DISCUSSION PAPER SERIES

No. 8530

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INTERNATIONAL TRADE AND REGIONAL ECONOMICS

Centre for Economic Policy Research

www.cepr.org

Available online at: www.cepr.org/pubs/dps/DP8530.asp

ISSN 0265-8003

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Discussion Paper No. 8530
August 2011

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CEPR Discussion Paper No. 8530

August 2011

ABSTRACT

Price Distortions and Economic Growth in Sub-Saharan Africa*

To what extent has Sub-Saharan Africa's slow economic growth over the past five decades been due to price and trade policies that have discouraged production of agricultural relative to non-agricultural tradables? This paper uses a new set of estimates of policy distortions to relative prices to address this question econometrically. We first test if these policy distortions respond to economic growth, using rainfall and international commodity price shocks as instrumental variables. We find that on impact there is no significant response of relative price distortions to changes in real GDP per capita. We then test the reverse proposition and find a statistically significant and sizable negative effect of relative price distortions on the growth rate of Sub-Saharan African countries. Our fixed effects estimates suggest that, during 1960-2005, a one standard deviation increase in distortions to relative prices reduced the region's real GDP per capita growth rate by about half a percentage point per annum.

JEL Classification: F14, F43, N17, O13, O55 and Q18
Keywords: agricultural incentives, economic growth and trade restrictions

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* The paper has benefited from many useful comments and suggestions received at the 2011 Econometric Society Australasian Meeting and an Arndt-Corden seminar at the Australian National University. The authors gratefully acknowledge the financial support of the Spanish Ministry of Science and Technology provided by CICYTECO2008-04997 (Brückner) and the Australian Research Council, the Rural Industries Research and Development Corporation, and the World Bank (Anderson).
Submitted 08 August 2011

1. Introduction

Economic growth in Sub-Saharan Africa has been slow for decades (Easterly and Levine, 1997; Ndulu and O'Connell, 2007). According to data from the Penn World Table (Heston et al., 2009), Sub-Saharan African real income per capita grew at less than one percent over the past half century. In this paper we examine how and to what extent policy induced distortions to agricultural and non-agricultural production are responsible for Sub-Saharan Africa's dismal growth performance. The average share of GDP from agriculture in the Sub-Saharan African countries during the past half century has been more than one-third (WDI, 2010). Even in recent years agricultural production in Sub-Saharan Africa has constituted about a quarter of total GDP and more than half of total employment (Sandri, Valenzuela and Anderson, 2007). Given these large shares, the question of how much policy induced distortions to relative agricultural prices have slowed the region's economic growth is economically relevant – both for the academic debate on the determinants of Africa's growth tragedy as well as for the policy debate on what works and does not work for stimulating economic growth in Sub-Saharan Africa.

Our estimation strategy to identify the causal effects that policy distortions to relative agricultural prices have on economic growth in Sub-Saharan African countries is based on a two-step estimation approach. In the first step, we estimate the response of these policy distortions to economic growth, using plausibly exogenous variations in rainfall and international commodity price shocks as instrumental variables.[1] The instrumental variables approach enables us to examine how distortions to relative prices respond to exogenous changes in GDP per capita growth. Importantly, beyond informing the political economy debate on the determinants of policy distortions, the results from this first step provide useful information on the extent to which these policy distortions are endogenous to changes in Sub-Saharan African countries' GDP per capita growth. In the second step, we use this information to estimate the effects that policy distortions

1 We thus build on the prior literature that has shown that rainfall and international commodity price shocks have a significant effect on real GDP per capita growth of Sub-Saharan African countries. See for example Miguel et al. (2004), Barrios et al. (2010), or Brückner and Ciccone (2010, 2011).

have on economic growth.

Our first main finding is that there is no systematic response of relative agricultural price distortions to economic growth. Our instrumental variables regressions that control for country and year fixed effects yield a statistically insignificant effect of economic growth on relative agricultural price distortions. The estimated effects are also quantitatively small. They imply that a one percent higher GDP per capita growth decreased distortions to relative agricultural prices by at most 0.003 standard deviations. We document that the effects of economic growth on agricultural policy distortions are insignificant and quantitatively small regardless of whether we use rainfall as an excluded instrument or international commodity price shocks. Furthermore, we show that the effects continue to be quantitatively small and statistically insignificant when we use a distributed lag model, exclude outliers, restrict the sample to the post-1985 period, or include additional within-country controls that capture changes in the size of government, political institutions, and the incidence of civil war. Our first main finding therefore indicates that growth in average incomes does not trigger significant changes in distortions to the price of agricultural relative to non-agricultural tradables.

In the second part of the paper we examine the effects that these policy distortions have on economic growth. Our main finding there is that increases in policy distortions to relative agricultural prices have a statistically significant and quantitatively sizable negative effect on economic growth. Our panel fixed effects estimates yield that a one standard deviation increase in distortions to relative agricultural prices over the 1960-2005 period reduced real GDP per capita growth by about half a percentage point per annum on average. We document that this result is robust to allowing for country-specific growth effects, or using a distributed lag model to distinguish short-run from longer-run growth effects. We also document that there continues to be a significant negative and quantitatively sizable effect of relative agricultural price distortions on economic growth when we control for dynamics in GDP per capita growth using system-GMM estimation.

There are a number of telling country episodes that fit the pattern documented by our panel fixed effects analysis. Tanzania, for example, halved its distortion to the relative price of farm products over the 1985-2005 period, during in which time income per capita increased by over 30 percent. By contrast, over the same period Zimbabwe increased its distortions to relative agricultural prices by over 50 percent and experienced a drop in income per capita of more than 25 percent. Other less-extreme examples during the 1960-1980 period include Madagascar, which experienced an increase in relative agricultural price distortions of more than 50 percent when its real income per capita fell by more than 10 percent, and Uganda, which experienced a four-fold increase in relative agricultural price distortions and a decrease in real income per capita of over 25 percent.

Over 85 percent of the partial equilibrium welfare cost of policy distortions to agricultural prices in Sub-Saharan African countries are due to restrictions on exports and imports (Croser and Anderson, 2011). Our paper is thus closely related to the empirical literature on the growth effects of policy distortions to international trade.[2] More generally, our paper is related to the large literature that has examined the link between trade openness and economic growth.[3] Our paper contributes to this literature in several ways. First, we use a new measure of trade distortions – relative price distortions to agriculture – that is of particular relevance in the context of estimating the growth effects in largely agrarian Sub-Saharan African countries. Second, we control in the panel regressions for country and year fixed effects, identifying the effects that distortions to trade have on economic growth from the within-country variation of the data. Third, we provide an

2 See for example Edwards (1992) or Wacziarg and Welch (2008) for empirical evidence that policy distortions to international trade have significant negative growth effects. For historical evidence that trade policy distortions had a positive or insignificant effect on economic growth see, for example, O'Rouke (2000), Clemens and Williamson (2004), or Schularick and Solomou (2011).

3 See for example Sachs and Warner (1995), Frankel and Romer (1999), Alcala and Ciccone (2004), or Wacziarg and Welch (2008) for evidence of a positive effect of trade openness on economic growth. For a critique, see Rodriguez and Rodrik (2001). For empirical evidence that in Sub-Saharan Africa trade increases may have a negative effect on health (by increasing HIV), see Oster (2011). For empirical evidence that suggests that the positive effect of trade openness on economic growth is a more recent phenomenon of the later 20th century, see Vamvakidis (2002).

instrumental variables estimate of the response of agricultural policy distortions to economic growth, thereby informing the political economy debate on the extent to which trade and price policies are endogenous to economic growth.

The remainder of our paper is organized as follows. Section 2 describes the data. Section 3 discusses the estimation strategy. Section 4 presents the main results. Section 5 concludes.

2. Data

Relative Agricultural Price Distortions. The World Bank recently completed a major global empirical study that estimated policy distortions to agricultural incentives since 1955.[4] The study estimates nominal rates of assistance (NRAs) to agricultural industries as well as nominal rates of assistance to nonagricultural tradables. The NRA is defined as the percentage by which government policies directly raise the gross return to producers of a product above what it would be without the government's intervention (or lowered it, if NRA<0). This was estimated by comparing domestic and border prices of like products. To obtain the sectoral average NRA, the World Bank study's contributors got the weighted average of product NRAs for enough farm products (an average of 8 per country) to cover at least 70 percent of farm production valued at undistorted prices.

Our main variable that captures policy induced distortions to *relative* agricultural prices is the relative rate of assistance (RRA). This variable is defined as:

(1) $$RRA = [(100+NRAag^t)/(100+NRAnonag^t)] - 1$$

where $NRAag^t$ and $NRAnonag^t$ are the percentage NRAs for the tradables parts of the agricultural and non-agricultural sectors, respectively.[5] Since the NRA cannot be less than -100 percent if producers are to earn anything, neither can the RRA (since the weighted average $NRAnonag^t$ is

4 The study is summarized in four regional volumes, including one on Africa (Anderson and Masters, 2009) and a global overview volume (Anderson 2009). The panel dataset of estimates of price distortions has been made freely available (Anderson and Valenzuela, 2008), and the methodology is documented in Anderson et al. (2008).

5 The $NRAnonag^t$ is a weighted average of the trade taxes in the manufacturing and in the non-farm primary sectors, using sectoral shares of non-agricultural GDP as weights. See Anderson et al. (2008) and the Appendices of Anderson and Masters (2009) for further details.

non-negative in all the country case studies). And if both of those sectors are equally assisted, the RRA is zero.

Thus, economic policy reform that reduces sectoral bias is characterized by movements of the RRA towards zero from below (or from above, if a pro-agricultural policy bias had been in place). Note that the RRA takes into account that it is distortions to *relative* prices that affect aggregate outcomes: farmers are affected not only by prices of their own products but also by prices faced by nonagricultural producers bidding from the same national pool of inter-sectorally mobile resources. More than seventy years ago Lerner (1936) provided his Symmetry Theorem to prove that, in a two-sector economy, an import tax has the same effects on production, consumption, trade and national economic welfare as an export tax. This carries over to a model that has many sectors, and is unaffected if there is imperfect competition domestically or internationally or if some of those sectors produce only nontradables (Vousden, pp. 46-47).

Figure 1 plots the time-series evolution of the RRA for each of the 14 large Sub-Saharan African countries in our sample (which accounts for more than three-quarters of the population of Sub-Saharan Africa excluding South Africa). An interesting stylized fact from Figure 1 is that, for the majority of those Sub-Saharan African countries, the RRA is negative. Hence on average there was a strong policy bias against agriculture over the past half-century. However, there is also substantial RRA variation across time and countries. For example, in Ethiopia, Madagascar, and Tanzania there was a continuous reduction in policy biases against agriculture, while in countries such as Zambia and Zimbabwe the strong bias against agriculture was firmly maintained.

We note here that the RRA measure we use has several important advantages over other existing measures of policy distortions available for Sub-Saharan African countries. First, the estimated nominal rates of assistance to agriculture and non-agriculture reported in Anderson and Valenzuela (2008) provide by far the longest and most consistent annual time-series data on policy distortions in Sub-Saharan African countries.[6] Second, measures of just trade policy distortions typically use trade-weights to obtain sectoral averages, whereas the new World Bank study uses more-appropriate weights based on production values at undistorted prices. Third, most other estimates of agricultural trade policy distortions focus on just import tariffs (see, e.g., WTO 2011), thereby missing export distortions (as well as occasional import subsidies) which turn out to have been far more important in Africa over the past half-century (see Croser and Anderson 2011).

Commodity export price index. We construct a country-specific international commodity export price index for agricultural and natural resource commodities as:

$$ComPI_{i,t} = \prod_{c \in C} ComPrice_{c,t}^{\theta_{i,c}}$$

where $ComPrice_{c,t}$ is the international price of commodity *c* in year *t*, and $\theta_{i,c}$ is the average (time-invariant) value of exports of commodity *c* in the GDP of country *i*.[7] We obtain data on annual international commodity prices from UNCTAD Commodity Statistics and our data on the value of commodity exports are from the NBER-United Nations Trade Database. The commodities included in the agricultural commodity export price index are beef, coffee, cocoa, cotton, maize, rice, rubber, sugar, tea, tobacco, wheat, and wood. The commodities included in the natural resource export price index are aluminum, copper, gold, iron, and oil. In case there were multiple prices listed for the same commodity a simple average of all the relevant prices is used.

Rainfall. The annual rainfall data are monthly time series of terrestrial air temperature and precipitation from 1900 to 2006 (Matsuura and Willmott, 2007). The rainfall data come at a high resolution (0.5°x0.5° latitude-longitude grid) and each rainfall observation in a given grid is

6 The only other study of this kind is by Krueger, Schiff and Valdés (1988), which covered three farm products for each of just three Sub-Saharan African countries over an average of 21 years: Cote d'Ivoire (1960-82), Ghana (1955-77) and Zambia (1966-84). A crude set of estimates of pre-1980 export tax equivalents for an average of two products in seven African countries is reported in Bates (1981, Appendix B). All other estimates known to the authors have smaller time series and are mostly single-country or single-commodity studies.

7 This functional form of the commodity export price index follows common practice in the literature. See for example, Collier and Goderis (2007) and the references cited therein.

constructed by interpolation of rainfall observed by all stations operating in that grid. Rainfall data are then aggregated to the country level by assigning grids to the geographic borders of countries.

GDP per capita and other controls. Data on real per capita GDP are from the Penn World Table, version 6.3 (Heston et al., 2009). Data on political institutions are from the Polity IV database (Marshall and Jaggers, 2009). The data on civil war incidence are from the PRIO/UPPSALA database on armed conflicts (CSCW, 2010). Data on the share of agricultural value added in GDP are from WDI (2010). For some summary statistics see Table 1.

3. Estimation Strategy

To examine the effects that within-country changes in distortions to relative agricultural prices (Δabs($rra_{i,t}$)) have on real GDP per capita growth (Δln($GDP_{i,t}$)), we estimate the following econometric model:

(1) $$\Delta \ln(GDP_{i,t}) = \alpha_i + \beta_t + \eta \Delta \mathrm{abs}(rra_{i,t}) + \Gamma X_{i,t} + u_{i,t}$$

where α_i are country fixed effects that account for cross-country differences in geography, history, ethnicity and other time-invariant determinants of economic growth such as initial income per capita levels. The year fixed effects, β_t, capture common year shocks that affect both GDP per capita growth in Africa and changes in agricultural product price distortions (for example, common shocks to economic growth that are due to changes in the world business-cycle or political events such as the end of the Cold War). The vector $X_{i,t}$ includes additional within-country controls such as variations in a country-specific international export price index, rainfall, political institutions, and civil war incidence. Note that we use the change in the *absolute* rate of assistance because, as argued in Section 2, economic policy reform that reduces inter-sectoral bias is characterized by movements of the RRA towards zero (either from below if an anti-agricultural policy bias had been in place, or from above if a pro-agricultural policy bias had been in place).

As a baseline regression, we estimate the average marginal effect η that within-country changes in relative agricultural price distortions have on economic growth. We then examine lagged effects of these price distortions on economic growth by means of a distributed lag model where we include further lags of the relative rate of assistance on the right-hand side of the estimating equation. By doing so, we can examine both short-run and medium/long-run growth effects. For example, the short-run growth effects could differ from the longer-run growth effects if there are adjustment costs to capital so that it takes time for the capital stock in the sectors to fully adjust to the relative agricultural price distortions.

It is possible that the growth effects of relative agricultural price distortions may be country-specific. Country-specific growth effects could arise for example due to cross-country differences in sectoral compositions or due to cross-country differences in political economy factors that drive the relative agricultural price distortions. An important econometric issue, therefore, is whether the restricted form of equation (1) provides a consistent estimate of the average marginal effect of agricultural price distortions on economic growth in Africa. To check this, we use the mean-group estimator developed by Pesaran and Smith (1995). This estimator computes country-specific slope estimates and allows us to check whether the mean of these country-specific slope estimates is close to the estimate of the average marginal effect obtained in equation (1).

A further necessary condition for consistent estimation of the growth effects of agricultural price distortions is that our distortions variable is exogenous to within-country changes in economic growth. To examine whether this is the case, we use a two-stage least squares estimation approach that regresses the distortions variable on real GDP per capita growth which we instrument by within-country variations in rainfall and an international commodity export price index. We therefore make use of prior research by Miguel et al. (2004) and Brückner and Ciccone (2010, 2011) that has used these instruments for economic growth in African countries to examine how growth shocks affect civil war risk and within-country variations in political institutions. The exclusion restriction in this two-stage least squares estimation is that, conditional on economic growth, year-to-year variations in rainfall and international commodity prices only affect relative agricultural price distortions through their income per capita effects. We examine this exclusion restriction in detail in the section that follows.

4. Results

4.1 The response of relative agricultural price distortions to economic growth

We begin our empirical analysis by estimating the response of agricultural policy distortions to within-country changes in real GDP per capita. This first-step exercise serves the purpose of clarifying whether indeed our policy distortions variable – the change in the absolute value of the relative rate of assistance – is exogenous to economic growth. Our first-step exercise also sheds light on the question of how and to what extent plausibly exogenous growth shocks affect the political process of setting relative price distortions in the economy.

Table 2 presents our instrumental variables estimates of the effect that economic growth has on the RRA. Column (1) reports country and year fixed effects estimates where we instrument the within-country change in real GDP per capita with the within-country change in rainfall and the within-country change in the international commodity export price index. The main result in Panel A is that the estimated coefficient on real GDP per capita growth is statistically insignificant and quantitatively small. The estimated coefficient implies that at most a one standard deviation change in real GDP per capita growth leads to a 0.02 standard deviation change in the absolute value of the RRA.

To ensure that the insignificant coefficient on GDP per capita growth is not driven by outliers, we report in column (2) instrumental variable estimates that exclude the top/bottom 1 percentile of GDP per capita growth. In this case the obtained estimates are also quantitatively small and statistically insignificant. In column (3) we show that similar results are obtained if we restrict the sample to the post-1985 period (thus excluding events such as the oil price shock of the 1970s and the upward trend in the relative rate of assistance that began to occur during the pre-1985 period); and in column (4) we show that there is also no significant effect of economic growth on the RRA when including on the right-hand side of the estimating equation additional within-country control variables such as the government expenditures share, the polity2 score, and an indicator variable for the incidence of civil war.[8] Hence, the main result of these instrumental variables estimates is that on impact there is no systematic response of the RRA to economic growth.

For comparison purposes with the instrumental variables estimates, we report least-squares estimates in Appendix Table 1. The least squares estimates are negative in sign but statistically insignificant. We note that if policy distortions to relative agricultural prices have a negative effect on economic growth, reverse causality bias implies that the least-squares estimates are biased downward. This downward bias can explain why the least-squares estimate on the impact response of the RRA to economic growth is negative. The negative reverse causality bias can also explain why in absolute size, the least squares coefficient is larger than the coefficient that is obtained from the instrumental variables regression.

We note that the quality of our instrumental variables is reasonable. Panel B of Table 2 reports the first-stage estimates, which are individually highly statistically significant. The joint first-stage F-statistic is well above 10. Given this first-stage F-statistic we can reject at the 5 percent significance level, based on the tabulations reported in Stock and Yogo (2005), that the maximal IV relative bias is larger than 5 percent. Bias due to weak instruments is therefore unlikely to be an issue in our instrumental variables regressions. Moreover, the validity of our instruments in terms of being uncorrelated with the second-stage error term cannot be rejected. The Hansen J test produces an insignificant p-value on the joint hypothesis that our instruments are uncorrelated with the

8 Research by Miguel et al. (2004) and Brückner and Ciccone (2010, 2011) has shown that rainfall and international commodity price shocks have a significant effect on civil war and political institutions. Reporting results that control for within-country changes in the incidence of civil war and political institutions is therefore an important robustness check.

second-stage error term. This is a first reassuring indication that our instruments do not systematically violate the exclusion restriction.

In Table 3 we show that there are no significant reduced form effects. Changes in neither the agricultural commodity price index nor the natural resource commodity price index are significantly correlated with changes in the absolute value of the RRA. We also do not find a significant reduced form effect of year-to-year variations in rainfall. This is true regardless of whether we consider the largest possible Sub-Saharan African sample (column (1)); exclude observations in the top/bottom 1 percentile of GDP per capita growth (column (2)); exclude the pre-1985 period (column (3)); or include additional within-country control variables on the right-hand side of the regression (column (4)). Hence, despite Panel B of Table 2 showing that international commodity price shocks and rainfall shocks have a highly significant effect on GDP per capita growth of Sub-Saharan African countries, Table 3 shows that there are no significant reduced-form effects. The reduced-form estimates in Table 3 therefore echo the insignificant instrumental variables estimates, reported in Panel A of Table 2, which show that there is no significant impact response of the RRA to plausibly exogenous variations in real GDP per capita growth.

A more intuitive way to demonstrate that rainfall and international commodity price shocks are valid instruments is to report the effects that rainfall and international commodity price shocks have on the RRA conditional on GDP per capita growth. In Panel A of Table 4 we report estimates for instrumenting GDP per capita growth with the change in the international commodity export price index and including rainfall on the right-hand side of the second-stage equation. In Panel B of Table 4 we report estimates for instrumenting GDP per capita growth with the change in rainfall and including the international commodity export price index on the right-hand side of the second-stage equation. Both panels show that, conditional on GDP per capita growth, rainfall and international commodity price shocks do not have significant effects on the RRA. Hence, when conditioning on GDP per capita we find that there are no significant effects of rainfall and international commodity price shocks on the relative rate of assistance. This more intuitive examination of the exclusion restriction therefore reconfirms the results of the Hansen J test that showed that there is no systematic evidence of the instruments being correlated with the second-stage error term.

A further issue in the estimation of the effects that economic growth has on policy distortions to the relative price between agricultural and non-agricultural products is whether there are significant lagged effects. Recall that Table 2 reports the contemporaneous response of the RRA to economic growth. The sample autocorrelation of economic growth is fairly low (0.1) and hence examining the contemporaneous effect that economic growth has on the RRA without controlling for additional lags of economic growth is unlikely to lead to inconsistent estimates of the impact effect. To show that this is indeed the case, Table 5 reports estimates from a distributed lag model that include up to two additional lags of GDP per capita growth on the right-hand side of the estimating equation. The main result is that in these augmented regressions the contemporaneous effect of economic growth on the RRA continues to be quantitatively small and statistically insignificant. Note also that the lagged effects of economic growth are insignificant for most of the specifications.[9]

To summarize, the main message of our instrumental variables regressions is that the impact and lagged effects of the change in the absolute value of the RRA are exogenous to within-country variations in GDP per capita growth. This is an important result because it implies that the necessary condition of exogeneity is satisfied in the following part of our empirical analysis where we examine the effects that changes in the absolute RRA have on economic growth.

4.2 The effects of relative agricultural price distortions on economic growth

Table 6 reports the least-squares estimates of the impact effect that changes in the absolute value of

9 We have also explored the effects of further lags of GDP growth at t-3 and t-4. The estimates on these lags turned out to be insignificant and quantitatively small.

the relative rate of assistance have on economic growth. The results for the largest possible sample are in column (1). The estimated coefficient on the RRA is -0.04 and this estimate is significant at the 10 percent level. Quantitatively, the estimate implies that on average a one standard deviation increase in the absolute RRA is associated with a lower GDP per capita growth rate of about 0.6 percentage points. In column (2) we show that the precision of our estimates improves somewhat when we exclude potential outliers. Excluding observations that fall in the top/bottom 1 percentile of the GDP per capita growth distribution yields an estimated coefficient of -0.03. This coefficient is statistically significant at the 1 percent level. When we exclude the pre-1985 period the effect of relative agricultural price distortions on economic growth becomes quantitatively larger (column (3)). However, the smaller sample size also leads to a substantial increase in the standard error so that we cannot reject that the estimated effect in column (3) is significantly different from the estimated effect in column (1). In column (4) we show that results are quantitatively similar to our baseline estimates if we include additional within-country control variables such as the government expenditure share, the polity2 score, and an indicator variable for the incidence of civil war.

An important econometric issue is whether our results are robust to allowing for country-specific growth effects of policy distortions to relative agricultural prices. It is well known from the panel data literature that if the country-specific slope estimates are correlated with the error term this produces inconsistent estimates in the restricted panel data model of the average marginal effect. To check whether cross-country parameter heterogeneity leads to inconsistent estimates of the average marginal effect in our sample, we use the mean-group estimator developed by Pesaran and Smith (1995) that allows for country-specific coefficients. We report the results of this regression graphically in Figure 2, where we provide a kernel density plot of the distribution of the country-specific slope estimates. The mean (median) of this kernel density plot is -0.04 (-0.03). Therefore, cross-country parameter heterogeneity does not lead to a significant bias of the average marginal effect in our sample.

An interesting question is whether beyond the significant negative impact effect of price distortions on economic growth there is also a significant negative lagged effect. Such a lagged effect could arise if, for example, there are significant adjustment costs to capital that differ across sectors in the economy. Our panel data set has a fairly large *T* dimension (the average *T* is about 35) and, therefore, is well suited to explore lagged effects of within-country changes in policy distortions to relative agricultural prices on economic growth. In fact, we would like to restate here that a key advantage of using annual panel data is that this allows us to examine not only short-run growth effects, which are of substantial interest in and of themselves, but also medium/long-run growth effects by means of a distributed lag model.

In Table 7 we report dynamic panel data estimates as a first approximation to characterize the medium/long-run effect of relative agricultural price distortions on economic growth. We report system-GMM estimates (Blundell and Bond, 1998) as well as least-squares estimates. The presence of country fixed effects leads to inconsistent least-squares estimates in the dynamic panel regression. However, in our regressions this bias should be relatively small since the average *T* is fairly large. Panel A of Table 7 shows that the dynamic panel data regression produces a coefficient on lagged GDP per capita growth of about 0.05 to 0.1. A test for second-order serial correlation produces always insignificant results. Thus, specification tests indicate that the model is well specified. We compute the long-run growth response from the dynamic panel data model by inverting the characteristic polynomial. This yields a cumulative (long-run) growth effect of a permanent increase in relative agricultural price distortions of about -0.05. This estimate is very similar to the static panel data model where we concentrate on the impact growth effect of relative agricultural price distortions. Panel B of Table 7 shows that very similar results are obtained if we use the fixed effects least squares estimator instead of the system-GMM estimator.

Another way to examine short-run and longer-run growth effects is by means of a distributed lag model. In Table 8 we show the results for the case of including in addition to the year *t* effect the year *t*-1 and *t*-2 effect of within-country changes in the absolute RRA. The least-squares estimates on the lagged effects are negative in sign, but statistically insignificant and quantitatively much smaller in absolute size than the estimated impact effect for most of the specifications. Moreover, these regressions show that including additional lags of the RRA on the right-hand side of the estimating equation changes little the coefficient on the contemporaneous effect of policy distortions on economic growth.

The main conclusion from our panel fixed effects estimates is thus that increases in distortions to relative agricultural prices have a significant negative effect on economic growth in Sub-Saharan African countries. For welfare purposes, it is also of interest to examine whether these distortions had a significant negative effect on private consumption. In Table 9 we therefore report panel fixed effects estimates of the effect that changes in the relative rate of assistance had on real consumption per capita. Our main finding is a significant negative effect. Both the impact and lagged effects of changes in relative agricultural price distortions on consumption are negative. This is true regardless of whether we consider the largest possible Sub-Saharan African sample (column (1)); exclude outliers (column (2)); exclude the pre-1985 period (column (3)); or include additional within-country control variables on the right-hand side of the regression (column (4)). Hence, Table 9 reinforces the earlier finding that increases in the absolute RRA led to a significant decrease in economic well-being in Sub-Saharan Africa.

5. Conclusion

In the 1960s and 1970s, farm output in Sub-Saharan African countries was subject to very heavy export taxation, but since then the disincentives facing farmers have been reduced, albeit much less rapidly than in other developing countries (Anderson, 2009). The dismal growth performance of Sub-Saharan Africa's agrarian economies provides an important case study for exploring how much distortions to agricultural incentives have slowed economic growth.

We have addressed this issue empirically using rigorous panel fixed effects estimation techniques. Our fixed effects analysis yielded that, during the period 1960 to 2005, a one standard deviation increase in distortions to relative agricultural prices decreased real GDP per capita growth by about half a percentage point per annum on average. Our empirical results thus suggest that the anti-agricultural policy bias contributed significantly to Sub-Saharan Africa's dismal growth performance over the past half century.

Our findings are important for several reasons. First, they imply that reducing distortions to incentives faced by even the world's poorest farmers can be growth-enhancing. Our findings thus do not support the view that there are significant growth benefits associated with subsidizing manufacturing and other sectors at the expense of agriculture. Second, our findings suggest that the returns from investments in agricultural development will be greater in countries with less distorted relative prices. Funding for agricultural development in Sub-Saharan Africa is expanding rapidly at present, particularly via development assistance programs.[10] Our findings provide additional empirical support to those arguing that aid flows would be more effective if those numerous African countries that still have an anti-agricultural policy bias (see Figure 1) were to reduce it. Third, our empirical analysis shows that there is a significant within-country effect of policy distortions on economic growth. This is an important result because it implies that the relationship between price distortions and economic growth is unlikely to be a consequence of the strong ethnic divisions that characterize many Sub-Saharan African countries. The reason is that ethnic divisions, as measured by countries' ethnic fractionalization or polarization, are mostly time-invariant variables. Hence, these variables cannot be a cause of within-country variations in price distortions. From an economic policy viewpoint, our findings of a significant within-country effect of price distortions on economic growth is therefore important because it suggests that in African countries there are

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10 See, for example, the wide range of major donor partners that have joined with the Alliance for a Green Revolution for Africa, at www.agra-alliance.org/section/links and the Partnership to Cut Hunger and Poverty in Africa, at www.partnership-africa.org, as well as the contribution from the Bill and Merlinda Gates foundation at www.gatesfoundation.org/agriculturaldevelopment/Pages/default.aspx.

significant factors that influence economic growth beyond ethnic divisions.

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Table 1. Descriptive Statistics

	Mean	Stdv.	Observations
Real GDP Per Capita	1637.1	713.0	532
Real GDP Per Capita Growth	0.004	0.078	532
Abs. Relative Rate of Assistance	0.372	0.225	532
Change Abs. Relative Rate of Assistance	-0.004	0.148	532
Share of Agricultural Value Added	0.342	0.139	400
Growth Rate of Agricultural Value Added	-0.005	0.120	400
Polity2 Score	0.685	7.498	394
Civil War Incidence	0.058	0.233	532

Table 2. The Effects of Economic Growth on the Relative Rate of Assistance (2SLS Estimates)

	(1)	(2) Excluding Top/Bottom 1 Percentile	(3) Excluding the Pre-1985 Period	(4) Additional Within-Country Controls
	Panel A: Second Stage for Δabs(RRA)			
	2SLS	2SLS	2SLS	2SLS
Δln(GDP)	-0.04	0.35	-0.09	-0.10
	(0.10)	(0.27)	(0.27)	(0.12)
Hansen J, p-value	0.15	0.60	0.19	0.48
First-Stage, F-Statistic	18.45	14.55	149.46	11.29
Country Fe	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes
	Panel B: First Stage for Δln(GDP)			
Δln(ComPIAgri)	2.03**	1.74*	5.34***	1.86***
	(0.80)	(0.96)	(0.38)	(0.64)
Δln(ComPINatres)	1.80***	1.62***	3.11**	2.80**
	(0.60)	(0.54)	(1.25)	(1.34)
Δln(Rainfall)	0.05**	0.05***	0.06***	0.03*
	(0.02)	(0.02)	(0.02)	(0.02)
Country Fe	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes
Observations	532	522	280	390
Countries	14	14	14	12

Note: The dependent variable in Panel A is the change in the absolute relative rate of assistance; Panel B the change in the log of real GDP per capita. The method of estimation is two-stage least squares. Huber robust standard errors (shown in parentheses) are clustered at the country level. Column (2) excludes observations of the top and bottom 1 percentile of the real GDP per capita growth distribution. Column (3) excludes observations for the pre-1985 period. Column (4) adds the within-country change of the government expenditures share, the polity2 score, and an indicator variable for the incidence of civil war. *Significantly different from zero at the 10 percent significance level, ** 5 percent significance level, *** 1 percent significance level.

Table 3. The Reduced-Form Effects of International Commodity Price Shocks and Rainfall Shocks on the Relative Rate of Assistance
(Reduced Form)

	Δabs(RRA)			
	(1)	(2) Excluding Top/Bottom 1 Percentile	(3) Excluding the Pre-1985 Period	(4) Additional Within- Country Controls
Δln(ComPIAgri)	1.81 (1.17)	1.92 (1.16)	-0.37 (2.57)	2.07 (0.73)
Δln(ComPINatres)	-0.46 (0.32)	0.10 (1.17)	-1.00 (1.36)	-0.38 (2.20)
Δln(Rainfall)	0.02 (0.03)	0.02 (0.03)	0.05 (0.04)	0.00 (0.04)
Country Fe	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes
Observations	532	522	280	390
Countries	14	14	14	12

Note: The dependent variable is the change in the absolute relative rate of assistance. The method of estimation is least-squares. Huber robust standard errors (shown in parentheses) are clustered at the country level. Column (2) excludes observations of the top and bottom 1 percentile of the real GDP per capita growth distribution. Column (3) excludes observations for the pre-1985 period. Column (4) adds the within-country change of the government expenditures share,the polity2 score, and an indicator variable for the incidence of civil war. *Significantly different from zero at the 10 percent significance level, ** 5 percent significance level, *** 1 percent significance level.

Table 4. The Effects of Economic Growth on the Relative Rate of Assistance
(2SLS Estimates; Additional Tests of Exclusion Restriction)

	Δabs(RRA)			
	Panel A: Excluded Instrument is Commodity Price Index			
	(1)	(2) Excluding Top/Bottom 1 Percentile	(3) Excluding the Pre-1985 Period	(4) Additional Within-Country Controls
	2SLS	2SLS	2SLS	2SLS
Δln(GDP)	-0.09	0.38	-0.18	-0.11
	(0.10)	(0.46)	(0.26)	(0.15)
Δln(Rainfall)	0.02	0.00	0.06	0.00
	(0.03)	(0.05)	(0.04)	(0.04)
First-Stage, F-Statistic	11.41	7.97	164.13	10.96
Country Fe	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes
	Panel B: Excluded Instrument is Rainfall			
Δln(GDP)	0.32	0.32	0.82	0.08
	(0.57)	(0.66)	(0.76)	(1.19)
Δln(ComPIAgri)	1.25	1.38	-2.93	1.84
	(1.88)	(1.77)	(3.83)	(4.33)
Δln(ComPINatres)	-1.10	-0.45	-5.41	-0.53
	(-0.64)	(-0.22)	(3.95)	(2.45)
First-Stage, F-Statistic	8.14	8.87	12.26	2.97
Country Fe	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes
Observations	532	522	280	390
Countries	14	14	14	12

Note: The dependent variable is the change in the absolute relative rate of assistance. The method of estimation is two-stage least squares. Huber robust standard errors (shown in parentheses) are clustered at the country level. Column (2) excludes observations of the top and bottom 1 percentile of the real GDP per capita growth distribution. Column (3) excludes observations for the pre-1985 period. Column (4) adds the within-country change of the government expenditures share, the polity2 score, and an indicator variable for the incidence of civil war. *Significantly different from zero at the 10 percent significance level, ** 5 percent significance level, *** 1 percent significance level.

Table 5. The Effects of Economic Growth on the Relative Rate of Assistance
(2SLS Estimates; Distributed Lag Estimates)

	Δabs(RRA)			
	(1)	(2) Excluding Top/Bottom 1 Percentile	(3) Excluding the Pre-1985 Period	(4) Additional Within-Country Controls
Δln(GDP)	-0.07	0.54	-0.03	-0.18
	(0.21)	(0.43)	(0.22)	(0.28)
Δln(GDP), t-1	0.37	0.45	-0.33	0.39
	(0.28)	(0.36)	(0.24)	(0.25)
Δln(GDP), t-2	0.75	0.86	0.49***	0.60
	(0.46)	(0.56)	(0.18)	(0.42)
First-Stage F-statistic	9.69	5.44	137.75	14.03
Hansen J, p-value	0.24	0.35	0.28	0.40
Country Fe	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes
Observations	502	522	280	390
Countries	14	14	14	12

Note: The dependent variable is the change in the absolute relative rate of assistance. The method of estimation is two-stage least squares. The instrumental variables are rainfall and the international commodity export price indices. Huber robust standard errors (shown in parentheses) are clustered at the country level. Column (2) excludes observations of the top and bottom 1 percentile of the real GDP per capita growth distribution. Column (3) excludes observations for the pre-1985 period. Column (4) adds the within-country change of the government expenditures share, the polity2 score, and an indicator variable for the incidence of civil war. *Significantly different from zero at the 10 percent significance level, ** 5 percent significance level, *** 1 percent significance level.

Table 6. The Effects of Changes in the Relative Rate of Assistance on Economic Growth

	Δln(GDP)			
	(1)	(2) Excluding Top/Bottom 1 Percentile	(3) Excluding the Pre-1985 Period	(4) Additional Within-Country Controls
	LS	LS	LS	LS
Δabs(RRA)	-0.04*	-0.03***	-0.07	-0.06***
	(0.02)	(0.02)	(0.05)	(0.02)
Country Fe	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes
Observations	532	522	280	390
Countries	14	14	14	12

Note: The dependent variable is real GDP per capita growth. The method of estimation is least squares. Huber robust standard errors (shown in parentheses) are clustered at the country level. Column (2) excludes observations of the top and bottom 1 percentile of the real GDP per capita growth distribution. Column (3) excludes observations for the pre-1985 period. Column (4) adds the within-country change of the government expenditures share,the polity2 score, and an indicator variable for the incidence of civil war. *Significantly different from zero at the 10 percent significance level, ** 5 percent significance level, *** 1 percent significance level.

Table 7. The Effects of Changes in the Relative Rate of Assistance on Economic Growth (Controlling for Growth Dynamics)

	Δln(GDP)			
	Panel A: SYS-GMM			
	(1)	(2) Excluding Top/Bottom 1 Percentile	(3) Excluding the Pre-1985 Period	(4) Additional Within-Country Controls
	SYS-GMM	SYS-GMM	SYS-GMM	SYS-GMM
Δabs(RRA)	-0.04*	-0.04**	-0.05	-0.06***
	(0.02)	(0.02)	(0.03)	(0.02)
Δln(GDP), t-1	0.05	0.02	-0.01	0.11
	(0.07)	(0.08)	(0.09)	(0.08)
AR (1) Test, p-value	0.00	0.00	0.00	0.00
AR (2) Test, p-value	0.20	0.44	0.38	0.14
Country Fe	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes
Observations	531	521	280	389
Countries	14	14	14	12
	Panel B: LS			
	(1)	(2) Excluding Top/Bottom 1 Percentile	(3) Excluding the Pre-1985 Period	(4) Additional Within-Country Controls
Δabs(RRA)	-0.04*	-0.03*	-0.07	-0.06***
	(0.02)	(0.02)	(0.05)	(0.02)
Δln(GDP), t-1	0.07	0.06	0.01	0.11
	(0.06)	(0.06)	(0.10)	(0.08)
Country Fe	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes
Observations	531	521	280	389
Countries	14	14	14	12

Note: The dependent variable is real GDP per capita growth. The method of estimation in Panel A is system-GMM. In Panel B the method of estimation is least squares. Huber robust standard errors (shown in parentheses) are clustered at the country level. Column (2) excludes observations of the top and bottom 1 percentile of the real GDP per capita growth distribution. Column (3) excludes observations for the pre-1985 period. Column (4) adds the within-country change of the government expenditures share,the polity2 score, and an indicator variable for the incidence of civil war. *Significantly different from zero at the 10 percent significance level, ** 5 percent significance level, *** 1 percent significance level.

Table 8. The Effects of Changes in the Relative Rate of Assistance on Economic Growth (Distributed Lag Estimates)

	Δln(GDP)			
	(1)	(2) Excluding Top/Bottom 1 Percentile	(3) Excluding the Pre-1985 Period	(4) Additional Within-Country Controls
	LS	LS	LS	LS
Δabs(RRA), t	-0.05**	-0.05***	-0.09	-0.06***
	(0.02)	(0.02)	(0.05)	(0.02)
Δabs(RRA), t-1	-0.03	0.00	-0.07*	-0.04
	(0.02)	(0.02)	(0.04)	(0.03)
Δabs(RRA), t-2	-0.01	0.00	-0.01	-0.01
	(0.02)	(0.02)	(0.02)	(0.02)
Sum of coefficients	-0.09***	-0.05	-0.16**	-0.10*
	(0.03)	(0.04)	(0.07)	(0.06)
Country Fe	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes
Observations	517	502	280	382
Countries	14	14	14	12

Note: The dependent variable is the change in the log of real GDP per capita. The method of estimation is least squares. Huber robust standard errors (shown in parentheses) are clustered at the country level. Column (2) excludes observations of the top and bottom 1 percentile of the real GDP per capita growth distribution. Column (3) excludes observations for the pre-1985 period. Column (4) adds the within-country change of the government expenditures share,the polity2 score, and an indicator variable for the incidence of civil war. *Significantly different from zero at the 10 percent significance level, ** 5 percent significance level, *** 1 percent significance level.

Table 9. The Effects of Changes in the Relative Rate of Assistance on Consumption

	Δln(Consumption)			
	(1)	(2) Excluding Top/Bottom 1 Percentile	(3) Excluding the Pre-1985 Period	(4) Additional Within-Country Controls
	LS	LS	LS	LS
Δabs(RRA), t	-0.04	-0.05	-0.07	-0.05
	(0.04)	(0.04)	(0.08)	(0.03)
Δabs(RRA), t-1	-0.03	-0.00	-0.05	-0.04*
	(0.02)	(0.02)	(0.05)	(0.02)
Δabs(RRA), t-2	-0.07***	-0.06**	-0.09***	-0.05**
	(0.02)	(0.02)	(0.03)	(0.02)
Sum of coefficients	-0.13**	-0.11*	-0.21	-0.14**
	(0.05)	(0.06)	(0.13)	(0.06)
Country Fe	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes
Observations	517	502	280	382
Countries	14	14	14	12

Note: The dependent variable is the change in the log of real consumption per capita. The method of estimation is least squares. Huber robust standard errors (shown in parentheses) are clustered at the country level. Column (2) excludes observations of the top and bottom 1 percentile of the real GDP per capita growth distribution. Column (3) excludes observations for the pre-1985 period. Column (4) adds the within-country change of the government expenditures share,the polity2 score, and an indicator variable for the incidence of civil war. *Significantly different from zero at the 10 percent significance level, ** 5 percent significance level, *** 1 percent significance level.

Appendix Table 1. Least Squares Estimates of the Effects of Economic Growth on the Relative Rate of Assistance

	Δabs(RRA)			
	(1)	(2) Excluding Top/Bottom 1 Percentile	(3) Excluding the Pre-1985 Period	(4) Additional Within-Country Controls
Δln(GDP)	-0.15	-0.16	-0.25	-0.26
	(0.13)	(0.15)	(0.25)	(0.15)
Country Fe	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes
Observations	532	522	280	390
Countries	14	14	14	12

Note: The dependent variable is the change in the absolute relative rate of assistance. The method of estimation is least-squares. Huber robust standard errors (shown in parentheses) are clustered at the country level. Column (2) excludes observations of the top and bottom 1 percentile of the real GDP per capita growth distribution. Column (3) excludes observations for the pre-1985 period. Column (4) adds the within-country change of the government expenditures share, the polity2 score, and an indicator variable for the incidence of civil war. *Significantly different from zero at the 10 percent significance level, ** 5 percent significance level, *** 1 percent significance level.

Figure 1. Time-Series Plots of the Relative Rate of Assistance

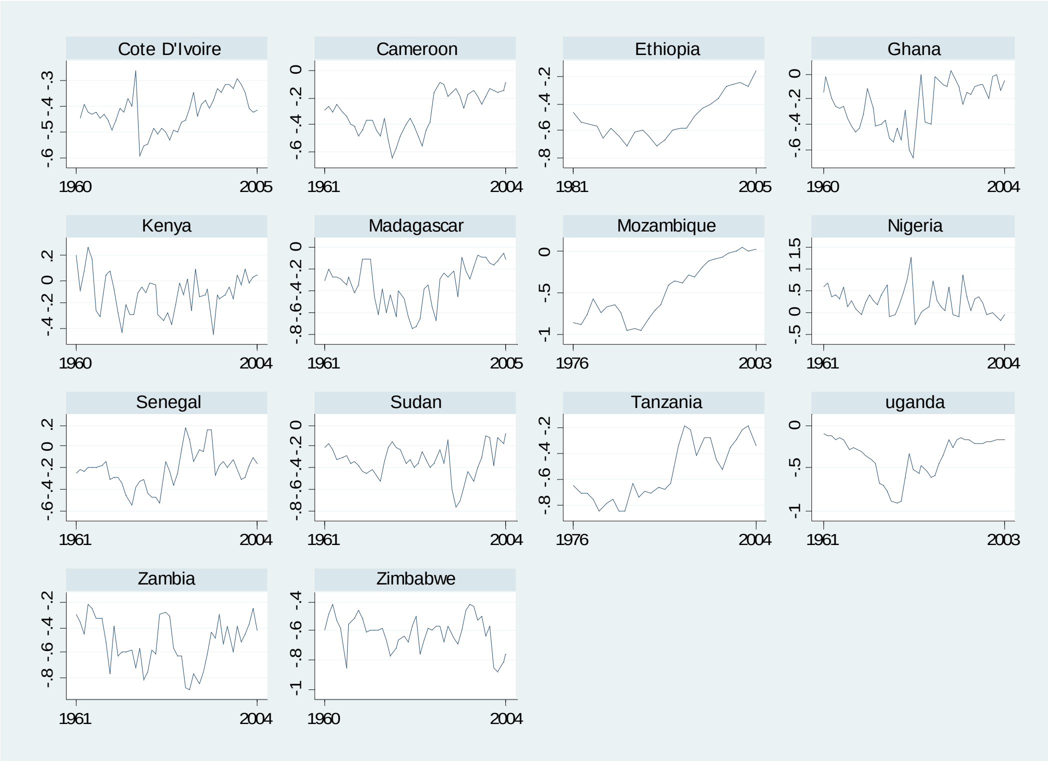
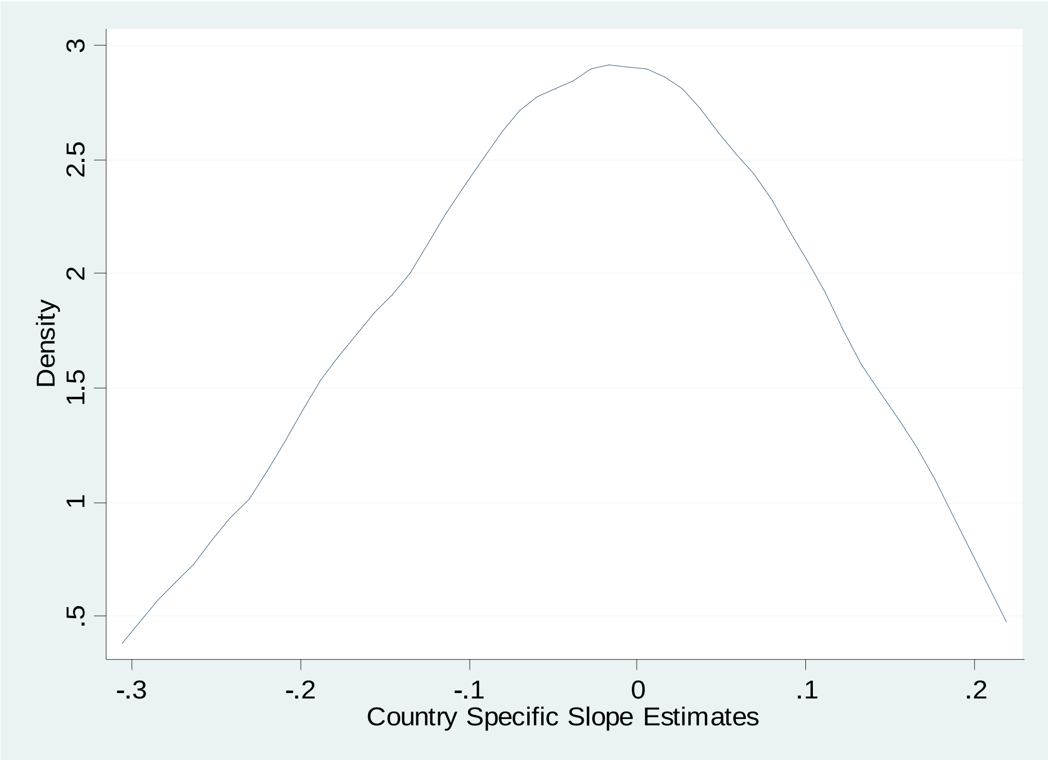


Figure 2. Distribution of Country-Specific Slope Estimates



Note: The figure shows the kernel density plot of the country-specific slopes estimates that are obtained from a panel fixed effects regression where the dependent variable is the change of the log of real GDP per capita and the explanatory variable is the change in the absolute relative rate of assistance. The kernel density plot is generated using an Epanechnikov kernel.