypothesis is the non-existence of first-order autocorrelation of errors in the level equation.

To ensure the stability of the results, two other dynamic panel methods are used: the bias-corrected estimation of linear dynamic panel data models by Breitung et al. [6] and regression with Driscoll–Kraay with standard errors.

Table 5 Results of estimates of the effects of corruption on the share of expenditure in %GDP [13]

Variables	hl_pctgdp	edu_pctgdp	def_pctgdp	fuel_pctgdp	min_pctgdp	trn_pctgdp	com_pctgdp	oth_pctgdp
corrup	0.478**	−0.911***	2.285**	0.141	−0.153	0.384**	−0.00387	20.952*
	(0.364)	(0.562)	(1.302)	(0.106)	(0.0956)	(0.363)	(0.0179)	−11.043
Pop_grow	−1.251***	−1.978**	−2.624**	−0.0474	−0.400***	−0.858***	−0.0330***	−15.753*
	(0.318)	(0.728)	(0.978)	(0.0344)	(0.0552)	(0.121)	(0.0110)	−8.384
GDP_grow	0.0673	0.0439	0.151	−0.00647	−0.00771	0.00844	0.00188	1.178
	(0.0544)	(0.0507)	(0.191)	(0.0103)	(0.00844)	(0.0477)	(0.00308)	−1.379
infla	−0.00859**	−0.00941**	−0.0176*	−0.00106*	−0.00215***	−0.00821***	0.00709***	−118.3
	(0.00319)	(0.00358)	(0.00886)	(0.000589)	(0.000665)	(0.00233)	(0.00210)	(71.50)
kh_BLE	0.0826***	−0.0234	0.244**	−0.0187**	0.0301***	0.0944***	−0.00272	2.078***
	(0.0279)	(0.0338)	(0.0929)	(0.00692)	(0.0103)	(0.0135)	(0.00282)	(550.6)
FBCF	−0.0681**	0.0132	−0.231***	0.00823	−0.00952	−0.0752***	0.00322*	−1.663***
	(0.0251)	(0.0305)	(0.0752)	(0.00550)	(0.00659)	(0.00750)	(0.00170)	(429.6)
Ouverture	0.0140**	0.0203***	0.0169	−0.000615	0.000231	0.00381	−2.00e−05	83.18
	(0.00613)	(0.00696)	(0.0138)	(0.00116)	(0.00101)	(0.00531)	(0.000309)	(81.09)
rente_res	−0.0296*	−0.0149	−0.0944*	0.0170***	0.0110	−0.0294***	0.00666***	−780.4*
	(0.0144)	(0.0272)	(0.0529)	(0.00269)	(0.00850)	(0.00961)	(0.00170)	(407.4)
Constant	4.495***	10.82**	7.692***	0.851**	2.122***	4.165***	−0.00714	17.932*
	(1.223)	(3.878)	(1.882)	(0.398)	(0.394)	(0.911)	(0.0370)	−10.391
Observations	462	462	462	336	401	386	269	625
R-squared	0.103	0.056	0.116	0.064	0.279	0.198	0.468	0.111
Number of groups	21	21	21	18	19	20	17	29

Standard errors in parentheses

Table 6 Results of estimates of the effects of corruption on the share of expenditure as % expenditure Drisc/Kraay [13]

Variables	hl_pctexp	edu_pctexp	def_pctexp	min_pctgdp	trn_pctexp	com_pctexp	oth_pctexp
Corrup	−0.825	−1.086	−0.916**	−0.153	−0.645***	−0.0482	2.547
	(0.494)	(0.692)	(0.422)	(0.0956)	(0.226)	(0.0535)	(1.993)
Pop_grow	0.537**	1.325*	3.704***	−0.400***	0.761**	−0.0263	−1.103
	(0.194)	(0.649)	(1.141)	(0.0552)	(0.348)	(0.0380)	(1.243)
GDP_grow	0.0251	−0.0691	−0.506**	−0.00771	0.0483**	0.00333	−0.283
	(0.0444)	(0.0818)	(0.187)	(0.00844)	(0.0202)	(0.00836)	(0.224)
Infla	−0.00777***	−0.0146	0.0274	−0.00215***	−0.00895***	0.0204***	0.00955
	(0.00216)	(0.0111)	(0.0395)	(0.000665)	(0.00209)	(0.00586)	(0.0142)
kh_BLE	−0.0358	0.0281	−0.158**	0.0301***	0.0618*	−0.00926	−0.355
	(0.0218)	(0.0284)	(0.0706)	(0.0103)	(0.0351)	(0.00770)	(0.344)
FBCF	0.0638***	0.116***	0.102*	−0.00952	−0.00369	0.00924	−0.107
	(0.0150)	(0.0241)	(0.0577)	(0.00659)	(0.0207)	(0.00561)	(0.243)
Ouverture	0.0220***	0.0431***	−0.0732**	0.000231	0.00608	0.000117	−0.106***
	(0.00128)	(0.00823)	(0.0268)	(0.00101)	(0.00700)	(0.000894)	(0.0301)
rente_res	−0.0111	−0.188***	−0.178***	0.0110	−0.0527**	0.0211***	−0.0481
	(0.0107)	(0.0205)	(0.0484)	(0.00850)	(0.0217)	(0.00577)	(0.128)
Constant	4.386***	11.60***	12.93**	2.122***	4.424***	−0.0185	78.64***
	(1.211)	(1.793)	(4.692)	(0.394)	(1.207)	(0.0990)	(4.626)
Observations	462	462	462	401	386	269	625
R-squared	0.253	0.272	0.151	0.279	0.104	0.447	0.094
Number of groups	21	21	21	19	20	17	29

Standard errors in parentheses

Driscoll–Kraay standard errors are robust to very general forms of spatial and temporal dependence when the temporal dimension becomes important. This non-parametric technique for generating standard errors imposes no restrictions on the limiting behavior of the number of panels. Consequently, the size of the cross-sectional dimension in finite samples is not a constraint on feasibility—even if the number of panels is much larger than T. However, it should be noted that the estimator is based on asymptotics of large T. Some caution is, therefore, called for. Therefore, some caution should be exercised when applying this estimator to panel data sets with a large number of panels but a small number of observations over time.

For the bias-corrected estimation of models of linear dynamic panel data from Breitung et al. [6], this is an estimator based on a simple set of moment conditions which can be easily solved using standard numerical optimization procedures. It is easy to generalize the estimator to higher order auto-regressive models or to random effects dynamic models. An estimator of the asymptotic covariance matrix is readily accessible, as is robust standard errors that efficiently adjust for cross-sectional dependence, an important feature in panel macroeconomic analysis.

Findings and comments

The results show that corruption not only increases the overall level of public expenditures, but also distorts the allocation of public resources between different sectors of activity. Post-estimation tests show that the results are valid and robust to alternative estimation methods. Indeed, it favors certain sectors to the detriment of others. Corruption positively affects the share of public funds allocated to health, the army, fuel and energy and transport on the one extreme, and on the other, but negatively affects the share of resources allocated to education, communication and mining. It should be noted that the results are significant, of the order of 1% for the defense sector, 10% for health and 5% for energy and transport. Indeed, a 1% increase in the level of public corruption leads to a 0.386% increase in health-care spending. This result can be easily interpreted as the purchase of certain imported materials, the net costs of which are difficult to verify, and other large-scale projects in the health field. In the defense sector, a 1% increase in corruption leads to a respective increase of 0.928% in military expenses, 0.1365% in energy expenses and 0.0235% in transportation expenses. It should be noted that the purchase of combat equipment and investigations remains the least controlled areas due to the sensitivity of information and confidentiality, and it is easy to extract rents. The results show that a 1% increase in corruption leads to a drop in public spending in certain areas. In fact, these are sectors where the risk of corruption being detected is very high, and rents are difficult to extract. These include education, down 1.222%, communications, down 0.0377%, and mining, down 0.0894%. Delavallade [10] found a similarly similar result for 64 countries over the period 1964–2001, using triple least squares (3LS).

Aside from the distorted budget allocation, the last column of Table 2 highlights the fact that corruption significantly inflates global spending levels in Sub-Saharan African countries. A 1% rise in corruption leads to a 2.349% boost in total spending. This increase in public expenditure is due to the over-invoicing of certain imported products and others that genuinely escape the price control mechanism. It may also result from the deliberate intention of rent-seeking decision-makers in that the misappropriation of public funds, the state budget includes not only actual public expenditure but also the sums embezzled. This result is confirmed by the work of Tanzi and Davoodi [31], who show that the total amount of expenditure is artificially inflated by the sums embezzled or bribed when public decision-makers are corrupt, particularly in a "bureaucratic" regime.

Examination of the results indicates that the sectors in which corruption negatively impacts the share of the budget allocated to them appear to be the less rent-producing sectors. Nevertheless, those that benefit from budgetary favors are those in which resources are easily concealed, either through the awarding or execution of public contracts, or through the provision of working materials. In developing countries in general, and in the emerging economies of Sub-Saharan Africa in particular, certain areas are fertile ground for rent-seeking. Indeed, the transport, military and health sectors, as well as the fuel and energy industries, seem to be ideal for corruption, since the risk of detection remains minimal. For Hessami [18], these types of sectors where corruption increases public spending are those where rent-seeking is more secretive and where auditing is extremely difficult to detect over-invoicing and fraudulent awarding of large contracts. On the other hand, sectors such as education,

communication and mining present high risks of detection, as these sectors are much more involved in operating with small projects.

Our findings are compatible with those obtained by De la Croix and Delavallade [9, 11] on 63 countries with biennial data from 1996 to 2004. Using a dynamic corruption model estimated by triple least squares with endogenization of graft, they show that public investment is distorted in favor of certain rent-seeking expenditures. Indeed, a 1% increase in corruption leads to a decrease of more than 1% in public spending on education in Sub-Saharan African countries. In contrast with the education sector, in the health sector, a 0.386% increase in public spending is caused by a 1% increase in corruption. This result is in phase with that of Gupta et al. [16] and is contrary to that found by De la Croix and Delavallade [11]. For the latter, the health sector is not subject to corruption and, therefore, does not benefit from large budgets and projects. However, in Sub-Saharan Africa, corruption seems to be rampant in the health sector, where even access to certain health services is conditional on bribes. The case of the coronavirus and many other pandemics are a perfect illustration of this, as the importation of certain equipment generates rents. This distortion in the allocation of public resources to education can be explained by the fact that in SSA countries, there are no major public projects in favor of education, and this sector is highly vulnerable to corruption. Furthermore, investment in education does not seem to be used effectively. This is why, in December 2018, the World Bank adopted an Education Development Project calls on the governments of African countries, particularly those in Sub-Saharan Africa, to invest effectively and massively in education, training for their populations and health.

The results of the estimates of the effects of corruption on the share of public expenditure in %GDP are shown in Table 2.

Conclusion and economic policy implications

The aim of this study was to analyze the role of the institutional environment in budget execution in developing countries. In particular, the role of corruption in the allocation of public resources is analyzed, highlighting the discretionary power of the budgetary authority. To this end, data from several sources were estimated in a panel of 48 Sub-Saharan African (SSA) countries using sophisticated methods, namely, the generalized method of moments, bias-corrected estimation linear dynamic panel dada [6] and type error correction [13].

The results indicate that corruption is detrimental to the allocation of public resources, as it inflates the level of public expenses and distorts the distribution of the budget. The study reveals that corruption creates a distortion in resource allocation that favors sectors where resources are easily concealed (defense, transport and health) to the detriment of those where control over the use of funds is easier (education and mining).

In terms of economic policy, political decision-makers need to strengthen budgetary control and anti-corruption laws throughout the economic sphere.

And it fosters the business environment by combating corruption in the awarding of public contracts, in order to attract foreign investors wishing to invest in a given field (Tables 3, 4, 5 and 6).

Appendix

See Fig. 1.

(See figure on next page.)

Fig. 1 Stylized facts: correlation between corruption and various human capital indicators and some public spending. **a** Correlation corruption_military spending. **b** Correlation corruption_communication spending. **c** Correlation corruption/education spending. **d** Correlation corruption/health spending. **e** Correlation corruption/fuel spending. **f** Correlation corruption/transport spending. **g** Correlation corruption mine spending

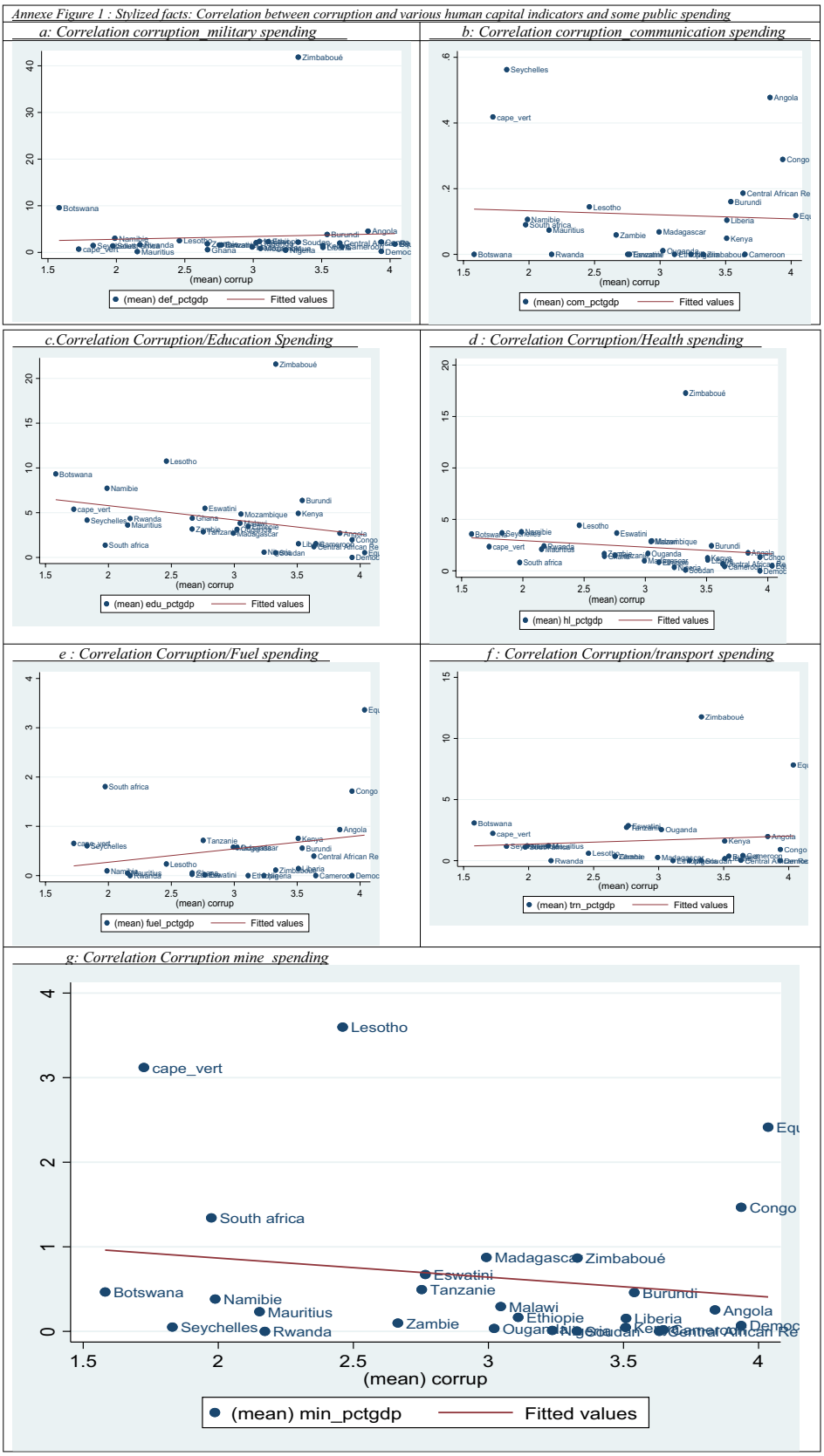

Fig. 1 (See legend on previous page.)

Abbreviations

SSA	Sub-Saharan African
GMM	Generalized moments method
OECD	Organization for Economic Cooperation and Development
WHO	World Health Organization

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Declarations

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