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Markus Brückner and Mark Gradstein

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Markus Brückner, University of Adelaide
Mark Gradstein, Ben-Gurion University and CEPR

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Centre for Economic Policy Research
77 Bastwick Street, London EC1V 3PZ, UK
Tel: (44 20) 7183 8801, Fax: (44 20) 7183 8820
Email: cepr@cepr.org, Website: www.cepr.org

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ABSTRACT

Government Spending Cyclicality: Evidence from Rainfall Shocks as an Instrument for Cyclical Income

This research revisits the cyclicality of fiscal policies. To identify and estimate more precisely the magnitude of a causal effect of cyclical income on government spending, we employ annual rainfall data as an instrument for national income in the context of sub-Saharan countries. Our results confirm procyclical behavior of government spending and of tax revenues; debt and deficit are found to be countercyclical. Specifically, government spending is procyclical during upturns and acyclical during downturns. We also find that its procyclicality is correlated with corruption, especially among democracies.

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Markus Brückner
University of Adelaide
Department of Economics
10 Pulteney Street
5000 Adelaide
AUSTRALIA

Email:
markus.bruckner@adelaide.edu.au

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Mark Gradstein
Department of Economics
Ben-Gurion University
Beer-Sheva 84105
ISRAEL

Email:
grade@bgu.ac.il

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1. Introduction

The behavior of fiscal policies over the business cycle has attracted recently quite a bit of attention (e.g., Aizenman and Hausmann, 2000, Gavin and Perotti, 1997, Hercowitz and Strawczynski, 2004, Lane, 2003, Talvi and Vegh, 2005). In particular, a number of scholars, notably Talvi and Vegh, 2005, Kaminsky et al., 2005, have found that, especially in developing countries, procyclicality is generally observed. This begs an explanation, since the Keynesian school of thought maintains that policies should be countercyclical, whereas the rational expectations approach argues that they should be acyclical (Barro, 1979; see Talvi and Vegh, 2005, for a more detailed discussion of empirical implications of these approaches).

An important methodological issue that has plagued work addressing this research question is that of endogeneity of fiscal policies. In particular, while the concern with cyclicality obviously should focus on the causal link from income changes over the business cycle to policies induced by these changes, in principle, reverse causality – fiscal policies affecting income growth – is an important issue in and of itself.[1] Omitted variables are another potential source of a bias. Estimation biases resulting from ignoring reverse causality and omitted variables are illustrated in Rigobon, 2005, and Ilzetzki and Vegh, 2008.

We, therefore, propose in this paper an instrumental variables estimation approach to minimize the bias. Using a sample of sub-Saharan African countries, we employ rainfall as

1 See e.g., Blanchard and Perotti, 2002, Romer and Romer, 2009, and Shoag, 2011, for a sample of work on this causal link.

an instrument for national income there. In earlier papers, Miguel et al., 2004, and Bruckner and Ciccone, 2011, it has been established that, in the context of such countries, rainfall is a strong IV. Further, crucially for our purposes here, it is highly transitory, which makes it particularly suitable for the problem at hand. Additionally, as rainfall is idiosyncratic, expectations cannot possibly play a role here in shaping the government response. Finally, as is argued below, in the context of poor economies, rainfall is likely to affect government spending policies only via fluctuations in the GDP.

The sample being composed of some of the poorest countries in the world, on the basis of existing literature, one should expect procyclical policies. Our IV estimation confirms, indeed, procyclicality of government spending, consistent with the OLS estimation and with existing work (e.g., Kaminsky et al., 2005). Quantitatively, the average elasticity of government consumption expenditures with respect to the rainfall-induced GDP hovers around 0.5.

We then examine ratcheting, i.e. asymmetries in the response of government spending to positive and negative GDP growth shocks. We find strong procyclicality for the former, which is consistent with OLS estimation, as well as with existing literature. For the case of economic downturns, however, our IV results differ. Whereas some existing work, such as Gavin and Perotti, 1997, Hercowitz and Strawczynski, 2004, suggests countercyclical response, the former for developing and the latter for developed countries, we fail to detect this in our sample with the methodology employed. Although of signs consistent with countercyclicality, the coefficients are statistically insignificant, implying a lack of conclusive evidence of countercyclical spending in downturns.

While, consistent with much of the literature, we focus for the most part on government spending to gauge cyclicality, we also explore the cyclicality of the government deficit and debt. Here we detect countercyclicality of both. One possible explanation for this result has to do with the procyclical behavior of the tax revenues, feeding in as an automatic stabilizer.[2]

Finally, to rationalize procyclicality of government spending, we turn to the political economy channel, which has emerged recently as a leading explanatory factor, see Alesina et al., 2008, and Ilzetzki, 2011. Accordingly, we explore this channel along two dimensions, the level of corruption and the nature of the political regime, i.e., democracy versus autocracy. We find that, among democracies, corruption is associated with procyclicality in government spending – confirming the political economy theory in Alesina et al., 2008, and the calibrations in Ilzetzki, 2011. In contrast, among autocracies, corruption appears to have little to do with cyclicality.

Two recent papers, Ilzetzki and Vegh, 2008, and Jaimovich and Panizza, 2007, also employ an instrumental variable for national income – a (weighted) GDP of trading partners – to estimate cyclicality of fiscal policies, and this paper should be viewed as complementary

2 Because tax revenues act as automatic stabilizers, debt and deficit are to be considered as less direct measures of cyclicality than government spending.

to those.[3] We believe, however, that the rainfall variable has several major advantages. First, it is exogenous, whereas trade is a policy decision and an outcome of other factors, such as for example sector-specific technological change. Second, year-to-year variations in rainfall are clearly transitory, whereas the GDP of trading partners appears to be less so. Finally, rainfall's intertemporal variation is idiosyncratic, hence, plausibly unexpected. Consequently, we would like to argue that the strategy below is more precise, at least in the context of poor economies, to identify the magnitude of the causal effect that cyclical variations in GDP have on government spending.

There are a number of reasons why our analysis focuses on the group of sub-Saharan African countries. First, recent research on the macroeconomic effects of rainfall on income has shown that the significant effects of rainfall on GDP are limited to the sub-Saharan African region (see, for example, Barrios et al., 2010). That is, for other regions such as Asia and Latin America, there is no significant average effect of rainfall on aggregate income. Second, from an economic policy point of view, there exists considerable interest in the response of fiscal variables to the business cycle in sub-Saharan African countries (see, for example, Berg et al., 2009). Hence, our focus on sub-Saharan Africa is relevant from an economic policy point of view. Third, most of the sub-Saharan African countries have relatively weak state capacity. This makes the group of sub-Saharan African countries an interesting case study for examining the response of government expenditures to cyclical variations in income which are of exogenous nature.

3 Alesina et al., 2008, employ in their paper's empirical part the output gap of a country's region as an instrumental variable.

The paper proceeds as follows. Following data description, in the next section, Section 3 presents our empirical framework. Section 4 then contains the main estimation results, Section 5 rationalizes some of the results by employing corruption and democracy correlates, and Section 6 concludes.

2. Data

Rainfall. Our data on year-to-year variation of rainfall are from the National Aeronautics and Space Administration (NASA) Global Precipitation Climatology Project (GPCP), version 2.1 (Adler et al., 2003). These data are available from 1979 and to 2009. The rainfall data come on a 2.5°x2.5° latitude-longitude grid. We aggregate these data to the country level by assigning grids to the geographic borders of countries.

We use satellite-based rainfall data because these data have a number of important advantages over gauge-station based rainfall data. As pointed out in Bruckner and Ciccone, 2011, satellite-based rainfall data are less likely to suffer from measurement error that is due to the sparseness of operating gauge stations in Sub-Saharan African countries (especially after 1990). Also, as Bruckner and Ciccone, 2011, point out, the number of operating gauge stations in a country may be affected by socio-economic conditions, which could lead to non-classical measurement error in gauge-station based rainfall data.

GDP and Government Expenditures. Annual real per capita GDP data are for the period 1979-2009 period from the Penn World Table, version 7.0 (Heston et al., 2011). We also obtain from the Penn World Table data on real government consumption expenditures per capita.

Other Data. Data on democracy are from the Polity IV, 2010, project. Our main measure is the Polity2 score that ranges between -10 and 10, with higher values denoting stronger democratic institutions. Data on corruption are from the Worldwide Governance Indicators (Kaufmann et al., 2010). The WGI corruption variable ranges from -2.5 to 2.5 with higher values denoting a stronger absence of political corruption. Civil conflict incidence data are from the Peach Research Institute Oslo, 2010. The conflict incidence variable is a binary variable that is unity in the presence of civil conflict and zero otherwise. Data on public and publicly guaranteed external debt, the overall deficit, and central government tax revenues are from WDI, 2011. The data on temperature come from Matsuura and Willmott, 2009. Data on ethnic fractionalization are from Alesina et al., 2003. For some summary statistics on the above variables see Table 1 and the Data Appendix.

3. Estimation Framework

We estimate the cyclical response of government spending to transitory variation in GDP using two-stage least squares estimation. The second stage equation is:

(1) $$\Delta\ln(G)_{ct} = a_c + b_c t + \beta\Delta\ln(GDP)_{ct} + z_{ct}$$

where a_c are country fixed effects and $b_c t$ are country-specific linear time trends; $\Delta\ln(G)$ is the annual change of the log of real government consumption expenditures per capita; $\Delta\ln(GDP)$ is the annual change of the log of real GDP per capita; z_{ct} is an error term that is clustered at the country level.

The corresponding first stage equation is:

(2) $$\Delta\ln(GDP)_{ct} = g_c + d_c t + \gamma\ln(Rainfall)_{ct} + e_{ct}$$

We note that the Im, Pesaran, and Shin, 2003, panel unit root test cannot reject the hypothesis that the level of GDP per capita contains a unit root (p-value 0.94). But the test rejects the null that the first difference contains a unit root (p-value 0.00). Therefore, we use the change in the log of GDP per capita as the main explanatory variable.

We use the change in the log of government expenditures as the dependent variable because the panel unit root test cannot reject the null of a unit root at the 5 percent significance level. However, the test rejects the null of a unit root at the 10 percent significance (p-value 0.08). Hence, we will also present second-stage results that control for the lagged level of government expenditures on the right-hand side of the regression.

Concerning rainfall, the panel unit root test rejects the null hypothesis of a unit root at the 1 percent significance level. This is not surprising since year-to-year variations in rainfall are highly transitory: controlling for country fixed effects and country-specific linear time trends, the average AR(1) coefficient on rainfall is 0.07 with a standard error of 0.03. Hence, to identify the rainfall shock, and thus the response of government spending to cyclical variations in GDP, we have to use the level (and not the change) of rainfall as an instrument in the two-stage least squares estimation.[4]

Under the exclusion restriction that rainfall affects government spending through its effect on GDP, the two-stage least squares estimate β in equation (1) reflects the effect that transitory variations in GDP have on government spending. Thus, beyond correcting for possible bias that stems from reverse causality and omitted variables, an important advantage of our instrumental variables framework is that it allows us to separate transitory from permanent variations in GDP. This is key to our estimation objective since we are interested in estimating the response of government spending to cyclical variations in GDP per capita. Later in Section 4 we discuss the exclusion restriction underlying our results in detail.

4. Main results

4.1. Baseline estimates

Table 2 presents our first-stage estimates. Column (1) shows that above average rainfall has a significant positive effect on GDP per capita growth of Sub-Saharan African countries. The coefficient of 0.09 implies that a one percent increase in rainfall increased GDP per capita

4 For a further discussion of these issues, see Ciccone, 2011.

growth by around 0.09 percentage points on average. This estimate resonates with the findings of previous papers on the effects of rainfall on GDP in Sub-Saharan Africa. Column (2) shows that the impact effect of rainfall on GDP per capita growth continues to be highly statistically significant while the lagged effect is quantitatively small and statistically insignificant. Thus, column (2) shows that already after one year the effects of rainfall on GDP per capita growth have vanished.

In columns (3) and (4) of Table 2 we document that rainfall's effect on GDP growth is significant and of a similar magnitude both for negative as well as positive values of GDP growth. Hence, transitory variations in rainfall provide a good first-stage fit for upturns and for downturns of Sub-Saharan African economies. Again the coefficient on lagged rainfall is quantitatively small and statistically insignificant, and this further shows that it is the contemporaneous effect of rainfall that matters for the first-stage fit.

Panel A of Table 3 presents the second stage of our instrumental variables estimates. Overall, the estimates reveal a positive average response of government spending to transitory, rainfall induced GDP growth shocks. Quantitatively, the estimate in column (1) suggests that a one percent increase in GDP per capita increased government expenditures per capita by nearly half a percent. Column (2) shows however that if we exclude the post-2007 period (i.e. the recent financial crisis) from the sample the response of government spending to cyclical variation in GDP growth goes insignificant. On the other hand, column (3) shows that when the largest possible time-span is used then excluding the top or bottom 1 percentile of the change in the log of government expenditures (i.e. large changes in government expenditures) leaves the main finding in column (1) unchanged. Column (4) shows that this is also the case when excluding the top or bottom 1 percentile of rainfall observations (i.e. severe droughts or floods).

For comparison purposes to the instrumental variables estimates, we report in Panel B the corresponding least squares estimates. These are positive in sign and are quantitatively somewhat larger than the least squares estimates. Panel C of Table 2 also shows that estimates, which do not instrument GDP per capita but that use the Pesaran and Smith, 1995, mean-group estimator to allow for country-specific parameter heterogeneity, produce coefficients that are very similar to those in Panel B. Hence at face value, a no-instrumental variables approach suggests procyclicality of government spending in Sub-Saharan African countries. However, because government spending itself may have an effect on GDP growth in the short-run, such estimates should be interpreted with caution. Indeed, when we examine ratcheting – i.e. asymmetries in the response of government spending to positive and negative GDP growth shocks – we find that there are large differences between the least squares and instrumental variables estimates.

Before turning to these estimates, we present in Table 4 instrumental variables estimates when controlling for the lagged level of government spending. The estimates of the average effect that rainfall induced variations in GDP per capita growth have on government spending are still positive, but statistically less significant. Also quantitatively, the size of the estimated coefficient on the GDP variable is about half the size of the estimated coefficient in Table 3. On the other hand, the lagged level of government spending is negative and highly statistically significant.

Because the average time series dimension T of our panel is fairly large (28.8) we expect the Nickell, 1981, bias, which arises due to the presence of the country fixed effects on the lagged dependent variable, to be small. We strengthen this point by reporting in Panel A of Appendix Table 1 estimates that use the system-GMM estimator.[5] The main finding there is that the system-GMM estimates on the lagged dependent variable are of similar magnitude as the 2SLS estimates. However, the GMM estimates on the GDP variable are almost twice as large as the 2SLS estimates. This suggests that GMM, just like least squares estimates, suffers from an upward bias.

In Appendix Table 2, we also report instrumental variables estimates that are based on using the Hodrick and Prescott, 1997, filter to extract the cyclical components. Following Ravn and Uhlig, 2002, we use a lambda parameter of 6.25. The main result is that the second-stage estimate is positive and of similar magnitude as the IV estimate reported in Tables 2 and 3. However, the standard errors on the parameters are considerably larger when using the HP filter.

5 We use the first lag as an instrument in the system-GMM estimation to ensure that the number of moments is not too large.

4.2. Ratcheting

In Table 5 we explore whether there is ratcheting: an asymmetry in the response of government spending to positive and negative GDP growth shocks. Papers such as Hercowitz and Strawczynski, 2004, have found that government spending is countercyclical in recessions and procyclical in booms. To address this issue in our context, we now distinguish between positive and negative GDP growth values. Our main finding in Table 5 is that there is a quantitatively large and significantly positive response of government spending during times of GDP upturns. This can be seen from the coefficient on positive GDP growth. This coefficient is significant at the conventional confidence levels, thus indicating that government spending in Sub-Saharan African countries was on average highly procyclical during economic upturns. In particular, the estimated elasticity, of around 1.5, is higher than the one reported in Hercowitz and Strawczynski, 2004, for their sample of OECD countries (slightly larger than unity).

Regarding the response of government spending during economic downturns, we find that the coefficient on negative GDP growth is negative. The standard error on the coefficient of negative GDP growth is however larger than the standard error on the coefficient of positive GDP growth. This higher uncertainty implies that the coefficient on the negative GDP growth variable is not significant at the conventional confidence levels. A fair summary of these results is that our findings suggest government spending to be strongly procyclical during times of upturns while during times of downturns it is acyclical (countercyclical if one is willing to accept a more than 30 percent type I error). Again, for comparison, Hercowitz and Strawczynski, 2004, find government spending to be countercyclical during downturns in their sample of OECD countries.

In Tables 3 and 4, the first-stage F-statistic always exceeded the Staiger and Stock, 1997, rule-of-thumb criteria for instruments to be declared weak. In Table 5 the F-statistic is below 10. However, in Table 5 there are two endogenous regressors (positive and negative GDP growth values). The Staiger and Stock rule-of-thumb value is therefore not applicable. Instead, the critical values tabulated in Stock and Yogo, 2005, need to be used. Unfortunately, these critical values are based on homoscedastic errors. No critical values have been established yet when errors are heteroskedastic. Nevertheless, the critical values tabulated in Stock and Yogo, 2005, are often referred to in the applied instrumental variables literature.

If we use the Stock and Yogo critical values, then we can reject at the 5 percent significance level that there is a weak instrument bias leading to a size distortion of over 15 percent. This is not necessarily a small bias; however, it is also not terribly large in the sense that according to the third most stringent criteria in Stock and Yogo, we can reject that our 2SLS estimates are biased because of weak instruments.

To further address concern of weak instrument bias when examining ratcheting, we report in Table 6 results that split the sample into observations with positive and negative GDP growth. Column (1) reports the instrumental variables estimates for positive GDP growth observations and column (2) reports the estimates for negative GDP growth. Similar to Table 5, we find that the response of government spending to positive GDP growth shocks is statistically significant and positive. The first-stage F-statistic also exceeds the rule-of-thumb criteria of 10. For negative GDP growth values, we find that the coefficient is negative, suggesting counter-cyclicality of government spending. However, the standard error is almost twice as large as the standard error on the coefficient for positive GDP growth. As a consequence, the estimate on negative GDP growth is not significant at the conventional significance levels. We also note that the first-stage F-statistic of 6.66 in column (2) implies that we can barely reject the null that the IV size distortion is larger than 20 percent in this subsample.

4.3. Lagged effects

Our analysis so far examined the contemporaneous response of government spending to transitory income shocks. Theoretically, it is possible that there are also lagged effects of cyclical income variations on government spending, say, because of implementation lags. In Table 7 we explore this possibility by including the one-year lag GDP growth on the right-hand side of the regression. Column (1) shows the estimates when we include lagged GDP growth on the right-hand side without controlling for contemporaneous GDP growth. In column (2) we report estimates that include both, lagged and contemporaneous GDP growth. The main result is that the lagged average effect of GDP growth is also statistically insignificant. Likewise, column (2) confirms the results in Table 4, namely, that even when conditioning on lagged GDP growth the average contemporaneous effect of GDP growth of government spending is insignificant.

We also note that the first-stage fit in column (2) is reasonable. There, we instrument contemporaneous GDP growth as well as lagged GDP growth by contemporaneous and lagged rainfall. The first-stage F-statistic for this regression is 7.76. According to the tabulations in Stock and Yogo, 2005, this first-stage F-statistic implies that we can reject the hypothesis of the IV size distortion being larger than 10 percent at the 5 percent significance level.

4.4. Additional components of fiscal policy

While the above analysis focuses on government spending, it is also of interest to explore cyclicality of additional components of fiscal policies. In Table 8 we, therefore, examine precisely this. Its first column shows that instrumented national income has a significant positive effect on government tax revenues, implying that these are procyclical – which is hardly surprising. Quantitatively the size of the estimated coefficient implies a large tax revenue elasticity with respect to income changes of about 2.5, which is also in line with the more detailed tax revenue elasticity estimates reported in Bruckner, 2011.

The quantitatively large tax revenue elasticity also helps in understanding the next results, exhibited in columns 2 and 3, pertaining to the cyclicality of external debt and the deficit. As is evident from the table, both items are countercyclical. Quantitatively, the estimates in columns (2) and (3) imply that on average a one percent increase in GDP reduced external debt of sub-Saharan African countries by about 0.6 percent and the deficit-to-GDP ratio by about half a percentage point. Given that government spending is found to be procyclical in the previous tables, it appears that the procyclicality of tax revenues drives the results on external debt and the deficit. Finally, we take a look, in columns 4-6, at various items, such as public capital formation, military and public health spending, and find these to be acyclical.

4.5. Discussion of exclusion restriction

Beyond the first-stage fit, a necessary condition for instrumental variables estimation to provide consistent estimates is that the instruments fulfill the exclusion restriction. Prior research on the effects of economic shocks on civil conflict and democracy by Miguel et al., 2004, and Bruckner and Ciccone, 2011, has used rainfall as an instrumental variable for GDP. In these papers, the exclusion restriction was that rainfall should only affect civil conflict and democracy, respectively, through income. With respect to civil conflict, this exclusion restriction would be violated if, for example, flooding affected troop mobility and this troop mobility affects the incidence of civil conflict.

In our context, the exclusion restriction is that rainfall should only affect government spending through its effect on average income. In a sense, this is a weaker exclusion restriction than in the context of civil conflict or democracy: unless these variables affect government spending, we do not have to be concerned about whether rainfall via, for example, flooding has a direct effect on conflict and democracy change. Moreover, as shown in column (4) of Tables 3 and 4, the results are robust to excluding extreme rainfall observations.

Still, it could be that rainfall has an effect on government spending beyond GDP growth through its effect on income distribution. Unfortunately, the sparse data on income distribution for Sub-Saharan African countries prohibits us from examining this alternative channel in a rigorous manner.[6] We therefore rely on checking directly whether there is evidence of a violation of the exclusion restriction. We do this by using temperature as an additional instrument for GDP. Using this additional instrumental variable, which also is clearly exogenous, allows us to compute the Hansen J test. The Hansen J test is a joint test of the validity of the instruments. A significant p-value of this test should be taken as a red light that the exclusion restriction is violated.

Table 9, column (1), reports these two-stage least squares estimates that use rainfall and temperature as excluded instruments. The first-stage F-statistic is 27.43, and thus the

6 We have checked whether rainfall has a significant effect on the Gini coefficient of Sub-Saharan African countries. With the 113 observations that are available for this group of countries, we did not find a significant effect (estimates not reported).

first-stage fit between GDP growth and rainfall and temperature is strong. Moreover, the Hansen J test does not reject the validity of the instruments (the p-value is 0.38).

To show in a more intuitive way that rainfall does not have a significant effect on government spending beyond income, we report in column (2) estimates of the effect of rainfall on government spending when controlling for GDP growth. Our main finding is that rainfall does not have a significant direct effect on government spending. We also note that in this regression GDP growth is instrumented by temperature, and that this yields a first-stage F-statistic of 9.7. Finally, we show in column (3) that similar results are obtained if we control for the incidence of civil conflict and the Polity2 score, both of which are insignificant in the regression.

5. The Role of Democracy and Corruption

What can account for the strong procyclical response of government spending to positive GDP growth shocks? An emerging line of work suggests that political factors play a crucial role. Thus, in their political economy model, Alesina et al., 2008, provide the following political economy explanation: government spending increases during booms, because voters seek to "starve the Leviathan" to reduce political rents. The Alesina et al., 2008, voting model thus suggests that the positive response of government spending in times of economic upturns should be prevalent in countries which have a minimal form of democracy, and nevertheless, exhibit a significant amount of political corruption. Ilzetzki, 2011, corroborates this theory using simulations and argues that it explains empirical regularities better than alternative theories, such as those relying on borrowing constraints.

In Table 10 we empirically revisit this political economy channel using our instrumental variables approach. We first split the sample into democracies and autocracies based on the Polity2 score of the Polity IV, 2010, project. Following the Polity IV project and Alesina et al., 2008, as well as a large political economy literature, we group countries into democracies if their Polity2 score is strictly positive; otherwise countries are grouped as autocracies. Column (1) of Panel A in Table 10 shows that, for the democracy sample, there is a significant positive response of government spending during times of positive GDP growth. However, column (2) shows that this response is significantly increasing in cross-country differences of political corruption.[7] The predicted heterogeneity is so strong that in countries with low levels of political corruption procyclicality vanishes.

Figure 1 illustrates this heterogeneity in the marginal effect graphically. The figure plots the marginal effect of positive GDP growth on government spending in the democracy sample across different values of political corruption that are relevant for the sample. Clearly, for the majority of countries in the sample, the predicted relationship is positive. Only for

7 Note that we compute the interaction term as: $GDP_{c,t}$*(Lack-of $Corruption_c$ – Sample Average Lack-of Corruption). This ensures that the estimate on GDP reflects the effect of GDP on government spending when evaluated at sample mean. We use the country-average lack-of political corruption score, rather than the time-varying measure of lack-of political corruption, in order to maximize the number of observations. Using the average lack-of corruption score has also the advantage of reducing concerns of endogeneity bias.

relatively non-corrupt countries, such as Botswana that has a lack-of-corruption score of 0.8, is the relationship statistically insignificant and quantitatively close to zero.

To address concerns that the interaction with the country-average score of political corruption may be a potentially endogenous regressor, we use in column (3) of Table 10 ethnic fractionalization.[8] The strong (negative) cross-sectional correlation between ethnic fractionalization and lack-of political corruption is well documented, see for example Mauro (1995) among others. When using ethnic fractionalization as a more plausibly exogenous variable, we find that the result documented in column (2) continues to hold: there is a significant positive effect of cyclical GDP variations on government spending in countries with sample average ethnic fractionalization; the effect is predicted to be particularly large in countries with a high degree of ethnic fractionalization; and in countries with low levels of ethnic fractionalization, such as for example OECD countries, the predicted relationship implies a significant countercyclical response of government spending.

In Panel B of Table 10 we repeat the exercise for the autocracy sample. In this sub-group we do not find a significant response of government spending to positive GDP growth shocks. This is, too, consistent with the model in Alesina et al., 2008, which predicts procyclicality of government spending during booms for democracies, where citizens can affect policy outcomes through voting, but not for autocracies.

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8 Again note that we compute the interaction term as: $GDP_{c,t}$*(Ethnic fractionalization$_c$ – Sample Average Ethnic Fractionalization).

6. Conclusions

This paper's objective is to provide more precise estimates of the cyclical behavior of government spending and other dimensions of fiscal policies, an issue confounded by the endogeneity of economic performance. To this end, we have used annual rainfall data as an instrumental variable for national income in the context of poor sub-Saharan countries. Rainfall's exogenous, idiosyncratic, and transitory nature appears to be ideal to address the problem at hand. Our estimates confirm procyclicality obtained in the existing literature, especially during upturns. In contrast, whereas existing work (Gavin and Perotti, 1997, Hercowitz and Strawczynski, 2004) suggests a countercyclical response during downturns, our estimates turn out to be insignificant implying acyclicality. We also explore some political economy correlates of procyclical behavior. Here, consistent with theoretical suggestions, we find that it is correlated with countries' corruption levels, especially in democracies.

Since the government response to business cycles is an important policy issue, particularly in developing countries, it is hoped that this work will prove useful in its accurate assessment. This, in turn, should enable a more precise identification of the correlates of procyclicality.

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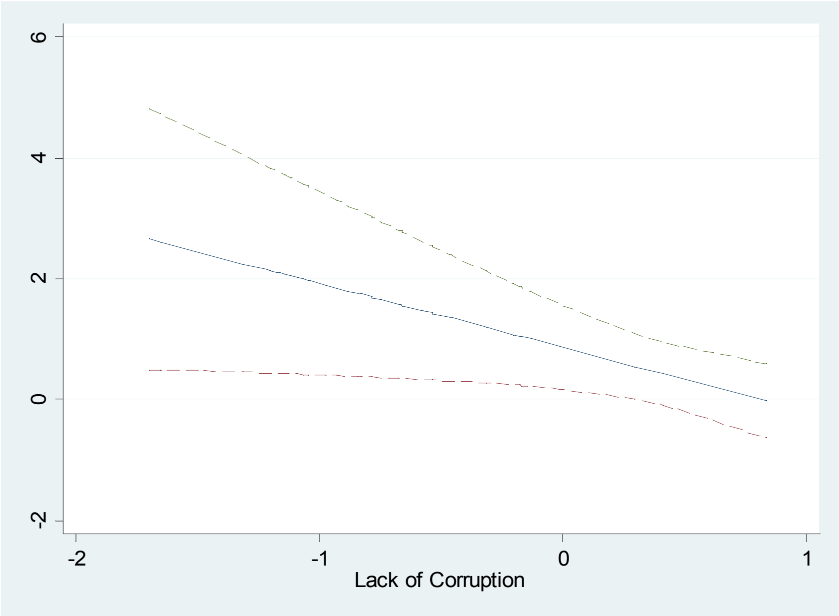
Figure 1. Procyclicality of Government Spending in Democracies



Note: The figure plots the marginal effect that GDP growth has on government spending based on the estimates reported in column (2) of Table 10. Dashed lines represent 90 percent confidence bands.

Table 1. Descriptive Statistics

Variable	Source	Mean	Stdv.	Obs
Δln(GDP)	PWT	0.031	0.10	1180
Δln(Gov)	PWT	0.035	0.20	1180
Δln(Central Gov. Revenues)	WDI	0.044	0.53	852
Δln(External Debt)	WDI	0.033	0.20	1068
Δ(Deficit/GDP)	WDI	-0.022	0.06	862
Δln(Public Capital Formation)	WDI	0.18	0.48	883
Δln(Military Expenditures)	WDI	0.17	0.41	644
Δln(Public Health Expenditures)	WDI	0.07	0.21	535
ln(Rainfall)	GPCP	6.70	0.65	1180
ln(Temperature)	MW	3.17	0.16	1180
Polity2 Score	Polity IV	-1.65	5.68	1180
Democracy	Polity IV	0.33	0.47	1180
Lack of Corruption	WGI	-0.69	0.52	1180
Civil Conflict	PRIO	0.26	0.44	1180
Ethnic Fractionalization	Alesina et al. 2003	0.70	0.19	1180

Table 2. Transitory Effects of Rainfall on GDP Growth

Dependent Variable: Δln(GDP)				
	(1)	(2)	(3)	(4)
	All Observations		Only Δln(GDP)>0	Only Δln(GDP)<0
	LS	LS	LS	LS
ln(Rainfall), t	0.09***	0.09***	0.05***	0.08**
	(0.01)	(0.01)	(0.01)	(0.03)
ln(Rainfall), t-1		0.00	0.00	0.01
		(0.02)	(0.02)	(0.02)
Country FE	Yes	Yes	Yes	Yes
Country Trends	Yes	Yes	Yes	Yes
Observations	1180	1180	855	325

Note: The method of estimation is least squares. The dependent variable is the change in the log of real GDP per capita. Standard errors in parentheses are Huber robust and clustered at the country level. *Significantly different from zero at the 10 percent significance level, ** 5 percent significance level, *** 1 percent significance level.

Table 3. Response of Government Spending to Cyclical Income Variations
(Baseline Estimates)

Dependent Variable: Δln(Gov)				
	(1)	(2)	(3)	(4)
	All Observations	Excluding Post-2007	Excluding Top/Bottom 1% ΔGov Spending	Excluding Top/Bottom 1% Rainfall
	Panel A: IV for GDP is Rainfall			
	2SLS	2SLS	2SLS	2SLS
Δln(GDP), t	0.47*	0.36	0.55**	0.52*
	(0.26)	(0.25)	(0.28)	(0.29)
First-Stage F-Stat	45.96	42.95	43.13	49.29
	Panel B: No IV for GDP (Least Squares Estimation)			
	LS	LS	LS	LS
Δln(GDP), t	0.56***	0.58***	0.48***	0.55***
	(0.12)	(0.12)	(0.08)	(0.12)
	Panel C: No IV for GDP (Mean Group Estimation)			
	MG	MG	MG	MG
Δln(GDP), t	0.48***	0.48***	0.42***	0.45***
	(0.10)	(0.10)	(0.08)	(0.10)
Country FE	Yes	Yes	Yes	Yes
Country Trends	Yes	Yes	Yes	Yes
Observations	1180	1098	1157	1157

Note: The method of estimation in Panel A is two-stage least squares; Panel B least squares; Panel C the Pesaran and Smith (1995) mean group estimator. The instrumental variable in the two-stage least squares estimation is rainfall. The dependent variable is the change in the log of real government expenditures per capita. Standard errors in parentheses are Huber robust and clustered at the country level. *Significantly different from zero at the 10 percent significance level, ** 5 percent significance level, *** 1 percent significance level.

Table 4. Response of Government Spending to Cyclical Income Variations
(Controlling for Lagged Government Spending)

Dependent Variable: Δln(Gov)				
	(1)	(2)	(3)	(4)
	All Observations	Excluding Post-2007	Excluding Top/Bottom 1% ΔGov Spending	Excluding Top/Bottom 1% Rainfall
	2SLS	2SLS	2SLS	2SLS
Δln(GDP), t	0.27 (0.21)	0.32 (0.22)	0.43* (0.24)	0.31 (0.24)
ln(Gov), t-1	-0.28*** (0.07)	-0.33*** (0.07)	-0.13*** (0.04)	-0.28*** (0.07)
First-Stage F-Stat	46.97	46.23	42.63	50.07
Country FE	Yes	Yes	Yes	Yes
Country Trends	Yes	Yes	Yes	Yes
Observations	1180	1098	1157	1157

Note: The method of estimation is two-stage least squares. The instrumental variable is rainfall. The dependent variable is the change in the log of real government expenditures per capita. Standard errors in parentheses are Huber robust and clustered at the country level. *Significantly different from zero at the 10 percent significance level, ** 5 percent significance level, *** 1 percent significance level.

Table 5. Ratcheting: Positive vs. Negative Cyclical Income Variations

	Dependent Variable: Δln(Gov)			
	(1)	(2)	(3)	(4)
	All Observations	Excluding Post-2007	Excluding Top/Bottom 1% ΔGov Spending	Excluding Top/Bottom 1% Rainfall
	2SLS	2SLS	2SLS	2SLS
$\Delta\ln(GDP)^{Negative}$, t	-0.92	-0.97	-0.71	-1.01
	(0.83)	(1.02)	(0.79)	(0.91)
$\Delta\ln(GDP)^{Positive}$, t	1.51**	1.63**	1.36**	1.57**
	(0.70)	(0.84)	(0.65)	(0.75)
ln(Gov), t-1	-0.25***	-0.31***	-0.09	-0.25***
	(0.08)	(0.09)	(0.06)	(0.08)
First-Stage F-Stat	6.19	5.13	5.98	5.86
Fixed Effects	Yes	Yes	Yes	Yes
Country Trends	Yes	Yes	Yes	Yes
Observations	1180	1098	1157	1157

Note: The method of estimation is two-stage least squares. The instrumental variable is rainfall. The dependent variable is the change in the log of real government expenditures per capita. Standard errors in parentheses are Huber robust and clustered at the country level. *Significantly different from zero at the 10 percent significance level, ** 5 percent significance level, *** 1 percent significance level.

Table 6. Sample Split: Positive vs. Negative Cyclical Income Variations

	Dependent Variable: Δln(Gov)	
	(1)	(2)
	2SLS	2SLS
	Δln(GDP)>0	Δln(GDP)<0
Δln(GDP), t	0.83*	-1.00
	(0.48)	(0.94)
ln(Gov), t-1	-0.24**	-0.42***
	(0.10)	(0.08)
First-Stage F-Stat	35.49	6.64
Country FE	Yes	Yes
Country Trends	Yes	Yes
Observations	855	325

Note: The method of estimation is two-stage least squares. The instrumental variable is rainfall. The dependent variable is the change in the log of real government expenditures per capita. Standard errors in parentheses are Huber robust and clustered at the country level. *Significantly different from zero at the 10 percent significance level, ** 5 percent significance level, *** 1 percent significance level.

Table 7. Response of Government Spending to Cyclical Income Variations
(Lagged Effects)

Dependent Variable: Δln(Gov)		
	(1)	(2)
	2SLS	2SLS
Δln(GDP), t		0.25
		(0.21)
Δln(GDP), t-1	0.18	0.15
	(0.41)	(0.39)
ln(Gov), t-1	-0.30***	-0.29***
	(0.07)	(0.07)
First-Stage F-Stat	33.79	7.76
Country FE	Yes	Yes
Country Trends	Yes	Yes
Observations	1180	1180

Note: The method of estimation is two-stage least squares. The instrumental variable is rainfall. The dependent variable is the change in the log of real government expenditures per capita. Standard errors in parentheses are Huber robust and clustered at the country level. *Significantly different from zero at the 10 percent significance level, ** 5 percent significance level, *** 1 percent significance level.

Table 8. Response of Other Fiscal Variables to Cyclical Income Variations

Dependent Variable: Δ(Fiscal Variable)						
Fiscal Variable	Log of Central Gov. Tax Revenues	Log of Public External Debt	Overall Deficit as Share of GDP	Log of Public Gross Fixed Capital	Log of Military Expenditures	Log of Public Health Expenditures
	(1)	(2)	(3)	(4)	(5)	(6)
	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
Δln(GDP), t	2.75*	-0.61*	-0.46**	0.05	0.48	-0.03
	(1.44)	(0.35)	(0.20)	(1.13)	(0.92)	(0.40)
Fiscal Variable, t-1	-0.68***	-0.16***	-0.09	-0.25***	-0.20**	-0.45***
	(0.14)	(0.02)	(0.06)	(0.04)	(0.08)	(0.06)
First-Stage F-Stat	23.39	45.88	24.20	27.67	19.54	17.91
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Country Trends	Yes	Yes	Yes	Yes	Yes	Yes
Observations	852	1068	846	883	644	535

Note: The method of estimation is two-stage least squares. The instrumental variable is rainfall. The dependent variable in column (1) is the change in the log of central government tax revenues; column (2) the change in the log of external debt; column (3) the change in the GDP share of the overall deficit; column (4) the change in the log of public gross fixed capital formation; column (5) the change in the log of military expenditures; column (6) the change in the log of public health expenditures. Standard errors in parentheses are Huber robust and clustered at the country level. *Significantly different from zero at the 10 percent significance level, ** 5 percent significance level, *** 1 percent significance level.

Table 9. Response of Government Spending to Cyclical Income Variations
(Test of Exclusion Restriction: Additional Instrument is Temperature)

Dependent Variable: Δln(Gov)			
	(1)	(2)	(3)
	2SLS	2SLS	2SLS
Δln(GDP), t	0.39**	0.73*	0.78
	(0.17)	(0.42)	(0.49)
ln(Gov), t-1	-0.27***	-0.26***	-0.26***
	(0.07)	(0.07)	(0.08)
Rainfall, t		-0.04	-0.04
		(0.05)	(0.05)
Polity2, t			0.00009
			(0.002)
Civil Conflict, t			0.02
			(0.03)
First-Stage F-Stat	27.43	9.76	8.10
Hansen J, p-value	0.38	.	.
Country FE	Yes	Yes	Yes
Country Trends	Yes	Yes	Yes
Observations	1180	1180	1180

Note: The method of estimation is two-stage least squares. The instrumental variable is rainfall. The dependent variable is the change in the log of real government expenditures per capita. Standard errors in parentheses are Huber robust and clustered at the country level. *Significantly different from zero at the 10 percent significance level, ** 5 percent significance level, *** 1 percent significance level.

Table 10. The Response of Government Spending to Positive Cyclical Income Variations: The Role of Democracy and Corruption

Dependent Variable: Δln(Gov)

	Panel A: Democracy Sample		
	(1)	(2)	(3)
	2SLS	2SLS	2SLS
Δln(GDP), t	1.68**	1.59**	1.54**
	(0.65)	(0.77)	(0.76)
Δln(GDP), t* Country Average Lack of Corruption		-1.08*	
		(0.60)	
Δln(GDP), t* Ethnic Fractionalization			5.84**
			(2.82)
ln(Gov), t-1	-0.03	-0.03	-0.03
	(0.04)	(0.04)	(0.04)
First-Stage F-Stat	10.58	3.35	2.39
Country FE	Yes	Yes	Yes
Country Trends	Yes	Yes	Yes
Observations	282	282	282
	Panel B: Autocracy Sample		
	(4)	(5)	(6)
	2SLS	2SLS	2SLS
Δln(GDP), t	-0.49	1.26	1.15
	(1.64)	(0.89)	(0.90)
Δln(GDP), t* Country Average Lack of Corruption		-0.15	
		(1.53)	
Δln(GDP), t* Ethnic Fractionalization			-2.82
			(2.24)
ln(Gov), t-1	-0.18***	-0.37**	-0.38**
	(0.06)	(0.15)	(0.15)
First-Stage F-Stat	8.90	11.00	5.69
Country FE	Yes	Yes	Yes
Country Trends	Yes	Yes	Yes
Observations	573	573	573

Note: The table reports two-stage least squares estimates for country-years with Δln(GDP)>0. The method of estimation is two-stage least squares. The instrumental variable is rainfall. The dependent variable is the change in the log of real government expenditures per capita. Standard errors in parentheses are Huber robust and clustered at the country level. *Significantly different from zero at the 10 percent significance level, ** 5 percent significance level, *** 1 percent significance level.

Appendix Table 1. System-GMM Approach, Controlling for Lagged Gov Spending and Racheting

Dependent Variable: Δln(Gov)				
	All Observations	Excluding Post-2007	Excluding Top/Bottom 1% ΔGov Spending	Excluding Top/Bottom 1% Rainfall
	Panel A: Controlling for Lagged GDP			
	GMM	GMM	GMM	GMM
Δln(GDP), t	0.42***	0.46***	0.47***	0.43***
	(0.12)	(0.13)	(0.08)	(0.12)
ln(Gov), t-1	-0.33***	-0.35***	-0.26***	-0.35***
	(0.13)	(0.13)	(0.06)	(0.13)
AR(1), p-value	0.00	0.00	0.00	0.00
AR(2), p-value	0.58	0.64	0.50	0.58
Country FE	Yes	Yes	Yes	Yes
Country Trends	Yes	Yes	Yes	Yes
Observations	1189	1107	1166	1166
	Panel B: Controlling for Lagged GDP and Allowing For Ratcheting			
	GMM	GMM	GMM	GMM
$\Delta\ln(GDP)^{Negative}$	0.77***	0.78***	0.70***	0.79***
	(0.12)	(0.11)	(0.10)	(0.11)
$\Delta\ln(GDP)^{Positive}$	0.16	0.20**	0.32***	0.16
	(0.11)	(0.10)	(0.08)	(0.11)
ln(Gov), t-1	-0.34***	-0.35***	-0.16***	-0.33***
	(0.12)	(0.13)	(0.06)	(0.14)
AR(1), p-value	0.00	0.00	0.00	0.00
AR(2), p-value	0.63	0.69	0.52	0.84
Country FE	Yes	Yes	Yes	Yes
Country Trends	Yes	Yes	Yes	Yes
Observations	1189	1107	1166	1166

Note: The method of estimation is system-GMM. The dependent variable is the change in the log of real government expenditures per capita. Standard errors in parentheses are Huber robust and clustered at the country level. *Significantly different from zero at the 10 percent significance level, ** 5 percent significance level, *** 1 percent significance level.

Appendix Table 2. IV Results Using the Hodrick Prescott Filter

Dependent Variable: Gov_HP			
	(1)	(2)	(3)
	2SLS	2SLS	2SLS
GDP_HP, t	0.38 (0.45)	0.43 (0.45)	
$GDP\_HP^{Negative}$, t			-2.10 (1.56)
$GDP\_HP^{Positive}$, t			3.31* (2.01)
ln(Gov), t-1		0.03 (0.03)	0.06 (0.04)
First-Stage F-Stat	16.11	17.17	2.21
Country FE	Yes	Yes	Yes
Country Trends	Yes	Yes	Yes
Observations	1180	1180	1180

Note: The method of estimation is two-stage least squares. The instrumental variable is rainfall. The dependent variable is HP filtered real government expenditures per capita. Standard errors in parentheses are Huber robust and clustered at the country level. *Significantly different from zero at the 10 percent significance level, ** 5 percent significance level, *** 1 percent significance level.

Data Appendix

Country	Gov/GDP	Deficit/GDP	Tax/GDP	Ex. Debt/GDP	Lack of Corruption	Polity2
Angola	28.29	0.52	37.52	150.05	-1.31	-3.79
Benin	8.31	-7.44	14.01	58.18	-0.68	1.9
Botswana	11.35	0.04	40.91	14.51	0.84	7.24
Burkina Faso	15.1	-15.2	12.23	37.3	-0.14	-3.97
Burundi	16.79	-11.69	18.99	108.57	-1.1	-1.83
Cameroon	6.77	1.4	17.1	64.85	-1.07	-5.48
Central African Rep	11.7	-1.17	8.87	65.45	-1.17	-1.34
Chad	53.8	-14.32	9.87	42.5	-1.15	-3.28
Congo, Dem. Rep.	7	0.03	10.59	155.5	-1.66	-2.38
Congo, Republic of	16.24	1.24	28.46	205.59	-0.93	-4.03
Cote d'Ivoire	7.18	-9.67	20.77	133.75	-0.79	-4.55
Djibouti	28.66	.	.	.	-0.67	-3.86
Ethiopia	8.95	-0.07	12.85	69.67	-0.66	-2.07
Gabon	6.49	3.53	28.99	68.33	-0.67	-5.38
Gambia, The	11.47	-0.19	20.18	124.82	-0.47	0.34
Ghana	11.93	-0.02	16.77	68.34	-0.18	-0.07
Guinea	9.03	-36.42	13.34	94.96	-0.75	-3.83
Guinea-Bissau	11.19	-10.1	11.36	328.62	-1.05	-1
Kenya	5.89	-0.41	23.64	60.31	-0.98	-1.66
Lesotho	6.13	-0.07	44.21	43.63	-0.2	1.1
Liberia	6.87	-0.06	4.56	526.64	-1.22	-0.83
Madagascar	6.44	-21.84	11	100.86	-0.01	2.48
Malawi	12.66	-0.83	20.14	99.8	-0.58	-0.86
Mali	13.03	-15.17	21.23	92.16	-0.46	1.76
Mauritania	17.73	-4.19	22.61	166.78	-0.17	-5.69
Mozambique	7.45	-452.17	.	159.35	-0.54	-0.45
Namibia	8	-0.08	29.25	.	0.29	6
Niger	13.17	-14.99	9.62	68.52	-0.88	-0.1
Nigeria	3.21	0.39	28.85	79.07	-1.2	-0.79
Rwanda	25.2	-3.36	10.72	46.82	-0.54	-5.52
Senegal	6.85	-10.46	23.11	66.36	-0.14	2
Sierra Leone	6.49	-15.37	10.93	131.39	-1.04	-1.79
Somalia	13.3	.	.	203.14	-1.7	-2.41
South Africa	6	-0.08	24.64	17.03	0.41	7.03
Sudan	8.97	-0.01	16.55	109.46	-1.18	-4.69
Swaziland	7.71	-0.11	28.02	17.95	-0.32	-9.41
Tanzania	8.54	-17.34	12.46	96.58	-0.79	-3.31
Togo	9.4	-8.55	17.35	99.39	-0.83	-4.21
Uganda	13.82	-30.93	9.63	52.27	-0.79	-3.1
Zambia	16.08	-21.1	19.47	174.09	-0.84	-0.21
Zimbabwe	7.91	.	23.05	53.69	-1.12	-3.34