Government spending, corruption and economic growth

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Abstract

This paper considers the effects of corruption and government spending on economic growth. It starts from an endogenous growth model and extends it to account for the detrimental effects of corruption on the potentially productive components of government spending, namely military and investment spending. The resulting model is estimated on a sample of African countries and the results show, first, that the growth rate is strongly influenced by the interaction between corruption and military burden, with the interaction between corruption and government investment expenditure having a weaker effect. Second, allowing for the cyclical economic fluctuations in specific countries leaves the estimated elasticities close to those of the full sample. Third, there are significant conditioning variables that need to be taken into account, namely the form of government, political instability and natural resource endowment. These illustrate the cross country heterogeneity when accounting for quantitative direct and indirect effects of key variables on economic growth. Overall, these findings suggest important policy implications.

Keywords: corruption; military spending; development economics; panel data; Africa
JEL Classification : O57, H5, D73

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1. Introduction

The effect of corruption on economic growth has been extensively researched in the last two decades. Most studies have followed the approach of Barro (1991) and Levine and Renelt (1992) and have regressed cross-sectional estimates of corruption on the average rate of economic growth and a set of control variables. While not denying that corruption may have played a positive role at particular times in specific countries, the main findings of the empirical literature have been that corruption is endemic and pervasive and tends to lead to lower growth, hampering both private and productive government spending in investments and inhibiting the efficiency of public services (see, for a review, Aidt, 2003; Svensson, 2005). The literature remains divided on the channels through which corruption is transmitted and the size of the direct and indirect impact of corruption on the growth rate. The seminal work by Mauro (1995) found that much of the effect of corruption growth comes through its effect on investment, while Pellegrini and Gerlagh (2004) find that the indirect effects of corruption on human capital, political stability, and trade openness are also important. Corruption can also affect the growth rate through distortions in tax collection, the level of public expenditure and the composition of government expenditure. Rose-Ackerman (n.d.) suggest that corrupt government officials may come to prefer the types of expenditure that allow them to collect bribes and to keep them hidden and Shleifer and Vishny (1993) suggest that large expenditures on specialised items such missiles and bridges, whose exact market value is difficult to determine provide more opportunities for corruption. It is certainly likely to be easier to collect substantial bribes on the high technology defence component or infrastructure projects than on teacher's salaries (Mauro, 1997). For example, the limited competition in defence sector may lead t o a relatively high level of informal contracts and to rent-seeking activities, providing fertile ground for the growth of corrupt practices and so increase the cost of military activities, encourage rent seeking in the military sector and crowd out productive investment in the private sector. In other areas, such as health, the picture is less clear-cut: opportunities to collect bribes may be abundant in the procurement of hospital buildings but more limited in the payment of doctors' and nurses' salaries. Indeed, Gupta et al. (2001) find that corruption increases the proportion of military spending in GDP and total government spending, more so than in the case of education and health (Tanzi, 1998; De La Croix and Delavallade, 2007).

This paper considers how the effect of the different components of government expenditure on economic growth is influenced by good or bad governance. A simple illustrative growth model is developed from the endogenous growth model of Barro (1990), assuming that the military sector and government spending in investments are potential productive inputs and so can affect long run economic growth, and allowing corruption to influence the allocation of public spending. This approach follows Mauro (1997) in using different types of public spending to evaluate the effect of corruption, but also the suggestion of De La Croix and Doepke (2009), who model the different kinds of budgetary distortions that can be caused by corruption. Thus, while corruption acts as a proportional tax on a budget surplus, the heterogeneous productivity of inputs assumed in the production function may also distort the composition of public spending, which is in line with the empirical analysis in Mauro (1998) and d'Agostino et al. (2011). In addition, to estimating the direct effects, this paper also undertakes an empirical analysis of the size of the indirect impact of corruption on growth rate through the public expenditure channels.

The analysis presented here moves beyond cross-country differences, as enough within-country variation is available for regressions of the growth rate of GDP on the components of government expenditure, corruption and other control variables. In line with the theoretical model, the public sector covariates are allowed to have some contemporaneous feedbacks on the error term, and following Dollar and Kraay (2004), Loayza et al. (2005) and Chang et al. (2009), the generalised method of moments (GMM) procedure that addresses endogeneity and controls for unobserved country specific factors is used. Thus, estimates of elasticities for policy variables that are, in principle, subject to improvement through economic and institutional reforms are provided. This represents a departure from studies that simply interact covariates and test whether country characteristics, such as the level of corruption, may have differential effects in the relationship between government expenditure and the growth rate. Instead, the direct and indirect effects are estimated, using an auxiliary regression for each covariate and the estimated parameters to calculate the indirect elasticities.

In investigating the detrimental effects of corruption on economic growth, it is useful to consider countries where the level of corruption is permanently high. This motivates the choice of a sample of Africa countries for this study, where the corruption perception index extracted from African development indicator dataset (World Bank, various years) showed stable patterns of disparities with the developed countries over the last decade. The empirical results, using a recent panel from 1996 to 2007, confirm the endogenous model predictions. While government spending in investments enhances economic growth, large military burden and current (non capital) government spending cut GDP growth and corruption has a negative impact. Significant indirect effects of corruption on economic growth are found for each components of government spending. There is also an asymmetric relation, with the negative effect of military spending on growth being consistently influenced by the indirect impact of corruption on military burden, but with different results for countries with high and low levels of corruption and military burden.

The remainder of the paper is organised as follows. Section 2, briefly reviews the baseline growth framework and Section 3 presents the endogenous growth model extended to allow for the detrimental effects of corruption and derives the expected effects of the model parameters using comparative statics. Section 4 offers insights about the dataset and variables used, while Section 5 discusses the methods used in the empirical analysis and related issues. Section 6 provides a discussion of the empirical results, includes various checks of the robustness of the results. Concluding remarks are then presented in section 7.

2. Preliminaries: the baseline model

Consider an economy where a representative household maximises an utility function choosing the optimal amount of private consumption. The agent produces a single commodity, which can be consumed, accumulated as capital or paid for as an income tax. The objective is to maximise the discounted sum of future instantaneous utilities:

$$MAX \int_0^{\infty} U(c)e^{-\rho t}dt \tag{1}$$

where c describe the amount of private consumption, and ρ is the subjective discount rate. Thus, the instantaneous utility function of private consumption is modelled by a constant elasticity of substitution (CES) function, described as :

$$U(c) = \frac{c^{1-\sigma} - 1}{1-\sigma}. \tag{2}$$

Following Barro (1990) and Devarajan et al. (1996), the production function is modelled as interaction between private capital k and total public spending G, which is disaggregated into military spending M, government investment I and an expenditure for current government consumption, c_p. The production function in aggregate embodies a technology of constant returns to scale and diminishing returns with respect to each factor,

$$y = Ak^{1-\alpha-\beta-\delta}M^{\alpha}I^{\beta}c_p^{\delta} \tag{3}$$

with the evolution of physical capital is given by:

$$\dot{k} = (1-\tau)Ak^{1-\alpha-\beta-\delta}M^{\alpha}I^{\beta}c_p^{\delta} - c \tag{4}$$

where τ is the flat-rate of income tax.

Government uses the total amount of collected taxes (τy) to finance total public spending (G), deploying them among public productive sectors ($M,\ I$) and current government consumption (c_p).

The representative household chooses the optimal amount of private consumption so as to maximise (2) subject to (4) and given the initial level of private capital k. The steady state growth equation is given by:

$$\gamma = \frac{\dot{c}}{c} = \frac{1}{\sigma}\left[(1-\alpha-\beta-\delta)(1-\tau)A\left(g_{mil}\right)^{\alpha}\left(g_{inv}\right)^{\beta}\left(g_{cons}\right)^{\delta}\left(\frac{G}{k}\right)^{\alpha+\beta+\delta} - \rho\right] \tag{5}$$

where γ measures the consumption growth rate, and $g_{mil},\ g_{inv}$ and g_{cons} denote the share of government spending allocated to military spending, government spending in investments and current government consumption, respectively. The government-specific parameters α, β and δ, and are assumed to be complements the private capital. Note that given the components of government spending, the model also corresponds to the Ramsey specification where diminishing returns to private capital are assumed.

This model assumes that the financing of government spending by income tax is an efficient allocation, but this can be relaxed by allowing corrupt practices in the economy to induce allocative distortions. This is done in the next section.

3. The proposed model

Mauro (1995, 1997) provides the first attempts to integrate corruption into the Barro model, considering it to act as a proportional tax on income. This leads to the prediction that the optimal shares of the components of government spending is independent of corruption, the ratio of each component of government expenditure to GDP remains the same no matter how corrupt or unstable the country is. The more corrupt the country, the higher is taxation and so the lower is private investment and economic growth. This does seem rather restrictive and, to develop a more general model, it seems reasonable to assume that the government follows some specific rules:

$$M_{h_1} = h_1 g_{mil} G \tag{6}$$

$$I_{h_2} = h_2 g_{inv} G \tag{7}$$

$$c_{p_{h_3}} = h_3 g_{cons} G \tag{8}$$

These rules determine the allocation of public spending, between the military, investment and government consumption components, net of the estimated value of corruption, where h_1, h_2 and h_3 are parameters that range between 0 and 1. This allows the detrimental indirect effects of corruption on each component to be identified. It also allows the degree of exposure to corruption to differ across categories of productive public expenditures (see, Mariani (2007); Acemoglu and Verdier (1998); Delavallade (2007)). Substituting (6)-(8) into (5) gives the steady state growth equation:

$$\gamma = \frac{\dot{c}}{c} = \frac{1}{\sigma}\left[(1-\alpha-\beta-\delta)(1-\tau)A\left(h_1 g_{mil}\right)^{\alpha}\left(h_2 g_{inv}\right)^{\beta}\left(h_3 g_{cons}\right)^{\delta}\left(\frac{G}{k}\right)^{\alpha+\beta+\delta} - \rho\right]. \tag{9}$$

Rearranging this to focus on the allocation of government expenditure into its components and the degree of corruption, and exploiting the fact that the tax rate τ (and hence G/k) is constant in the steady-state equation gives:

$$\gamma = \frac{1}{\sigma}\left[j\left(h_1 g_{mil}\tau\right)^{\frac{\alpha}{1-\alpha-\beta-\delta}}\left(h_2 g_{inv}\tau\right)^{\frac{\beta}{1-\alpha-\beta-\delta}}\left(h_3 g_{cons}\tau\right)^{\frac{\delta}{1-\alpha-\beta-\delta}} - \rho\right] \tag{10}$$

where $j = (1-\alpha-\beta-\delta)(1-\tau)A^{\frac{1}{1-\alpha-\beta-\delta}}$.

To investigate the properties of the model, the optimal levels of the different components of government expenditure, $g_i = [g_{mil}, g_{cons}, g_{inv}]$, are derived assuming that the rules of financing (6)-(8) are not affected by corruption and then the conditions for the rules to be affected by corruption in steady state are derived. Thanking the first rule, realting to military spendig, note that the condition can be can formulated:

$$\sum_{i=1}^{3} g_i = 1 \quad \Longrightarrow \quad g_{mil} = 1 - g_{inv} - g_{cons}, \tag{11}$$

and the effect of this component of government spending on the growth rate is characterised by the following proposition.

Proposition 1. If the financing rule (11) is always binding, the effect of the components of government spending depends on the relative share of g_i public expenditure devoted to each component and their relative output elasticities. For example, the partial differential of output with respect to g_{mil},

$$(a) \quad \frac{\partial \gamma}{\partial g_{mil}} \geq 0 \quad if \quad \frac{g_{mil}}{g_{inv} + g_{cons}} \leq \frac{\alpha}{\beta+\delta}$$

$$(b) \quad \frac{\partial\gamma}{\partial g_{mil}} < 0 \quad if \quad \frac{g_{mil}}{g_{inv}+g_{cons}} > \frac{\alpha}{\beta+\delta}$$

gives the conditions in which a change in g_{mil} will lead to an increase or a decrease in the long run economic growth rate, respectively.

Proof. Equation (10) can be combined with (11) to give:

$$\gamma = \frac{1}{\sigma}\left[j\left(h_1 g_{mil}\tau\right)^{\frac{\alpha}{1-\alpha-\beta-\delta}}\left[h_2\left(1-g_{mil}-g_{cons}\right)\tau\right]^{\frac{\beta}{1-\alpha-\beta-\delta}}\left[h_3\left(1-g_{mil}-g_{inv}\right)\tau\right]^{\frac{\delta}{1-\alpha-\beta-\delta}}-\rho\right], \qquad (12)$$

meaning the partial derivative of γ with respect to g_{mil} is:

$$\frac{\partial\gamma}{\partial g_{mil}} = \frac{1}{\sigma}\left\{\frac{1}{1-\alpha-\beta-\delta}\left[\frac{\alpha}{g_{mil}}-\frac{\beta}{g_{inv}}-\frac{\delta}{g_{cons}}\right]\lambda\right\} \qquad (13)$$

where $\lambda = j\left(h_1 g_{mil}\tau\right)^{\frac{\alpha}{1-\alpha-\beta-\delta}}\left(h_2 g_{inv}\tau\right)^{\frac{\beta}{1-\alpha-\beta-\delta}}\left(h_3 g_{cons}\tau\right)^{\frac{\delta}{1-\alpha-\beta-\delta}} > 0$ and $(1/1-\alpha-\beta-\delta > 0)$. Thus, the sign of the partial derivative depends on the last three components of equation (13) and the condition $\frac{\partial\gamma}{\partial g_{mil}} \geq 0$ requires that $\frac{\alpha}{g_{mil}} - \frac{\beta}{g_{inv}} - \frac{\delta}{g_{cons}} \geq 0$, or that $\frac{\alpha}{g_{mil}} \geq 0\frac{\beta}{g_{inv}} + \frac{\delta}{g_{cons}}$, which can be manipulated to prove the proposition. These steps in the proposition can be applied to the other components.

Now the effects of corruption can be introduced into the model. This is done by allowing decisions on resource allocation in each sector to be influenced by the expectation of private gain by bureaucrats or policy-makers, rather than the allocation of government spending being driven exclusively by social needs. The model also allows the degree of exposure to corruption to differ across categories of government spending, a useful property given that some categories such as defence do seem more suscepible to corrupt practices (Gupta et al. (2001)). To operationalise the model, the following assumptions are made:

A.1. Corruption has a negative impact on growth, i.e. $\frac{\partial\gamma}{\partial h} < 0$. This excludes the possibility that it might promote economic growth, by relaxing inefficient and rigid regulations imposed by government (see for example, Dreher and Herzfeld (2005)).

A.2. The inefficiencies due to corruption are negligible for current government expenditure, that is $h_3 \cong 1$ in (8). This seems reasonable as it should be easier to collect bribes on large infrastructure projects or high technology defence equipment than on current expenditure, such as nurses' or doctors' salaries (Mauro, 1998).

A.3. The productivity of the categories of public expenditure is not homogeneous. In particular, in the production function (5) β (government investment spending) is greater than α (military spending).

Finally, this model can also account for the indirect effects of corruption:

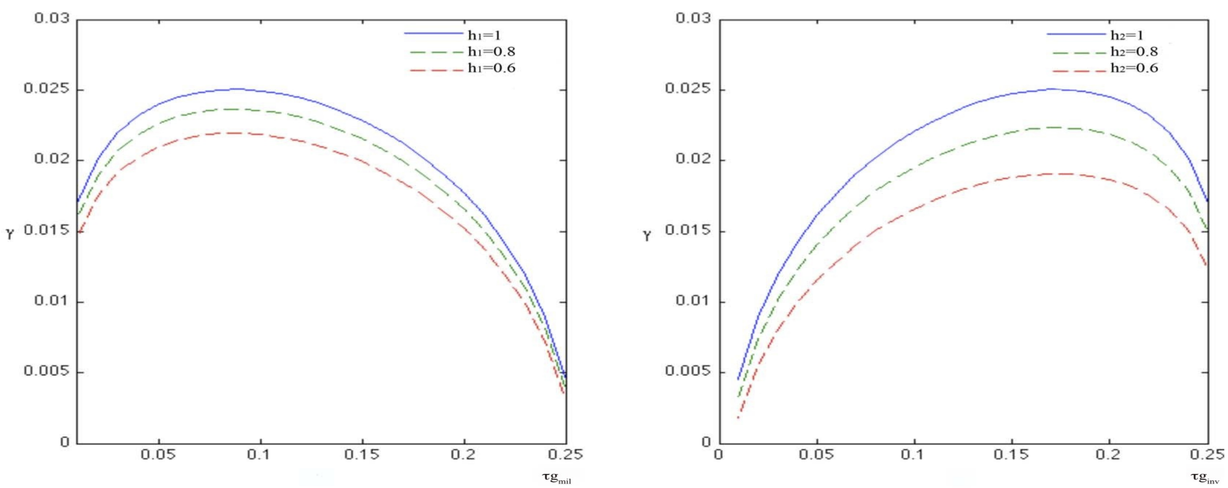
Lemma 1: Given assumption A.3, the mixed partial derivatives of γ, with respect to $g_i = [g_{mil}, g_{inv}]$ and h_i, can account for the detrimental effects of corruption if the following inequalities are satisfied:

$$\begin{aligned} (a) \quad & \frac{\partial\gamma}{\partial g_i} \geqslant 0 \quad \left|\ \frac{\partial\gamma}{\partial h_i} < 0 \Longrightarrow \frac{\partial\gamma}{\partial g_i \partial h_i} \leqslant 0\right. \\ (b) \quad & \frac{\partial\gamma}{\partial g_i} < 0 \quad \left|\ \frac{\partial\gamma}{\partial h_i} < 0 \Longrightarrow \frac{\partial\gamma}{\partial g_i \partial h_i} > 0\right. \end{aligned} \qquad (14)$$

The proof of this follows from Proposition 1 and assumptions A.1-A.3.

It is worth noting that when the impact of government spending is positive, as in case (a) of equation (14), the mixed partial derivate conditions imply that the indirect impact on the growth rate is negative, with a reduction in utility resulting from increases in government spending. When it is negative, as in case (b), they predict that the negative effect of government spending on the growth rate is enhanced by corruption, suggesting complementarity between corruption and government spending.

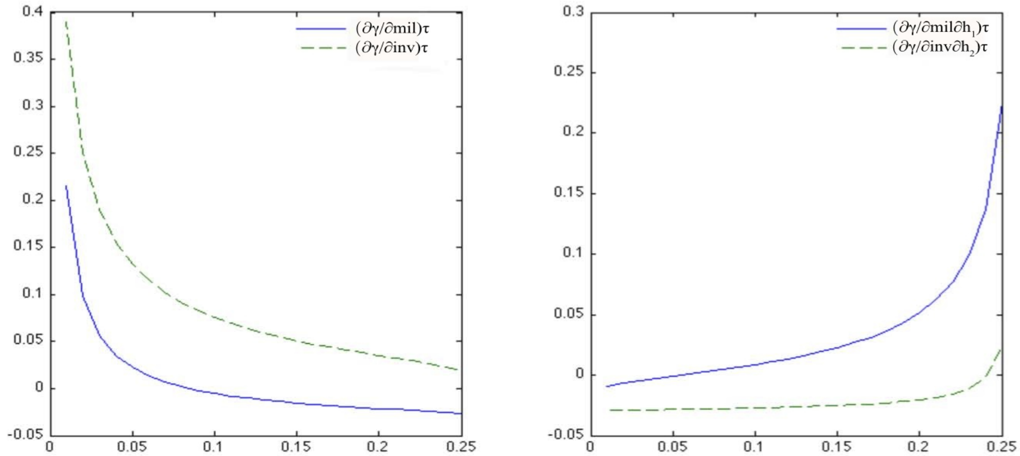
Figure 1 presents the simulation results for the effects on growth of changes in military spending (τg_{mil}) and government investment spending (τg_{inv}) as shares of GDP. The solid line representing the baseline case in which corruption does not affect the growth rate (i.e., $h_1 = h_2 = 1$), with the parametrs used to calibrate the model mainly taken from Devarajan et al. (1996). The left hand panel shows that an increase in the share of of military spending initially has a positive effect on the growth rate, but then its effect becomes negative, while the right hand panel shows that for investment spending the positive effect is more sustained. So reallocating funds from military spending to public investment is likely to increase growth. These results also clarify the conditions under which the growth rate rises when government spending falls. It is when the share of government expenditure is less that its optimal share (g_i^*), with the precise path it takes depending on the relative productivity of the different sectors. The broken lines show the degree to which corruption can reduce the the impact of these spending categories on growth (i.e., $h_i < 1$, with i=1,2). As expected, the interaction of corruption and government investment spending does the most damage.



Notes: $g_{mil}\tau$ and $g_{inv}\tau$ represent the shares of military and investment spending in GDP, respectively, while h_1 and h_2 illustrate the inefficiencies due to corruption in the two public sectors. The parameters used for the simulations are: $\alpha = 0.1$, $\beta = 0.2$, $\eta = 0.6, A = 0.7, \rho = 0.02$.

Fig. 1: *Simulations of the effects of corruption on the relationship between the components of government spending and the growth rate*

In Figure 2 the simulation results are consistent with the expected signs in (14), with the left hand panel showing that being more productive investment spending is able to shift the optimal level of g_{inv} to the right,



Notes: For the parameters used for the simulations of partial and mixed derivative functions, see Fig 1.

Fig. 2: *Partial and mixed partial derivate functions of government spending components and corruption on growth*

with the derivative of γ, with respect to g_{inv}, indicating a positive effect up to a share of 20%. The right hand panel shows the effects on growth of the interaction between corruption and the government spending components, with corruption causing a slight reduction on the effect of government investment spending and enhances the negative effect that military spending has on the growth rate.

4. Regression specification and data

In operationalising the model the first step is to extend the traditional cross section model into a panel data form by specifying as:

$$\gamma_{it} = \psi_0 + \psi_1 X_{it}^1 + v_i + \eta_t + e_{it} \tag{15}$$

where i and t characterise each country and time period (with $t = 1, 2, ..T$) and γ_{it} is the average annual growth rate of GDP for country i during period t. $X_{it}^1 = [mil_{it},\ inv_{it},\ cons_{it},\ corr_{it}]$ is the vector of covariates of government spending components, expressed as a share of GDP, and $corr_{it}$ an index of corruption, with (η_t) and (v_i) unobserved country and time specific effects. It is important to point out that, when $h_1,\ h_2,\ h_3 = 1$, equations (6), (7), (8) allow us to define $mil_{it} = \tau g_{mil} = M_{h_1}/y$, $inv_{it} = \tau g_{inv} = M_{h_2}/y$ and $cons_{it} = \tau g_{cons} = M_{h_3}/y$. The explanatory variables are potentially endogenous in the sense that they are correlated with e_{it} and as the model presented in section 2 takes advantage of out-of-steady-state dynamics, there is an identification issue for A in equation 3. As Mankiw et al. (1992) points out, if countries have permanent differences in their production functions, i.e. different initial technological development, these A's would enter as part of the error term and would be positively correlated with initial per capita income, i.e. $e_{it} = f(A)$. To deal with this, A is modelled as $A = \psi_2 log(Y_{t-1}) + e^*_{it}$ and included in equation (15). Following Barro (1990) private investment in GDP ($priv_{inv_t}$) is also included as an explanatory variable, giving:

$$\gamma_{it} = \alpha + \psi_1 X^1_{it} + \psi_2 y_{it-1} + \psi_3 p\_inv_{it} + v_i + \eta_t + \mu_{it}\ . \tag{16}$$

The dataset used to estimate the model (16) covers 22 African countries over the period 1996-2007 and is mainly extracted from African development indicators of the World Bank (WBI). Descriptive statistics are reported in Table A1 of Appendix A. The government spending components in the vector X^1 are obtained by disaggregating government expenditure into military expenditure, using the NATO definition (all current and capital expenditures on the armed forces, including peacekeeping forces, defence ministries and other government agencies engaged in defence projects and paramilitary forces, if these are judged to be trained and equipped for military operations and military space activities); gross domestic fixed investment (i.e. gross fixed capital formation), comprising all additions to the stock of fixed assets (purchases and own-account capital formation) less any sales of second-hand and scrapped fixed assets by government units and non-financial public enterprises (variable outlays by government on military equipment are excluded); current government consumption, current expenditures of goods and services, including compensation of employees; the share of gross private investment (including private nonprofit agencies as well as fixed domestic assets) in GDP. Corruption is measured using the WBI control of corruption index (CCI) (a measure based on the perceptions of firms and is interpreted as indicating the extent to which public power is exercised for private gain, including administrative and grand corruption, as well as capture of the state by elites and private interests. It ranges from 0 to 100, where 0 means that a country is perceived to be non-corrupt. Appendix A reports the countries covered and the means of each "key" variable.

A number of control variables are added that reflect the particular strategic and institutional factors likely to be relevant to this sample of African countries, giving the extended model:

$$\gamma_{it} = \alpha + \psi_1 X^1_{it} + \psi_2 y_{it-1} + \psi_3 priv_{inv_t} + \psi_4 X^2_{it} + v_i + \eta_t + \mu_{it}\ . \tag{17}$$

where $X^2_i = [regime_i,\ instability_i,\ resources_i]$ is the vector of covariates that accounts for the form of government, the importance of political instability and natural resources. These variables reflect the recognition in the literature that there are wider influences on growth. First, institutional arrangements can shape policy and affect growth, though an autocratic government does not necessarily mean bad economic performance (Besley and Kudamatsu, 2007)[1]. It is, however, generally argued that autocratic regimes allocate more of their economic resources to military spending than democracies (Hewitt, 1992; Sandler and Keith, 1995; Goldsmith, 2003), while the electoral incentives associated with democracy can lead to policies that promote

[1]Both the economic literature has found no strong relationship between income growth and changes in democracy, nor income and democracy (see, Acemoglu et al. (1998); Barro (1999, 160).

consumption over investment to a greater degree than an autocracy (Huntington, 1968; Rao, 1984). To measure of form of government the Polity IV dataset is used[2], with the index measured on a scale from -10, fully autocratic, to 10, fully democratic, with regimes being democratic if they have a positive score[3]. In addition to the form of government, political instability can also influence growth, through its effect on government spending. Politically unstable countries tend to devote a more of the budget to public administration and defence, ostensibly to address internal and external security matters (Morekwa and Schoeman, 2006). More generally, Alesina (1996), finds that the uncertainty associated with an unstable political environment may lead to reduced investment and a slowing of the speed of economic development, while at the same time poor economic performance may lead to government collapse and political unrest. To measure political instability an indicator is taken from the World Bank's World Governance Indicators (WGI)[4], which reflects the perceptions of the chance that a countries government will be destabilised or overthrown by unconstitutional or violent means, including armed conflict, terrorism and military coups. It takes values between 0 and 100, where the maximum degree of instability is 100.

While having an abundance of natural resources can benefit to developing country, it can also cause it problems. A literature on the 'resource curse', where a cycle of conflict and poor governance that can be created when resource revenues are not managed in the interests of the population as a whole (van der Ploeg, 2006). This is particularly important for Africa, where huge natural resource endowments create opportunities for rent-seeking behaviour on a large scale, diverting resources away from more socially fruitful economic activity (Auty, 2001). In particular, Tornell and Lane (1998) show that terms-of-trade windfalls and natural resource booms may trigger political intrigue among powerful interest groups that can result in current account deficits, disproportionate fiscal redistribution and reduced growth. In contrast, Deaton and Miller (1996) and Raddatz (2007) find that natural resources positively affect growth for low-income countries mediated by higher commodity prices, while others have argued that natural resources can be a curse in some countries and a blessing in others depending on country-specific characteristics such as inequality or institutions (Collier and Hoeffler, 2009). For this study, the current value of exports of primary commodities as a percentage of average exports in the initial year (2000) is used as a proxy for the importance of natural resources to the countries.

Given the limited time period and the relatively time invariant nature of the variables, three country specific dummy variables were constructed from the original indices. Firstly, the regime type, $regime_i$, takes the value 1 if the country, independently from the quantitative value of the Polity score (i.e., -10 to 0), is autocratic for more years than it is democratic, and 0 otherwise. The natural resource and instability

[2]See Gleditsch and Ward (1997) for a further discussion.

[3]This index takes into account different degrees of autocratic regimes by weighting different institutional aspects such as: i) the competitiveness of political participation; ii) the regulation of participation; iii) the openness and competitiveness of executive recruitment; and iv) constraints on the chief executive. Note that this index is not, however, able to capture the degree of intrusion of the regime in the economic life of the country (see Ndulu et al., 2007, among others).

[4]See (Kaufmann et al., 2009, 2010) for a methodological discussion of this indicators.

dummies, $instability_i$ and $resources_i$ take the value 1 if the relevant index of a country is higher than the mean of the sample of African countries and 0 otherwise[5].

To get some ides of the distribution of the sample across the continent and its characteristics the map in Figure 3 shows the African countries covered by the dataset and the countries that present high and low levels of autocracy, political instability, natural resources. This shows a reasonable distribution across the continent and a range of country sizes, with reasonable variation across the conditioning variables. A better idea of the distribution of these characteristics is shown in the graphs of Figure 4, which plot the non parametric cross country kernel estimates of the density functions for the growth of GDP. These show autocracy to have a relatively complex relation to growth, having a lower peak growth rate and generally smaller tails, but not markedly so. While autocracies would seem to achieve lower growth rates in general, some may perform better than the best performing democracies (Besley & Kadamotsu, 2007). Highly unstable countries seem to have similar peak growth rates, but higher tails than stable ones, while high natural resource extraction countries have a lower peak growth rates and a lower tail than low, which is consistent with the findings of Alesina (1996), Jong-A-Pin (2009), Alexeev and Conrad (2009) and Brunnschweiler and Bulte (2009).

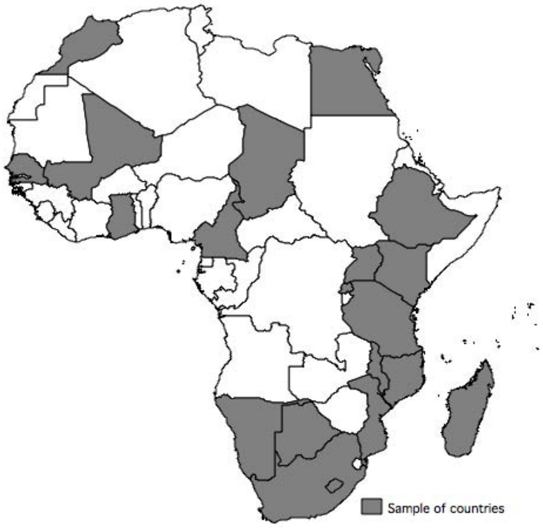
5. Econometric methods and elasticities

Regression equation (17) is dynamic in the sense that it includes the lagged level of per-capita income as an independent variable. This means that endogeneity bias can arise if the individual fixed effects and the lagged dependent variable are correlated (Hsiao, 2003). In addition, when adding regressors, correlation between them and the individual fixed effects can cause inconsistency in least squares estimators. These two sources of endogeneity bias are addressed in the literature by building a set of orthogonality conditions and estimating the model with generalised method of moments (GMM), eliminating the fixed effects by first-differencing the model and including period dummies to account for unobserved time effects (η_t) (Arellano and Bond, 1991; Arellano and Bover, 1995). Note that differencing also eliminates any variables that are constant over time. Specifying the dynamic panel data model as:

$$\Delta\gamma_{it} = \psi_1 \Delta X^1_{it} + \psi_2 \gamma_{it-1} + \psi_3 \Delta priv_{inv_{it}} + \psi_4 \Delta X^2_{it} + \mu_{it}. \tag{18}$$

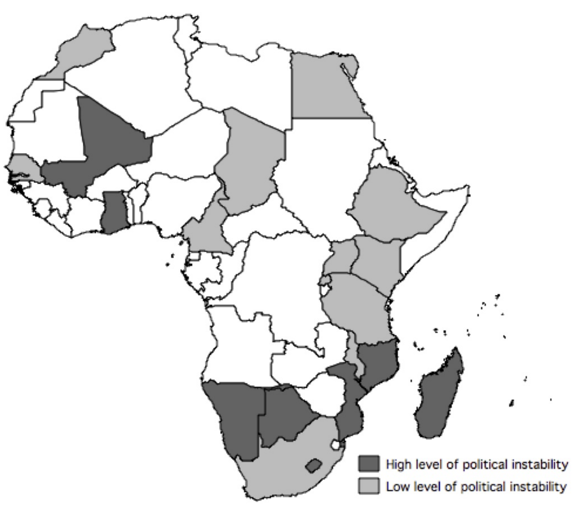
where X^1_{it} are the expenditure variables, X^2_{it} the conditioning variables and $priv_{inv_{it}}$ private investment, clearly gives a specification that violates the assumption of non correlation between the error term $\mu_{it} - \mu_{it-1}$, and the lagged dependent variable $\gamma_{it} - \gamma_{it-1}$. Following Arellano and Bond (1991) and Ahn and Schmidt (1995, 1997), a matrix of instrument Z can be constructed from dependent variables lagged two periods or more. Under the assumptions of no serial correlation in the error term and weak exogeneity of the explanatory variables, applying the GMM dynamic panel estimator means using the usual moment conditions:

[5]The results were found to be robust when the median was used in the political instability and natural resource variables.

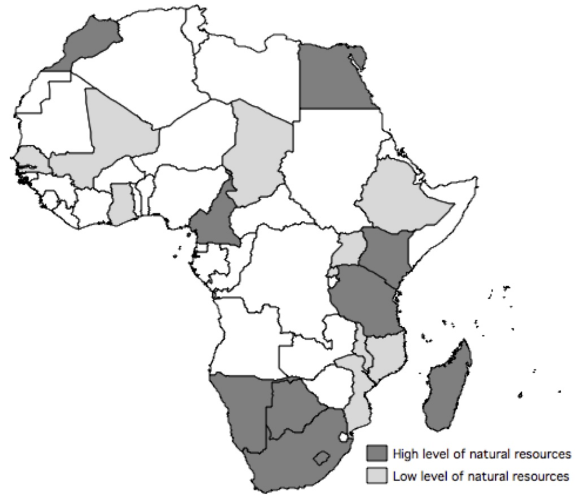


(a) Sample of countries

(b) Form of government



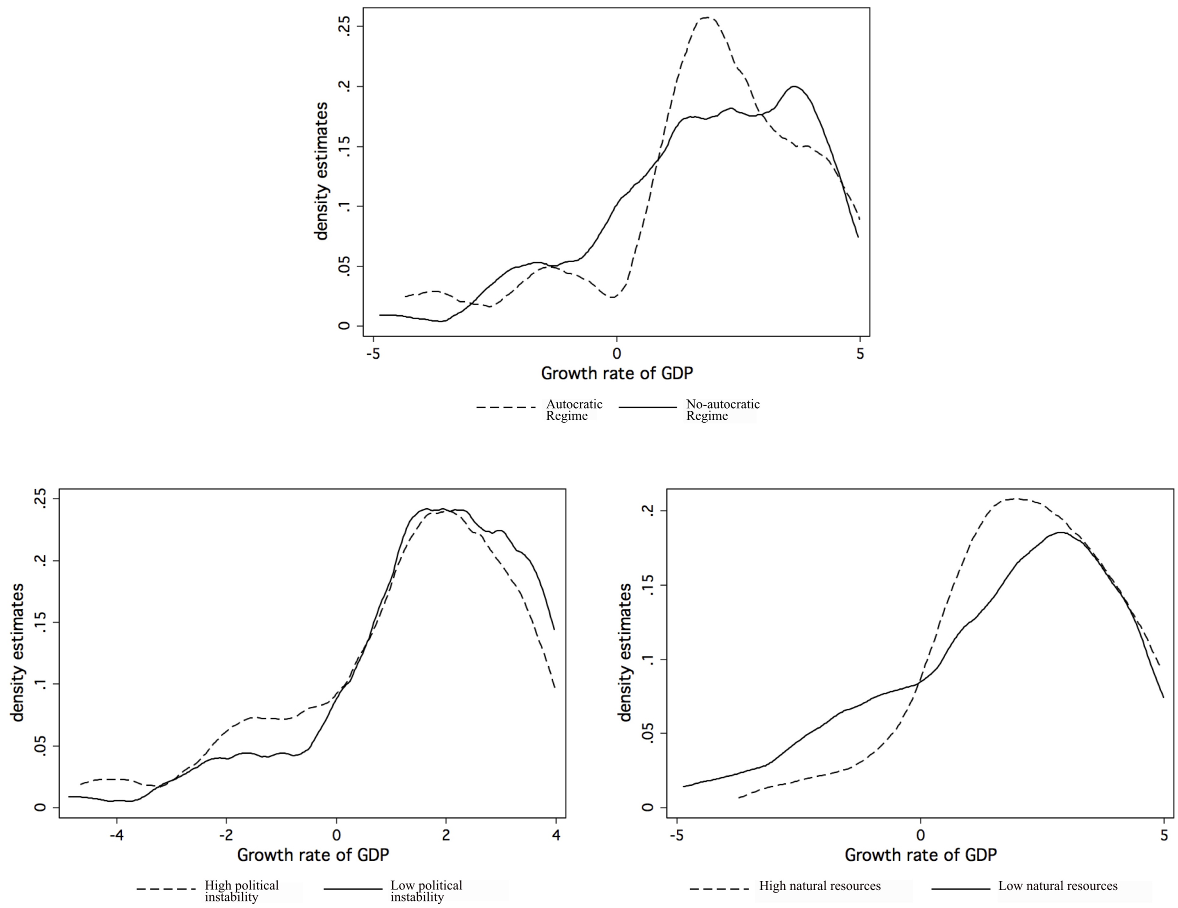
(c) Political instability



(d) Natural resources

Notes: The sample of countries are shown in graph (a). Graph (b) shows the countries with different form of government, based on Polity IV index (source: Center for Systemic Peace). Graph (c) reports an index that indicates countries with high or low level of political instability (source: World Governance Indicators (WGI), World Bank (various years)). Based on a proxy which measures the export of primary commodities, graph (d) shows countries with high or low level of natural resources (source: Africa Development Indicators (ADI), World Bank (various years)).

Fig. 3: *Sample of African countries and geographical distribution by control variables*



Notes: Notes: Plotted are the density functions estimated by using the Gaussian kernel and the bandwidth that minimizes the mean integrated squared error.

Fig. 4: *Density distributions: cross-countries estimates for selected control variables*

$$E\left[\gamma_{it-2}\left(\mu_{it} - \mu_{it-1}\right)\right] = 0 \tag{19}$$

$$E\left[\bar{X}_{it-2}\left(\mu_{it} - \mu_{it-1}\right)\right] = 0 \tag{20}$$

where the vector $\bar{X}_{it-j} = [X^1_{it}, X^2_{it}]$ now includes the covariates in a compact form of the model.

This specification of the components of government spending, with the static government budget constraints (i.e. equation (6), (7), and (8)), implies contemporaneous feedbacks to the errors in the growth equation that may violate the orthogonality conditions. Extending the conditions (19) and (20) to be the predetermined variables for the government spending variables, deals with this and excludes the influence of future shocks on the covariates. In addition, notwithstanding its advantages with respect to simpler panel-data estimators, the difference estimator has important statistical shortcomings. When the explanatory variables are persistent over time, lagged levels of the variables are weak instruments in the first difference specification of the growth regression (Blundell and Bond, 1998). This weakness of instruments influences the asymptotic properties and small-sample performance of the difference estimator, meaning it is inefficient and produces biased coefficient estimates that can be large (Roodman, 2009). To prevent this potential inefficiency and bias in the difference estimator, the specification in differences (18) is combined with the regression equation in levels (15) into a unique system of equations (Arellano and Bover, 1995; Blundell and Bond, 1998). The set of instruments described above are then used for the regression equation, with differences and lagged differences introduced as explanatory variables in the levels equation. These are appropriate instruments under the assumption that the correlation between the explanatory variables and the country-specific effects (v_i) is the same for all time periods. That is:

$$E\left[\gamma_{it+p}v_i\right] = E\left[Z_{it+q}v_i\right] \ and \tag{21}$$

$$E\left[\bar{X}_{it+p}v_i\right] = E\left[\bar{X}_{it+q}v_i\right] \ for \ all \ p \ and \ q \tag{22}$$

where Z is the vector of instrumental variables. By assuming stationarity and exogeneity of future shocks, the moment conditions for the second part of the system are given by[6]:

$$E\left[\left(\gamma_{it-1} - Z_{it-2}\right)\left(\mu_{it} + v_i\right)\right] = 0 \tag{23}$$

$$E\left[\left(\bar{X}_{it-1} - \bar{X}_{it-2}\right)\left(\mu_{it} + v_i\right)\right] = 0 \tag{24}$$

Moment conditions (19), (20), (23), and (24) are used to specify a GMM procedure that generates consistent and efficient estimates of the parameters of interest and their asymptotic variance and covariance matrix:

$$\hat{\theta} = \left(\bar{X}'Z\hat{\Omega}Z'\bar{X}\right)^{-1}\bar{X}'Z\hat{\Omega}Z'\bar{\gamma} \tag{25}$$

$$AVAR(\hat{\theta}) = \left(\bar{X}'Z\hat{\Omega}Z'\bar{X}\right)^{-1} \tag{26}$$

where $\hat{\theta} = [\psi_i]$ is the vector of parameters, $\bar{\gamma}$ is the dependent variable stacked first in differences and then in levels and $\hat{\Omega}$ is a consistent estimate of the variance-covariance matrix of the moment conditions. Estimates of the variance-covariance matrix are obtained from a two-step procedure. First, estimating the parameters assuming the residuals μ_{it} are independent and homoskedastic both across countries and over time and second, using the residuals from the first step to obtain a consistent variance-covariance matrix and then re-estimating the parameters of the model (Arellano and Bond, 1991).

A recent paper by Roodman (2009) argues for caution when using difference and system GMM methods. He replicates published studies to illustrate how the estimators can generate results that are invalid, but appear valid. This stems from the ability of the methods to readily generate numerous instruments, which introduces the danger that the instrumented variables are overfitted. This can mean the method is inefficient in accounting for the endogenous components and means the estimates will tend to be biased towards the

[6] For predetermined variables, levels lagged one or more periods are valid instruments. See, for example, Arellano and Bond (1991, 290).

value that would be obtained if instrumenting was not used[7]. To avoid the dangers of instrument proliferation the empirical analysis below uses only one lag to provide the instruments, then, uses a test strategy for the GMM regressions that differs from the conventional Sargan (1958) test statistic and offers a theoretically superior overidentification test for the one-step estimator, based on the Hansen statistic from a two-step estimator. To allow for the estimators generating moment conditions prolifically, with the instrument count quadratic in the time dimension, an additional difference in-Sargan/Hansen test is reported. This checks the validity of a subset of instruments, by estimating with and without the subset of suspect instruments under the null of joint validity of the full instrument set. The difference in the two reported Sargan/Hansen test statistics is distributed χ^2 distribution, with degrees of freedom equal to the number of suspect instruments[8].

While the theoretical model emphasises the interaction between corruption and government spending in distorting the patterns of growth, the central concern here is the interaction of corruption with the allocation of funds to the different components of government spending. Rather than following the current literature (e.g. Lee, 2006) and using interaction terms to address the indirect effects of corruption on growth, a more general framework is adopted, estimating auxiliary regressions for pairs of variables of interest $[mil_{it},\ inv_{it},\ cons_{it},\ corr_{it}]$. The aim of these auxiliary regressions, which control for fixed and time effects, is to account for the simultaneous correlations between the variables that determine a government's choices. They allow for multiple causations and so move beyond the assumption of "symmetric causation" that is implicit in the approach that has been used in the literature of introducing interaction terms into the estimated relation. Direct and indirect elasticities can then be computed from the estimated system GMM model parameters.

Defining the direct elasticity as:

$$e_{d_\gamma} = \pi \tilde{X}'_{(.,.)} \tag{27}$$

where $\tilde{X}_{(.,.)} = [\bar{mil}/\bar{\gamma},\ \bar{inv}/\bar{\gamma},\ \bar{cons}/\bar{\gamma},\ \bar{corr}/\bar{\gamma}]$ is a vector of the country and period means of the ratios of military spending, government investment spending and corruption to the growth rate of GDP and $\pi = [\psi_{mil},\ \psi_{inv},\ \psi_{corr}]$ is a vector of parameters estimated using equation (25). Taking the military component of government spending as an example, the estimated direct elasticity is given by:

$$_{mil}e_{d_\gamma} = \hat{\psi}_{mil} \frac{\bar{mil}}{\bar{\gamma}} \tag{28}$$

Given assumption A.3, the indirect elasticities can be calculated by using the fixed effects panel data procedure to regress each component of $\tilde{X}$ on the others, excluding consumption[9]. For the military spending component:

$$mil_{it} = a + b_1 inv_{it} + b_2 corr_{it} + v_i + \eta_t + m_{it} \tag{29}$$

[7]See, Bond (2002) for a technical discussion, whereas for a classical discussion, Tauchen (1986).

[8]See Baum et al. (2003).

[9]Note that the use of predetermined variables in equation (18) means that equation (29) is unlikely to include any unobservable factors that are correlated with the errors in equation (18) and so it is not necessary to specify a simultaneous equation model for the analysis.

where v_i and η_t are the usual country and time effects and m_{it} is the error term. The parameters estimated by (27) and (29), are then used to obtain the indirect elasticity for military spending with respect to corruption:

$$_{mil/g\_corr}e_{ind_\gamma} = \left(\hat{\psi}_{corr}\hat{b}_2\right)\frac{\bar{mil}}{\bar{\gamma}} \tag{30}$$

Finally, the total elasticity is obtained as the algebraic sum of the direct and indirect elasticities for each component of government spending. For military spending this is:

$$_{mil}e_{tot_\gamma} =_{mil} e_{d_\gamma} +_{mil/corr} e_{ind_\gamma} +_{mil/inv} e_{ind_\gamma} \tag{31}$$

Sensitivity analyses of these elasticities can be carried out by changing the points where the elasticities are calculated, e.g. replacing the means with the median or the interquartile mean of the empirical distribution of the variables.

6. Empirical results

The first two columns of Table 1 report the results of the system GMM estimation of equations (17) and (18), including the components of public spending, private investments (I) and time dummies (II), with column (III) introducing the index of corruption and columns (IV) to (VI) introducing the control variables (natural resource abundance, political instability and autocratic regime). All specifications include the lagged value of private investment to account for capital accumulation, as described in equation (4), and current government consumption expenditure.

To evaluate the GMM estimator and the validity of the lagged values of the explanatory variables as instruments, the test described above was used. The results suggested that the hypothesis that the estimated models are generated by consistent estimators could not be rejected, at the usual 5% level of significance. The instruments did not appear to weaken the ability of the tests to detect the invalidity of the system GMM instruments, with the Difference-in-Hansen test giving $p-values$ over 0.1 for all of the models and the tests of the over-identification restrictions, showing the results to be robust across the different set of instruments. The estimated coefficients are significant with the expected signs and stable across the different specifications. They show the accumulation of private investment ($priv_{inv_{t-1}}$) plays an important role in increasing GDP per-capita over the period. After controlling for time dummies (column III), the share of military spending in GDP exhibits a strong negative effect on the growth rate, with government investment spending having a positive effect[10]. This implies that there is differential productivity between the components of government spending and suggests that the resources devoted by the government to the military sector are greater than would be optimal. In line with the results of the kernel estimates, the differential effects of the control variables are significant, with natural resources having a positive effect on the growth rate and political instability and autocratic regime having negative effects.

[10]In line with the literature, a negative impact of current government spending on per capita growth rate is also apparent.

Table 1:

Estimation results: dynamic panel data

Variables	(I)	(II)	(III)	(IV)	(V)	(VI)
γ_{t-1}	0.180 ***	0.157 ***	0.182 ***	0.195 ***	0.177 ***	0.190 ***
	(0.054)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)
$priv_{inv_{t-1}}$	0.248 ***	0.253 ***	0.281 ***	0.265 ***	0.256 ***	0.271 ***
	(0.057)	(0.054)	(0.059)	(0.057)	(0.058)	(0.060)
mil	-0.382 **	-0.580 ***	-0.282 *	-0.219	-0.261 *	-0.248 *
	(0.183)	(0.195)	(0.168)	(0.166)	(0.168)	(0.167)
inv	0.243 ***	0.268 ***	0.316 ***	0.287 ***	0.266 ***	0.294 ***
	(0.088)	(0.080)	(0.089)	(0.081)	(0.085)	(0.089)
cons	-0.099 *	-0.169 ***	-0.153 ***	-0.248 ***	-0.083 *	-0.147 ***
	(0.056)	(0.054)	(0.052)	(0.061)	(0.048)	(0.046)
corr			-0.039 ***	-0.037 ***	-0.028 ***	-0.039 ***
			(0.012)	(0.011)	(0.010)	(0.012)
regime	-1.057 *	-1.647 ***	-0.932 *		-2.655 **	
	(0.629)	(0.629)	(0.607)		(1.141)	
instability	-0.495	-0.465	-1.410 *			-1.913 ***
	(0.650)	(0.617)	(0.762)			(0.737)
resources	0.648 *	0.424	0.781 *	1.021 **		
	(0.459)	(0.450)	(0.477)	(0.493)		
Time dummies	No	Yes	Yes	Yes	Yes	Yes
Second order serial correlation test	0.956	0.537	0.474	0.516	0.469	0.497
Sargan test statistic	0.043 (53) *	0.159 (53)	0.105 (53)	0.093 (53)	0.147 (53)	0.077 (53)
Unrestricted Sargan/Hansen test (a)	0.052 (25)	0.147 (25)	0.099 (25)	0.095 (25)	0.125 (25)	0.103 (25)
Difference in Sargan (a)	0.187 (28)	0.326 (28)	0.284 (28)	0.403 (28)	0.169 (28)	0.244 (28)
Unrestricted Sargan/Hansen test (b)	0.035 (48) *	0.083 (48)	0.051 (47)	0.095 (49)	0.068 (49)	0.069 (49)
Difference in Sargan (b)	0.442 (05)	0.953 (05)	0.891 (06)	0.836 (04)	0.430 (04)	0.613 (04)
Unrestricted Sargan/Hansen test (c)		0.132 (43)	0.103 (43)	0.125 (43)	0.073 (43)	0.084 (43)
Difference in Sargan (c)		0.462 (10)	0.345 (10)	0.439 (10)	0.345(10)	0.379(10)
Number of observations	242	242	242	242	242	242

Notes: The dependent variable is the growth rate of GDP, (γ). Labels of variables are defined in Section 4. The asterisks stand for the *p-value* significance levels (* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$). At the bottom of the table four different test statistics are reported in terms of *p-value*. The first is the Arellano Bond second order no-autocorrelation test statistic which has a χ^2 distribution, the second the Sargan (1958) test statistic for the whole set of instruments, the rest are unrestricted Sargan/Hansen and difference-in-Sargan tests of exogeneity of instrument subsets (Roodman, 2009). Instruments' subsets: (a) includes instruments for the levels (equation 17); (b) includes over-identifying restrictions on differenced variables *mil*, *cons*, *corr*, *regime*, *instability*, *resources*; (c) includes restrictions on the time dummies. Degrees of freedom are reported in parentheses.

Table 2:

Multiple causal correlations: fixed effect panel estimations

	mil (I)		*inv* (II)		*corr* (III)	
mil			-0.896	***	1.625	*
			(0.257)		(0.850)	
inv	-0.048	***			0.165	
	(0.014)				(0.192)	
corr	0.008	*	0.018			
	(0.004)		(0.017)			
Time dummies	Yes		Yes		Yes	
BP Lagrange Multiplier (LM) test	762.17	***	401.72	***	1136.37	***
	(0.00)		(0.00)		(0.00)	
Number of Observations	264		264		264	

Notes: The dependent variables are military spending in GDP (*mil*), government investment in GDP (*inv*) and corruption index (*corr*). Standard errors are in parentheses, while the asterisks give *p-value* significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. The econometric specification also includes a constant term. At the bottom of the table Breusch-Pagan (BP) Lagrangian multiplier test is reported, which is χ^2 under the null hypothesis that error variance in the regression is equal to zero. The alternative hypothesis of Breusch-Pagan test statistic excludes the random-effect panel estimator.

Table 2 reports the results of the fixed effect panel data estimations for the auxiliary regressions (equation 29), used to measure the indirect effects of military spending, government investment spending, and corruption. It is important to stress that the use of fixed effect panel data estimator is allowed by the static structure of the government budget constraint, described by equations (6) to (8). The results confirm that there is causation in both directions between corruption and military spending, implying they complement each other. Following the discussion of the channels of transmission in the theoretical model, this suggest that corruption enhances the adverse effect of a larger military sector on the economy's growth, as it implies higher rents, involving larger amount of money and so larger bribes (Delavallade, 2005). On the other hand, corruption is not significantly related to government investment spending, although the sign of the correlation is as expected. There may be a "'substitution effect"' between military spending and government investment spending, with the indirect transmission of these effects biasing the estimated impact of the components of government spending on the growth rate.

Table 3 shows the direct, indirect and total elasticities for military spending, public investment spending

Table 3:

Elasticity measures, full sample

	Direct elasticity (I)		Indirect elasticity (II)		Total elasticity (III)		Indirect elasticity corruption (+) (IV)	
mil	-0.203 (0.122)	**	-0.253 (0.089)	**	-0.457 (0.151)	**	-0.046 (0.026)	*
inv	0.703 (0.197)	**	-0.029 (0.020)	*	-0.674 (0.198)	**		
corr	-0.761 (0.234)	**	-0.043 (0.036)		-0.805 (0.236)	**		

Notes: The direct elasticity measures reported here are calculated from coefficients presented in the third column of Table 1, whereas indirect elasticities use those reported by the multiple causal correlations estimated in Table 2 at the mean of the sample. Bootstrapped standard errors (10.000 replications) are in parenthesis, while the asterisks give the *p-value* significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. From Table 2, we know that the relationship between military spending in GDP (*mil*) and the growth rate of GDP includes significant effects of government investment in GDP (*inv*) and corruption (*corr*); column IV (+), gives the specific impact of corruption.

and corruption calculated from equations (27), (30), and (31) in columns 1-3[11]. The direct elasticity measures are obtained using the estimated parameters from the third column of Table 1, while the indirect elasticity measures use only the statistically significant parameter estimates in the auxiliary regressions[12].

Considering the direct channel by which the components of government spending and corruption can affect the real per capita growth rate, the first thing to note is that the effect of changes in military spending on growth is significant and negative, with a 10% decrease in the allocation to military spending enhancing real per capita growth rate by 2%. The effects are even larger for corruption, with a 10% reduction of the level of corruption increasing the real per capita growth rate by 7.6%. A reduction in government investment spending by 10% enhances real per capita growth by 7%. These results seem reasonable for this sample and are consistent with Mauro (1995), Mo (2001) and Pellegrini and Gerlagh (2004), who also find significant and positive effects of reducing corruption on the per capita growth rate using larger samples, but shorter time series than this study[13]. The second thing to note is that the model predicts that indirect effects will enhance the negative effect of military spending and growth through both government investment spending and corruption. This seems to support the hypothesis that a sector that is open to rent-seeking,

[11]Since our model supposes that corruption has no indirect effect on government current consumption expenditure, this variable is omitted from the analysis although we calculate a direct elasticity of government current consumption spending of -0.732 from the parameters in Table 2

[12]Given the aim of the paper, column IV of Table 4 reports the indirect effects of corruption itself on the relationship between military spending and growth in order to separate out the indirect effects of government investment spending.

[13]Using GMM estimators to treat endogeneity also avoids issues linked with overestimation of OLS parameters.

such as the military, is affected by corrupt practices somewhat more than other productive sectors. With respect to the total estimated elasticity reported in column (III) of -0.457, the indirect elasticity of -0.046 represents about 10% of the indirect effect corruption has on the relationship between military spending and growth. Interestingly, the negative effect of military spending is partly the results of a reallocation of government investment spending, which responds strongly to changes in the military spending through "'within"' government spending substitution (the estimated parameter of the indirect elasticity of government spending is -0.207, which is about a 45% of the total elasticity). Since the growth model predicts that annual total government spending does not change, the effect of military spending increasing is to "'crowd out"' the "'productive"' government investment spending, so reducing the growth rate. There is also an indirect effect of military spending on government investment spending, but this is less pronounced (-0.029, in column 2). This does seem a reasonable result, as in many developing countries military spending is likely to be financed by public deficits, which can lead the crowding out of private investment and so reduce growth. Indeed, private investment has been found to be a complement of government investment spending in developing countries, so the finding that a change of 10% in government investment spending affects the growth rate by 0.29% through the military spending channel is not unexpected. There is also a significant, though smaller, effect of military spending on corruption -0.043, representing less than 5% of the total elasticity. This may well reflect the fact that the structural and institutional mechanisms that have recently been introduced to combat corruption in some African countries have altered the political structures that led to distortions and inefficiencies in the allocation of government spending (Tanzi and Davoodi, 1998; Delavallade and de la Croix, 2009). This may also explain why no significant multiple causality between corruption and government investment spending was found (Table 3), in contradiction to the predictions of our theoretical model and the conventional literature.

While the indirect effects of these key variables on each other cannot be calculated by the indirect elasticities, this does not mean that the traditional argument that corruption increases the number of public capital projects and so reduces growth is not valid. The general dynamic relationship between corruption and government spending does seem to have been weakened through heterogeneous behaviour in the African countries. Some African governments have responded to economic crises or cyclical downturns by implementing public investment programmes, often associated with anti-corruption policies, although not always motivated from an awareness of the positive externality effects on the economy. This line of argument is returned to below in discussing examples of country responses to cyclical and structural problems.

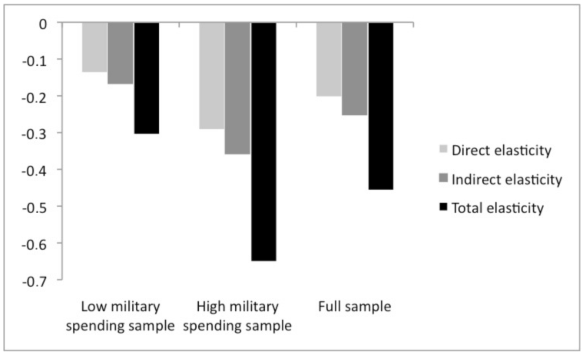
6.1. Robustness

While the estimation results have confirmed the common finding that government investment spending enhances economic growth, while military spending, current government spending and corruption reduce it, and that corruption seems to enhance the negative effect of military spending, there are still issues to consider. First the possibility of significant cross country heterogeneity in the coefficient estimates, which could mean the results are driven by hidden country variability not captured by the full sample estimates.

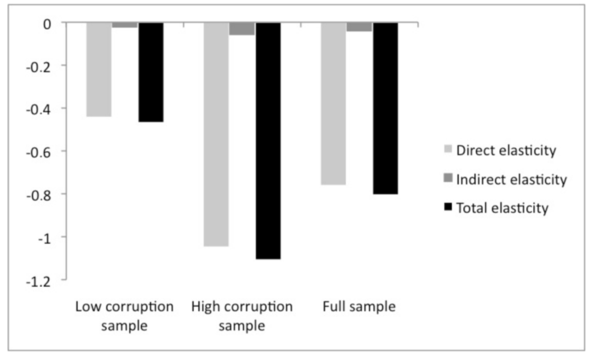
That they depend not on the relation we are estimating but on countries' specificities. Second, that the results may be unreasonably sensitive to the control variables discussed earlier and so not robust.

In considering potential heterogeneity, there are not enough time series observations to estimate country by country and use a mean group estimator, so a check is made by taking the parameter estimates from the baseline model, dividing the sample into two groups of countries identified to be below or above the median of the sample statistical distribution with respect to key explanatory variables and using these to calculate the subsample elasticities. This also provides an indirect check for nonlinearities. Figure 5 shows the distribution of the direct and indirect elasticities calculated in this way across the key covariates, all weighted by the mean of the variable of interest and there are some interesting findings. The high military spending group shows higher negative elasticities (total elasticity=-0.65) than the lower (total elasticity=-0.29), and larger indirect elasticities, particularly the proportion of the indirect elasticity that reflects the complementary effects of corruption and military and government investment spending on the per capita growth rate link. In contrast, corruption and government investment spending have much larger indirect than direct elasticities, with the former negative and in the range -0.44 to -1.08, and the latter positive in range 0.42 to 0.98, but in both cases the high value sample is also the most responsive. So countries with higher values of the variables do seem to have higher elasticities and this will need to be taken into account in interpreting the results for their policy implications.

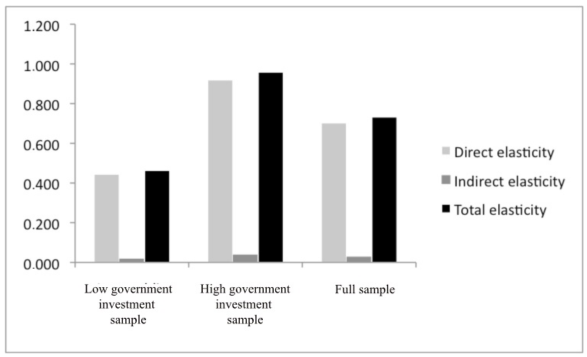
To get a better idea of cross country heterogeneity the aggregate coefficients and the individual country means were used to calculate country specific elasticities and the total and direct elasticities are presented in Figure 6. For military spending, there is some variation, with Kenya and Madagascar have the largest elasticities, but for corruption and government investment spending Malawi has strikingly large elasticities. In the case of corruption it is joined in this by Kenya and for government investment spending by Madagascar, while for the rest of the countries the measures are in line with the aggregate estimates. Considering corruption, Kenya has a direct elasticity of 2.7 and Malawi -2.75, but the size of the estimates are the result of quite different factors. Official statistics show that when the economic crisis affected Malawi at the end of 2001, it coincided with a marked and unexpected increase in corruption 2000-2002, which led to it being ranked as the fifth most corrupt African country (see, Figure B1 of Appendix B). After 2001, GDP increased for the next two years and corruption started to fall and has continued to do so. In contrast, Kenya is known as one of the most corrupt countries in Africa and remains so. In the Corruption Perceptions Index 2005, out of 159 countries Kenya was ranked the 15th most corrupt, with corruption particularly rife in strategic sectors as fuel and seemingly little affected by cyclical economic fluctuations. Real GDP in Malawi grew by 3.6% in 1999 and 2.1% in 2000, with the Government's expansionary monetary policy, and the average annual inflation hovered around 30% between 2000 and 2001, keeping discount and commercial bank rates high. Indeed, high volatility of the real interest rates from the end of the 1990s saw it reaching over 30% in 2003. In combination with large deficits financed by domestic borrowing this led to a sharp increase in the government's interest bill, leading to strict fiscal discipline to avoid a debt explosion and so a contraction



(a) Military spending in GDP (*mil*)



(b) Corruption (*corr*)



(c) Government investment in GDP (*inv*)

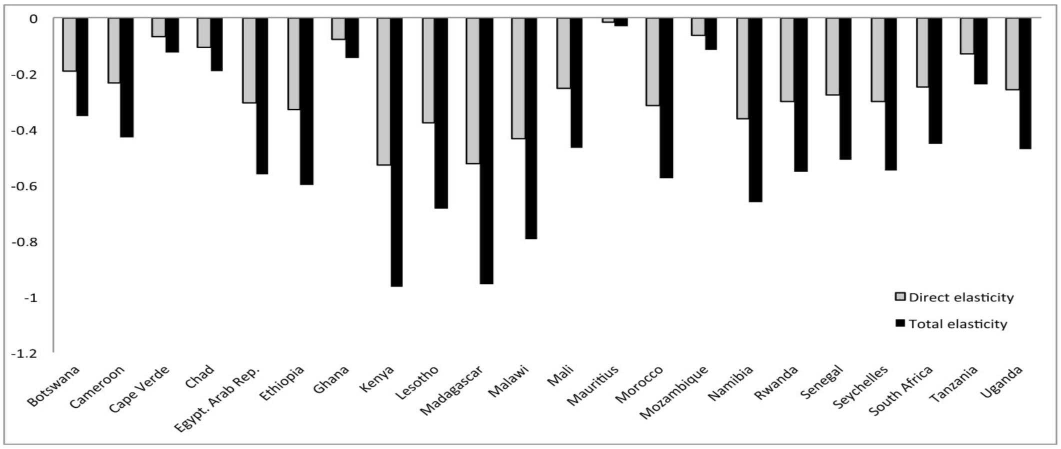
Notes: Elasticities use full sample coefficients and mean values for the sub-samples of countries for military spending, government spending and corruption.

Fig. 5: *Estimated elasticities across subsamples*

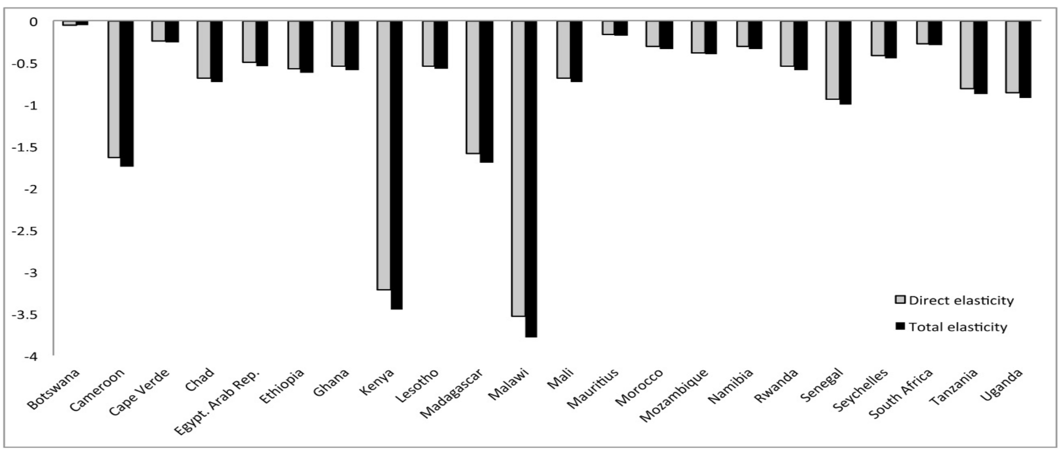
of government investment spending that lasted until 2004 (Whitworth, 2004)[14]. Malawi and Madagascar show the largest elasticities for government investment spending in Figure 6, with Madagascar seeing marked increases 2002-3, and Malawi from 2004. Following a political crisis in 2002, Madagascar attempted to set a new course and build confidence, in coordination with international financial institutions, identifying road infrastructure as a principle priority. This is evident in Figure 6 as is the more recent reductions in the share of government investment spending in GDP, suggesting robustness of the estimates may be questionable.

So there do seem to be reasonable explanations for the large elasticities for these countries and why they may be influencing the elasticities disproportionately. To assess their impact on the results, further tests where undertaken replacing the mean with the median and interquartile range. As reported in Appendix C (Table C1) and Appendix D (Tables D1 and D2) these aggregate and country level estimates, which remove the influence of the extreme values, were consistent with the results using the mean. This means that the countries with high elasticities are not disproportionately influencing the overall results.

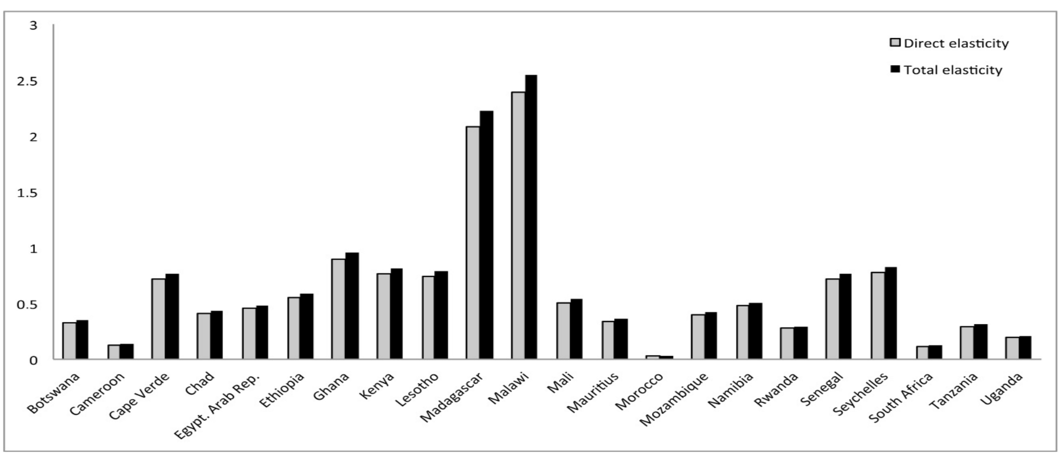
[14]Budget deficit went from 3% of GDP in 2000 to 9.2% in 2003.



(a) Military spending in GDP (*mil*)



(b) Corruption (*corr*)



(c) Government investment in GDP (*inv*)

Notes: The elasticity measures for each country use the parameters from the full-sample estimations weighted for the mean of the country in the sample period.

Fig. 6: *Estimated elasticities across countries*

6.1.1. The role of the political instability, natural resources and form of government

As a further check on the robustness of the results, the sensitivity of the parameter estimates to changes in the conditioning variables is investigated. To do this, the baseline model is estimated for groups of countries selected by whether or not they have high or low values of each of the conditioning variable, as shown in Table A1 of Appendix A.

Columns I and II of the Table show the results for the sub-samples of high and low levels of natural resources. Interestingly, the coefficient on corruption is only negative and significant for the subsample of countries with high levels of natural resources, while for the same group military spending is insignificant. This does seem consistent with the full sample estimates in Table 1, column IV. Leaving out distributional effects, it seems reasonable that countries with natural resources are more able to afford military spending. Indeed, it may also be that the military are important for supporting/protecting the extraction and sale of outputs, which could offset the expected negative impact of military spending that is generally found in the literature. As expected, the estimated coefficient for the growth of government investment spending is positive and significant. The next two columns (III) and (IV) show the results for high and low levels of instability. For high levels of instability only military spending is significant and that at 1%, while for low levels, corruption has a significant negative effect as does government consumption expenditure. This does suggest that the model tells us little about the determination of growth in unstable countries, which is consistent with findings that instability does act as a fetter on the growth process (Blomberg, 1996). Finally, columns V and VI show the results for countries with high and low levels of autocracy. Although the estimated parameters of autocratic regimes were of the expected sign and magnitude, they were not significant, probably because of the relatively small size of the subsample. For the non autocratic subsample there is a clear significant negative effect of corruption and military burden as well as a positive effect of government investment spending.

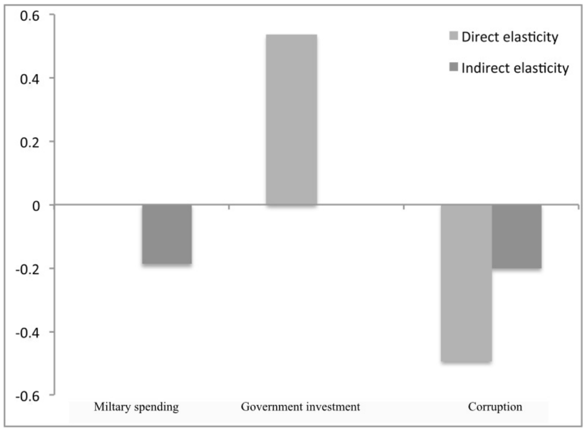
To investigate the sensitivity to the control variables further, the indirect elasticities were computed for the main variables using equation (30). The full results of multiple causation correlations are reported in Table E1 of Appendix E using the equation (29) for each key variable. Using only the significant coefficient estimates of GMM-system for each control variable subsample, the importance of the indirect channels on the economy is evaluated. Figure 7 plots the elasticities calculated in this way and shows the impact of the key explanatory variables on economic performance to be relatively robust, in the sense that the size of the elasticities is in line with those of the full sample. Breaking the results down into elasticities, show the significant effect of corruption on growth for relatively resource abundant countries to come through both direct and indirect channels. Military spending only has an indirect effect and government investment spending has a strong direct positive impact. For the low resource countries there is a much higher (negative) impact of military spending, through both the direct and indirect channels, but only an indirect negative effect of corruption. This seems consistent with the finding that natural resources can be a source of domestic conflict and international tension, with those in resource-producing areas not always benefiting from the flows

Table 4:

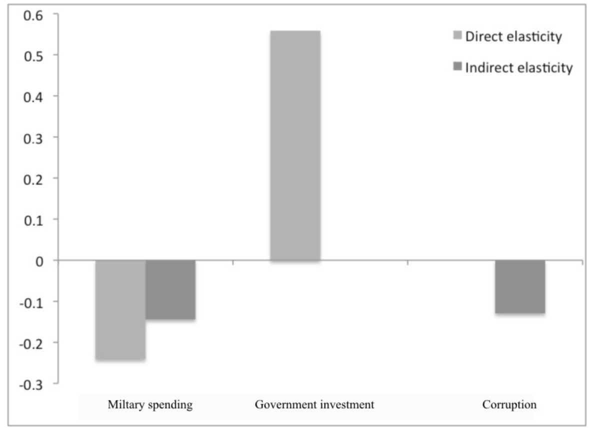
Dynamic panel data estimations, sub-samples analyses

Variables	High levels of natural resources (I)		Low levels of natural resources (II)		High levels of instability (III)		Low levels of instability (IV)		Autocratic regimes (V)		No-autocratic regimes (VI)	
γ_{t-1}	-0.175	**	0.221	***	0.080		0.128	*	0.251	***	0.063	
	(0.086)		(0.077)		(0.085)		(0.075)		(0.072)		(0.076)	
$priv_{inv_{t-1}}$	0.130	*	0.269	***	-0.005		0.346	***	0.045		0.446	***
	(0.084)		(0.054)		(0.050)		(0.068)		(0.059)		(0.065)	
mil	0.185		-0.351	*	-0.272	*	-0.148		-0.051		-0.651	*
	(0.235)		(0.259)		(0.145)		(0.201)		(0.185)		(0.370)	
inv	0.325	***	0.211	**	-0.048		0.291	*	0.090		0.642	***
	(0.122)		(0.104)		(0.087)		(0.157)		(0.084)		(0.168)	
$cons$	-0.062		-0.282	***	0.032		-0.196	***	-0.053		-0.114	
	(0.065)		(0.077)		(0.063)		(0.062)		(0.059)		(0.105)	
$corr$	-0.024	**	-0.016		0.022		-0.037	**	-0.021		-0.052	***
	(0.011)		(0.018)		(0.022)		(0.015)		(0.025)		(0.015)	
Time dummies	Yes		Yes		Yes		Yes		Yes		Yes	
Second order serial correlation test	(0.406)		(0.080)		(0.444)		(0.118)		(0.101)		(0.594)	
Sargan test statistic	0.880 (53)		0.019 (69)		0.130 (69)		0.101 (69)		0.051 (69)		0.052 (69)	
Difference in Sargan (a)	0.393 (25)		0.094 (25)		0.263 (25)		0.349 (25)		0.113 (25)		0.069 (25)	
Difference in Sargan (a)	0.979 (28)		0.056 (28)		0.151 (28)		0.034 (28)	*	0.111 (28)		0.146 (28)	
Unrestricted Sargan/Hansen test (b)	0.871 (50)		0.051 (50)		0.101 (50)		0.091 (50)		0.075 (50)		0.013 (50)	*
Difference in Sargan (b)	0.585 (03)		0.099 (03)		0.487 (03)		0.521 (03)		0.166 (03)		0.815 (03)	
Unrestricted Sargan/Hansen test (c)	0.846 (43)		0.013 (43)	*	0.203 (43)		0.086 (43)		0.057 (43)		0.084 (43)	
Difference in Sargan (c)	0.732 (10)		0.705 (10)		0.080 (10)		0.650 (10)		0.218 (10)		0.055 (10)	
Number of Observations	110		132		110		132		77		165	

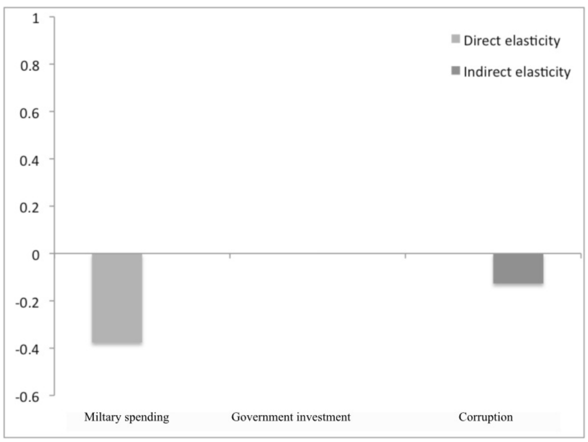
Notes: The dependent variable is the growth rate of GDP, (γ). The variables of the GMM system are defined in Section 4. The asterisks give the *p-value* significance levels ($^{*}p < 0.1$; $^{**}\ p < 0.05$; $^{***}p < 0.01$). At the bottom of the table four different test statistics are reported in terms of *p-value*. First, the Arellano Bond second order no-autocorrelation test statistic, which has a χ^2 distribution; second the Sargan (1958) test statistic for the whole set of instruments; third, the unrestricted Sargan/Hansen test; and fourth, the difference-in-Sargan test of exogeneity of subsets of instruments (Roodman, 2009): (a) includes instruments for the level equation (15); (b) includes over-identifying restrictions in differences on variables *mil*, *cons*, *regime*, *instability*, *resources*, *corr*; (c) includes restrictions in time dummy variables. Degrees of freedom are in parenthesis.



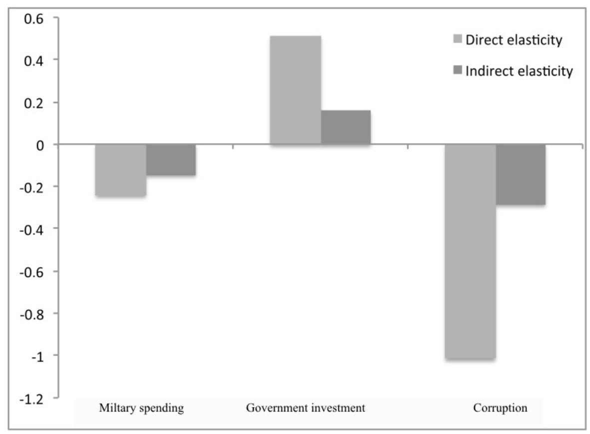
(a) High level of natural resources



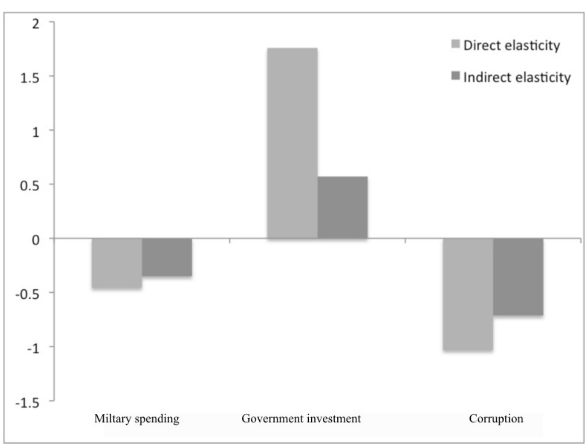
(b) Low level of natural resources



(c) High level of political instability



(d) Low level of political instability



(e) No-autocratic regime

Notes: The direct and indirect elasticity measures for each sub-sample use the significant coefficient from the Tables 4 and Table C1 of Appendix C, following equations (28) and (30).

Fig. 7: *Estimated elasticities of sub-samples by control variables*

of income and this can both generate grievances and provide the opportunity for insurrection if groups can get access to the resources (Collier and Hoeffler, 2009). This can lead to a higher "productivity" for military spending, as incumbents need to protect natural resources from internal or external enemies and so military spending may be positively related to resources revenues and growth.

On the other hand, the link to corruption suggests a negative impact for military spending. In this case military procurement can be thought of as a part of government revenues that are "re-invested" in arms purchases, which have a high probability of involving corruption, with a resulting complementarity effect. Even with different sources of financing in countries with low level of natural resources, this process may serve to explain why indirectly a +10% changes in military spending reduce of 2% the per capita growth for the sub-sample. Furthermore, the fact that resource revenues are often managed non-transparently and without proper accountability, may lead to large off-budget government investment spending that is open to corrupt practices, thus explaining the negative indirect effect. Interestingly, government investment spending has large positive direct effects on growth in both subsamples.

Part c of Figure 9 shows that growth in countries with high level of political instability is heavily affected by increases in military spending, both directly and indirectly, through the corruption channel[15]. This might support Blomberg (1996) argument that military spending can play an important role in providing insurance against political instability, which is consistent with the higher level of military burden in these countries and explains a higher elasticity for the subsample of countries with higher levels of political instability. Once we control for the effect of political instability (Figure 7, graph d), the key explanatory variables appear to have an impact in line with the results of the full sample model. Finally, the estimated elasticities for the non-autocratic subsample are close to those of the full sample (graph e), suggesting that this measure of regime does not seem to capture any relevant differences.

7. Conclusions

Growing concerns that high levels of corruption might reflect detrimental effects on economies have motivated a large amount of academic and policy-oriented research. Recent work has moved beyond simply analysing the direct effects and has tried to evaluate how corruption affects the relationship between government spending and economic growth. This paper has contributed to this literature, by developing an extended endogenous growth model that allows for this effect and highlighting by simulations the non-negligible indirect effect of corruption on military spending and government spending in investments that, given their different "'productivity"', may generate heterogeneous effects on per capita growth rate.

Specifying an estimable form of the model and applying it to a sample of African countries, confirmed the traditional prediction that government investment spending economic growth, while large military burdens,

[15] Note that, following equation (30), we estimate a significant correlation only between military spending in GDP and corruption (second frame, Appendix E) and, simultaneously, the direct parameter of corruption in column I of Table 5.

current government spending and high levels of corruption have a negative effect. Calculating direct and indirect elasticities led to the interesting finding that there seemed to be complementarity between corruption and military spending in the way they affected growth. Although multiple causal correlation were at work in the African countries, it appeared that corruption accentuated the negative effect of military burden on the growth rate. In contrast, the effect military burden on the corruption/economic growth link was much smaller. This suggests that combatting corruption is likely to directly increase aggregate economic performance, but can also have the added indirect effect of reducing the negative impacts of military burden.

Given the potential importance of these findings a range of robustness test were undertaken. These suggest that the elasticities of the keys explicative variables of the model were robust to the country heterogeneity, although a high persistence of corruption made the Kenya elasticities particularly sensitive. Breaking the sample of countries into subsamples based on the values of the conditioning variables suggested, that countries with higher levels of natural resources have a ”‘less unproductive”’ role for the military sector in protecting natural resource and this offsets the crowding out effect. Those with high level of political instability seem to have significant negative effects on growth, both directly, through increases of military spending and indirectly, through the corruption channel. Finally, the form of government does not seem to have any impact on the results.

Our results provide further evidence of the damaging effects of corruption on developing economies and go some way to improving the understanding of the channels at work. They highlight the need to identify and take account of both direct and indirect effect and show that the can be some significant complementarity effects between corruption and the different categories of government spending. In particular, corruption seems to significantly increase the negative effect of military spending on growth in these developing countries, suggesting that combined policies to reduce corruption and reduce military burdens, possibly through regional security agreements, would be of considerable value.

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Appendix A

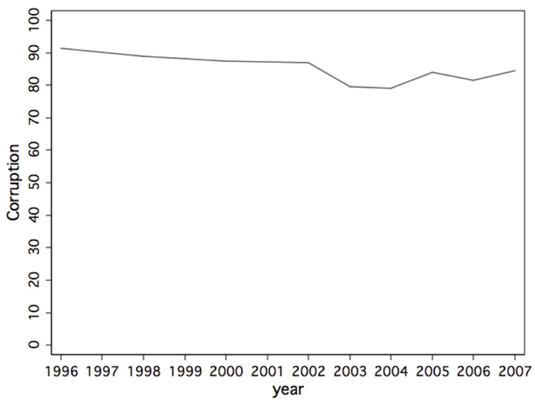
Table A1

Descriptive statistics

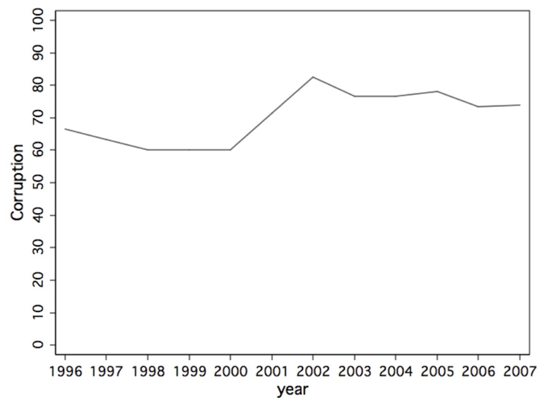
Country	γ	$priv_{inv}$	*cons*	*inv*	*mil*	*corr*	*regime*	*instability*	*resources*
Botswana	4.791	11.372	22.768	10.531	3.144	7.788	1	1	1
Cameroon	1.698	14.378	9.641	2.367	1.360	86.483	0	0	1
Cape Verde	3.406	14.142	17.456	12.329	0.792	25.164	1	1	0
Chad	3.928	16.718	6.566	9.058	1.418	83.340	0	0	0
Egypt. Arab Rep.	2.972	9.218	11.769	9.485	3.121	46.424	0	0	1
Ethiopia	3.603	8.669	12.536	13.378	4.043	64.871	1	0	0
Ghana	2.613	13.461	11.400	11.707	0.695	44.911	1	1	0
Kenya	0.826	12.480	16.468	4.470	1.491	82.986	1	0	1
Lesotho	2.244	32.894	18.296	10.738	2.879	38.021	1	1	0
Madagascar	0.701	10.253	8.721	8.139	1.250	34.792	1	1	1
Malawi	0.586	8.199	13.357	7.482	0.870	64.593	1	0	0
Mali	2.512	14.623	10.695	8.195	2.182	53.844	1	1	0
Mauritius	3.633	17.753	13.383	6.106	0.211	18.983	1	1	1
Morocco	3.231	21.270	17.933	3.955	3.472	31.483	0	0	1
Mozambique	5.360	10.661	9.322	11.244	1.143	63.512	1	1	0
Namibia	2.266	16.325	27.372	7.885	2.795	21.820	1	1	1
Rwanda	3.101	10.964	11.537	7.258	3.190	53.284	0	0	0
Senegal	1.555	17.395	12.340	6.732	1.480	45.491	1	0	0
Seychelles	1.808	21.719	26.313	8.482	1.856	23.815	1	1	0
South Africa	1.932	13.736	19.013	2.689	1.639	16.270	1	0	1
Tanzania	3.002	11.286	12.337	5.550	1.340	76.062	0	0	1
Uganda	2.771	14.651	13.848	5.049	2.431	74.191	0	0	0
Mean	2.660	14.643	12.739	5.910	1.945	51.903			
Standard deviation	3.592	7.410	5.512	3.960	1.184	20.816			
Median	2.566	12.981	11.819	5.636	1.646	54.501			
Interquartile mean	2.676	14.122	12.779	5.576	1.919	56.692			

Notes: Covariates values by countries are country means over the time span. At the bottom of the table are reported mean and standard deviation over country and time span, along with median and interquartile mean sample distribution. Sources of *regime*, *instability* and *resources* are reported in the footnote of Figure 3. We classify *regime* of a country as autocratic ("1") if results that the number of times (e.g., sample years) in which Polity score is negative overcome those positive and non-autocratic regime ("0") otherwise. Instead, $instability_i$ and $resources_i$ are ranked as "1" when the index described of a country are higher than the regional mean of the sample of African countries ("0") otherwise.

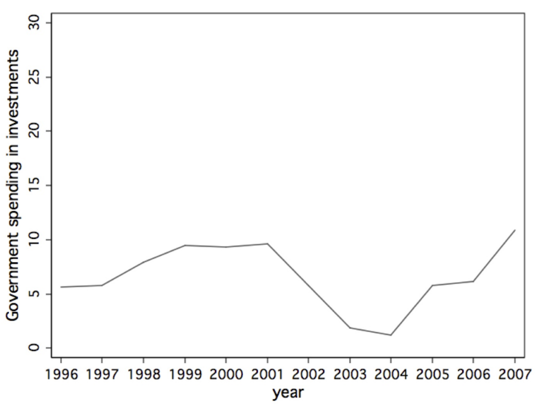
Appendix B



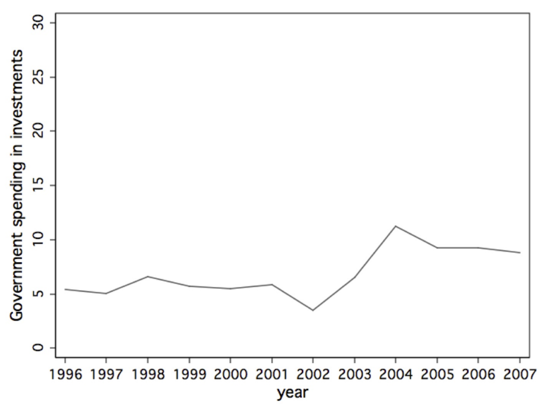
(a) Kenya



(b) Malawi



(c) Malawi



(d) Madagascar

Notes: Data for corruption and government investments are extracted from African development indicator of the World Bank (WBI).

Figure B1 - Patterns of corruption and government spending in investments on GDP

Appendix C

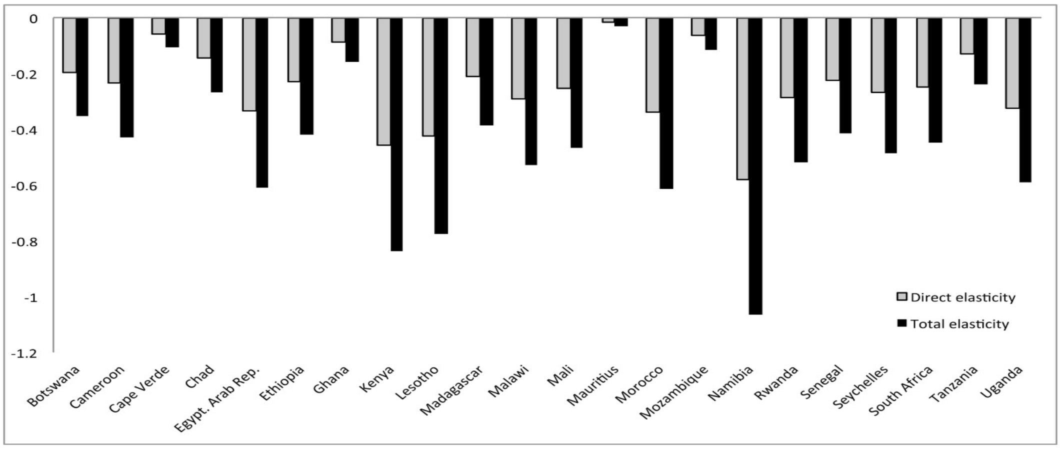
Table C1

Elasticity measures at the median and interquantile mean

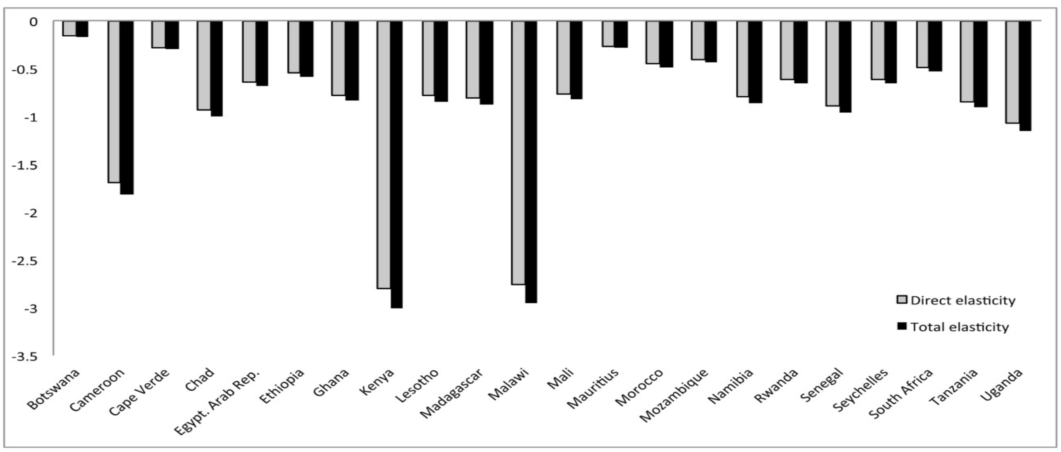
Variables	Direct elasticity (I)		Indirect elasticity (II)		Total elasticity (III)		Indirect elasticity corruption (+) (IV)	
Median								
mil	-0.181	**	-0.222	**	-0.403	**	-0.041	**
	(0.108)		(0.079)		(0.134)		(0.024)	
inv	0.694	**	0.030	*	0.724	**		
	(0.194)		(0.020)		(0.195)			
corr	-0.823	**	-0.048		-0.871	**		
	(0.255)		(0.040)		(0.258)			
Interquantile mean								
mil	-0.184	**	-0.227	**	-0.412	**	-0.041	**
	(0.109)		(0.080)		(0.136)		(0.024)	
inv	0.892	*	0.038		0.931	**		
	(0.252)		(0.026)		(0.254)			
corr	-0.810	**	-0.046		-0.857	**		
	(0.251)		(0.039)		(0.255)			

Notes: The elasticity measures reported are calculated from estimates presented Table 1. The labels of the variables are defined in Section 4. Direct elasticities use the estimated coefficients presented in the third column of Table 1, whereas indirect elasticities use those in Table 2. Bootstrapped standard errors are in parenthesis, while the asterisks stand for the $p - value$ significance levels and ** $p < 0.05$; *** $p < 0.01$. (+) Since the indirect elasticity of military spending depends on government spending in investments and corruption, the indirect elasticity of corruption on military spending is reported in a separate column.

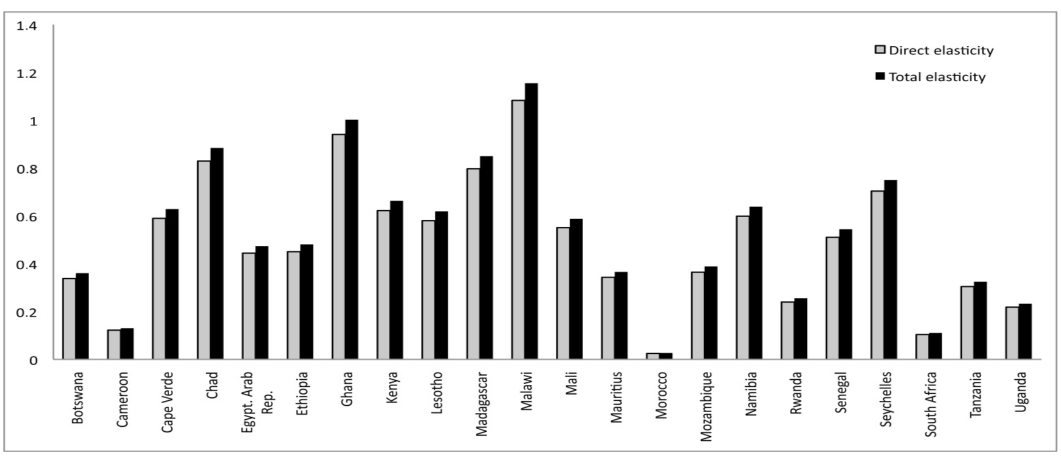
Appendix D



(e) Military spending in GDP



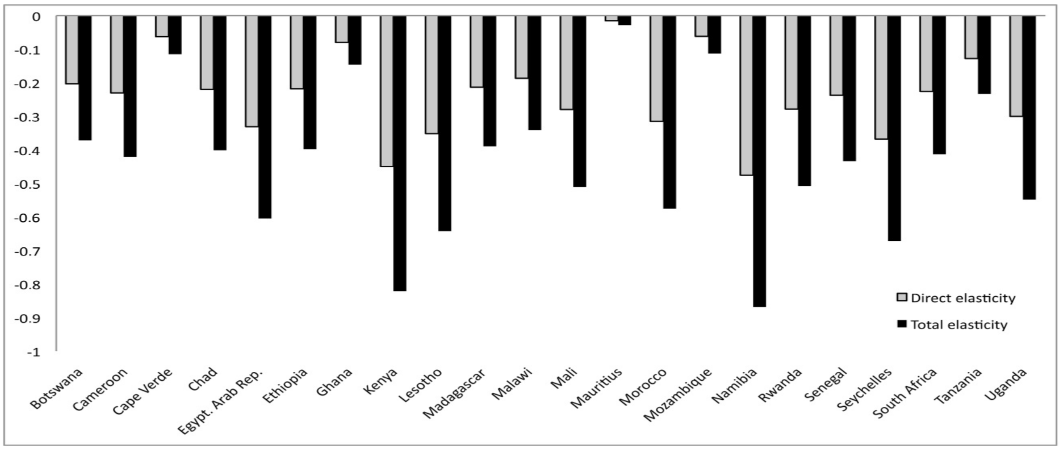
(f) Corruption



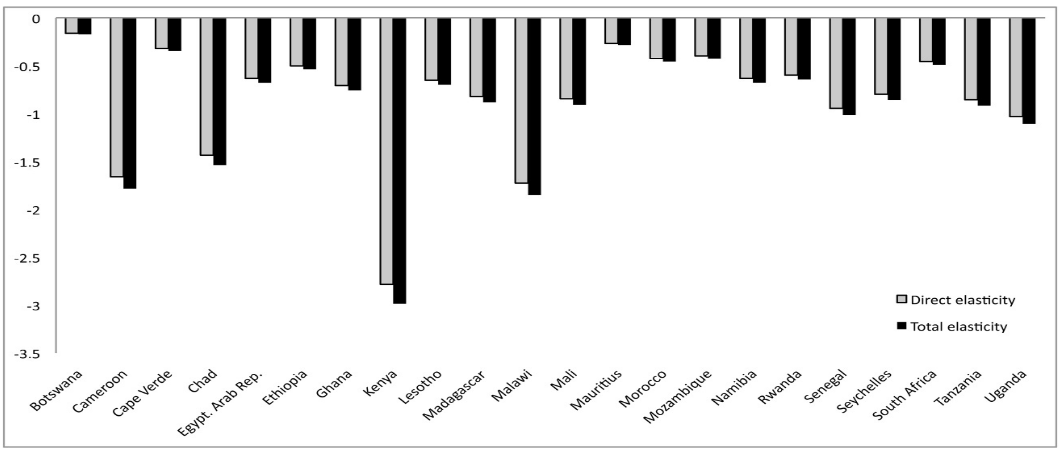
(g) Government investments in GDP

Notes: The elasticity measures for each country use the parameters from the full-sample estimations weighted for the median of each country in the sample period.

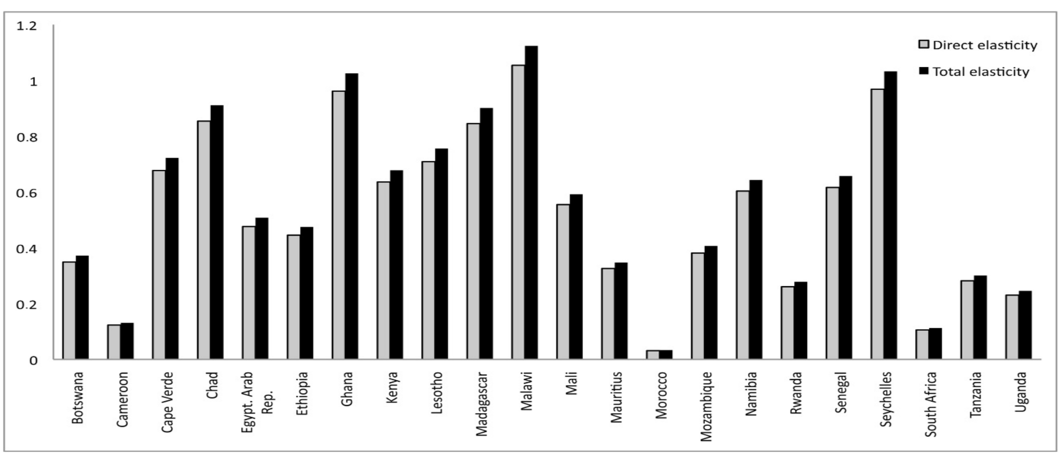
Figure D1 - Estimated elasticities at the median value, by country



(h) Military spending in GDP



(i) Corruption



(j) Government investments in GDP

Notes: The elasticity measures for each country use the parameters from the full-sample estimations weighted for the interquartile mean of each country in the sample period. Interquartile mean is obtained by the mean of each country in the sample period, after drop-out the values in the first and last quartiles.

Figure D2 - Estimated elasticities at the interquartile mean by country.

Appendix E

Table E1

Multiple causal correlations: fixed effect panel estimations, by sub-samples

Form of government	Autocratic regime						No-autocratic regime					
	mil		*inv*		*corr*		*mil*		*inv*		*corr*	
mil			-0.732	**	-1.589	**			-0.778	***	-2.225	
			(0.331)		(0.672)				(0.281)		-2.098	
inv	-0.038	**			0.070		-0.110	***			-2.629	***
	(0.016)				(0.142)		(0.039)				(0.701)	
corr	-0.016	**	0.017				-0.008		-0.056	***		
	(0.008)		(0.029)				(0.006)		(0.015)			
BP Lagrange Multiplier (LM) test	39.27	***	299.51	***	30.07	***	488.65	***	160.52	***	807.66	***
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
Number of Observations	84		84		84		180		180		180	
Political instability	**Countries with higher levels**						**Countries with low levels**					
	mil		*inv*		*corr*		*mil*		*inv*		*corr*	
mil			-0.759		4.717	**			-0.923	***	-2.862	***
			(0.546)		(1.844)				(0.182)		(0.847)	
inv	-0.004				0.181		-0.159	***			-1.254	***
	(0.007)				(0.145)		(0.034)				(0.363)	
corr	0.013	***	0.052				-0.024	***	-0.058	***		
	(0.004)		(0.035)				(0.007)		(0.018)			
BP Lagrange Multiplier (LM) test	510.97	***	20.26	***	453.77	***	260.81	***	319.69	***	477.45	***
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
Number of Observations	120		120		120		144		144		144	
Natural resources sub-sample	**Countries with higher levels**						**Countries with low levels**					
	mil		*inv*		*corr*		*mil*		*inv*		*corr*	
mil			-0.732	*	1.863				-0.994	***	-1.811	**
			(0.421)		(2.123)				(0.328)		(0.789)	
inv	-0.035	**			-0.454		-0.053	***			-0.116	
	(0.017)				(0.406)		(0.019)				(0.181)	
corr	0.004		-0.030	*			-0.017	**	-0.032			
	(0.004)		(0.018)				(0.008)		(0.031)			
BP Lagrange Multiplier (LM) test	551.45	***	321.47	***	519.71	***	272.19	***	66.37	***	482.15	***
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
Number of Observations	120		120		120		144		144		144	

Notes: The dependent variable are military spending in GDP (*mil*), government investment in GDP (*inv*) and corruption (*corr*), respectively. In parenthesis we report the standard errors, while the asterisks stand for the p-value significance levels. We have that: $^{*}p < 0.1$; $^{**}\ p < 0.05$; $^{***}p < 0.01$. The econometric specification includes both a constant and time dummies. At the bottom of the table Breusch-Pagan (BP) Lagrangian multiplier test is reported. The test statistic has a χ^2 distribution under the null hypothesis that error variance in the regression is equal to zero. The alternative hypothesis of Breusch-Pagan test statistic excludes the random-effect panel estimator.

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