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Foreign aid effectiveness in African economies

Evidence from a panel threshold framework

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Abstract: The aid-growth literature has been explored using a wide range of econometric methodologies. The evidence of the effectiveness of aid to promote economic growth is mixed, suggesting that the link between aid and growth is complex and may not be well identified by traditional methods. We take another perspective and frame the aid-growth literature within a nonlinear panel threshold framework applied to a panel of selected African economies for the period 1980 to 2007. We also compare our results with the linear and nonlinear-polynomial specification and address potential endogeneity using instrumental variables and dynamic panel estimations. In the linear setting, we find no clear evidence of a positive effect of aid on growth. In the nonlinear setting, we explore four threshold variables capturing various macroeconomic policies. For each threshold variable, we estimate a polynomial model by interacting aid with the considered threshold variable and a threshold model by splitting the sample according to some endogenous thresholds. Although we find no evidence of polynomial effect in the case of aid as a threshold variable, there is weak evidence of a threshold effect with a diminishing return of aid. In a lower regime of past aid receipts less than of 1.5 per cent of GDP, aid appears to have a strong positive and significant effect on growth while the effect is insignificant when aid exceeds that level. We also find that under good policy environment characterized by relatively low inflation, high trade openness and low budget deficit, the effect of aid is greater. These findings suggest that both donors and African aid recipient countries should continue their efforts in strengthening the macroeconomic management of aid.

Keywords: aid effectiveness and growth, nonlinear models, panel threshold, Africa
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1 Introduction

1.1 Background

The effectiveness of foreign aid in spurring growth in developing countries has been one of the most controversial debates in modern economics during the past 50 years (Hansen and Tarp 2001). The question has been examined from various perspectives, both at macro and micro levels, using different methodologies. No clear conclusion has emerged from the voluminous empirical literature, although from a theoretical perspective, several models predict that aid has a positive effect on growth. The inconclusive results of the empirical literature, instead of ending the debate, continue to revive it. Most empirical studies diverge on many aspects, especially on the methodologies, the specifications and the quality of data used. These differences are the key explanations for the divergences in the findings. Several comprehensive surveys of aid effectiveness studies have been documented in the empirical literature (see, for instance, Cassen et al. 1994; Tsikata 1998; Hansen and Tarp 2001; Roodman 2007).

The aid amounts to the least developed countries (LDCs) reached considerable sums, despite some important volatility during the last decades. Despite the relatively large aid inflow, several of the LDCs experienced little growth and many are still struggling to reach a sustained growth path. For instance, in Africa, the average GDP growth per capita during the period 1980–2007 was only about 0.64 per cent with an overall downward trend from 1980 to 1992 and a weak upward trend from 1993 to 2007 (see Appendix Figure A1). This pattern is almost identical to the one exhibited by the GDP growth rate, but with a much higher average growth of 3.3 per cent over the same period. These growth rates, however, are far below the average 6.3 per cent growth rate of net official development assistance and official aid (hereafter ODA) received by African countries. A comparison of income growth per capita and ODA growth highlights many episodes of opposite trends (see Appendix Figure 1). The simple correlation of the two variables is negative and relatively high (about -0.37). These facts have questioned the effectiveness of foreign aid in Africa. Some pessimists would argue that aid has a negative effect on growth. In her recent book, *Dead Aid*, Moyo (2009) goes much further by advocating the complete cessation of aid flows to Africa.

There are a number of reasons why one should continue to be concerned by the effectiveness of foreign aid, particularly in Africa. One justification arises from the goals ODA is expected to achieve. In general, ODA is conceived with the objective of promoting economic development and welfare growth in recipient countries (Cassen et al. 1994; Denkabe 2004). However, Bourguignon and Sundberg (2007) point out that in many circumstances, aid may not have any developmental purposes as, for example, aid delivered to countries experiencing disaster episodes or for military purposes. The importance of investigating the effectiveness of aid also resides in the need to understand the factors that limit the positive outcomes of aid.

In many developing as well as in many African countries, poverty is still persistent and poverty reduction has occurred only at a very slow rate. In the context of the global fight against poverty and with the willingness expressed at the Millennium Summit in 2000 to eradicate poverty, questioning the ability of ODA to stimulate growth and consequently reduce poverty is both a legitimate and a moral question (Rajan and Subramanian 2008). Although several authors point out that the relationship between growth and poverty reduction is weak or inexistent (Doucouliagos and Paldam 2008; Rajan and Subramanian 2008), it is nevertheless recognized that growth, at least at the macro level, is the engine for reducing poverty in poor countries. With the availability of more data and advanced econometrics methods, there is still room for new aid effectiveness studies, and the use of new methodological approaches can be useful to provide evidence for the aid effectiveness argument. In the next subsection we review our motivation to undertaking 'yet another' aid effectiveness study. We highlight our approach and the observations it adds to the existent voluminous aid-growth literature.

1.2 Motivation

Our motivation to undertake this study on foreign aid effectiveness is guided by many factors: the geographic scope, the time period and the econometric methodology used in estimating the effect. We focus on African countries for the period from 1980 to 2007, which constitutes the most up-to-date data available, using panel regression analysis and nonlinear modelling framework. All these aspects are addressed to some extent in previous studies but not simultaneously. Hence, the use of a panel threshold to investigate nonlinear effects in an Africa context based on more recent data could be advanced as the main contribution of this paper. We discuss in detail the advantage of our paper over earlier studies.

First, the study focuses specifically on African countries rather than on a larger sample of all least developed countries. Our choice of the geographic scope is justified by the fact that many African countries are among the top recipients of ODA. The US$47,932 million in ODA flows to African countries in 2010 represents 37 per cent of the total ODA targeted to all developing countries (OECD 2012). Also, a number of countries and recipients in Africa are among the poorest in the world. But as many aid effectiveness studies use a larger sample of developing countries that includes a sub-Saharan Africa (SSA) dummy to analyse African countries (Burnside and Dollar 2000; Rajan and Subramanian 2005, among others), the coefficient of the SSA dummy variable is consistently negative. Thus, the effectiveness of aid in African countries cannot be drawn from such results. Generally speaking, a clear conclusion on the effectiveness of aid in Africa cannot be inferred from a model based on a large sample that also includes non-African developing countries. By focusing on Africa, we expect to have Africa-specific results and avoid biasing the outcome by the presence of exceptional Asian or Latin American countries. We pool together most of the African countries with available data over the period 1980-2007 rather than conduct a case study on a single country. Omitted variable bias or unobserved heterogeneity problems have been a recurrent issue in cross-sectional growth regressions. This is also true for aid-growth regressions. With minimum assumptions, the use of panel data could partially solve the omitted variable bias (Wooldridge 2002).

The second contribution of the paper concerns the econometric model chosen. We use panel regression rather than cross-section regression to estimate the effect of aid on growth. We also frame the aid-growth relation in a nonlinear regression framework using a panel threshold model. Most of the earlier aid-growth studies were done in a linear regression setting using cross-country regressions (Hansen and Tarp 2001; Rajan and Subramanian 2005). Given that the relation between foreign aid is complex and that cross-country aid-growth regressions involve countries with different characteristics pooled together, the assumption of linearity may be too much restrictive. It may hide some interesting information on the link between aid and growth as this link may not necessarily be linear.

The recent aid-growth literature has accounted for nonlinearity in aid-growth regressions in several ways. To address the potential nonlinearity of the effect of aid on growth, several studies have estimated growth equations by including aid and a quadratic term of aid as additional control variables (e.g., Hadjicmichael et al. 1995; Burnside and Dollar 2000). Another approach is the inclusion of aid interacted with other variables (Pattillo et al. 2007. The most widely variables considered in this strand are policy variables or their proxies. In an influential paper, Burnside and Dollar (2000) build a theoretical model which is a modified version of the neoclassical growth model showing that aid effect on growth will be much high if there is no distortion in the economy. They assume that the major source of distortion is the existence of bad economic policies. These authors find that aid has a positive effect on growth when interacted with a 'policy index' variable. In this same line, Denkabe (2004) shows both theoretically and empirically the existence of some threshold values of aid defined by macroeconomic policies, below which aid tends to have a positive effect on growth and beyond which there is a non-positive impact on growth due to diminishing returns. In both Burnside and Dollar (2000), Denkabe (2004), and related studies, the value of the threshold that is source of nonlinearity in the aid-growth relation is not explicitly estimated. They mainly allow for a 'smooth polynomial' relation between aid and growth.

Our study adopts a similar perspective but uses a slightly different approach. First, using the approach described above, we investigate the possibility of a nonlinear effect. Then, we attempt to test empirically the existence of a threshold of aid and a threshold of policy that might induce nonlinear effect in aid effectiveness. More importantly, we allow the threshold to be endogenously determined by the historical data. Using a nonlinear panel model with threshold effect, we build our empirical analysis on the existent framework developed in Hansen (1999). This framework allows us to test, identify and estimate the threshold effect of aid on growth.

1.3 Objectives and research questions

As stated before, the main purpose of this study is to revisit the effectiveness of aid with a focus on Africa using a nonlinear panel modeling framework to investigate empirically the existence of a threshold effect in the impact of foreign aid on growth. Specifically, we try to determine if a certain level of aid or some policy variables exist under which aid produces growth or above which aid become ineffective or even growth-limiting. A threshold could allow the effect of aid to impact in both directions. Hansen (1999) argues that the threshold model is an interesting alternative when there are no theoretical models predicting a clear threshold. Our intention here is not to build a theoretical model with a threshold effect of aid or policy variable, but to simply investigate empirically whether such a possibility exists and, if so, to produce rough estimates of the thresholds. We base the plausibility of this presence on the model developed in Burnside and Dollar (2000) and later followed by Denkabe (2004). Burnside and Dollar (2000) argue that the threshold effect can potentially be introduced in the effect of aid on growth by the quality of domestic macroeconomic policies existing in the recipient country.

Another argument in favour of the potential existence of a threshold effect is from the literature on Dutch disease (Fielding 2010; Atingi-Ego 2006; Prati and Tressel 2006; Rajan and Subramanian 2010). This threshold hypothesis could also be empirically motivated by the diminishing returns of aid found in the literature (Cassen et al. 1994; Dalgaard and Hansen 2001; Hansen and Tarp 2001; Arndt et al. 2010). The diminishing returns of aid could be viewed as smooth or discrete. Most previous studies assume a smooth diminishing return with an implicit threshold (Hansen and Tarp 2001). We investigate this hypothesis from a discrete perspective. Following the literature, we consider two natural threshold variables: the amount of aid receipts as percentage of GDP and the level of selected policy variables.

2 Literature review

2.1 Aid-growth relation in the literature

There is a large body of theoretical and empirical literature on the effect of foreign aid. There are even several comprehensive surveys of this literature: Cassen et al. 1994; Hansen and Tarp 2001, and Arndt et al. 2010, for example, provide in-depth reviews. Here, we merely provide a brief review of the recent literature of the impact of aid on economic growth. Our review draws mainly from Hansen and Tarp (2001) who classify three generations of aid-growth studies, extended by Arndt et al. (2010) into four generations. Each generation was inspired by the most influential theory among the empirical methods available for testing. Across all generations, the conclusion on the relation between foreign aid and growth at macroeconomic level is unclear, as different and even opposing results are available. Some studies find that aid has a positive effect on growth, while others support the conclusion that it has no effect or even a negative effect on growth.

The earlier generations of aid-growth studies were largely influenced by two main theories. The first is the Harrod-Domar model which predicts that aid is expected to have a positive impact on growth through saving and investment. The second theory is the two-gap Chenery-Strout extension which also predicts aid to have the potential to stimulate growth through capital accumulation and investment. Reviewing the first generation of empirical analyses, Hansen and Tarp (2001) conclude that they find no strong evidence of a positive impact of aid on total savings. However, second-generation studies have consistently indicated a positive effect of aid on investment but failed to establish any clear positive relation between savings and growth. Criticizing this literature, Arndt et al. (2010) point out that the results suffer from numerous limitations such as the assumption that growth is less related to capital investment and the endogeneity of aid which might depend on economic performance and good policy environment.

The third generation of aid-growth studies takes advantage of the availability of better quality data and advanced econometrics methods (Arndt et al. 2010). This generation emerged in the early 1990s and tried to address some of the weaknesses of the previous generation such as the endogeneity of aid in the growth equation and the potential nonlinear effect. Their main conclusion on this third generation is that over the last 30 years, aid has had an effect but only under specific conditions. Burnside and Dollar (2000) highlight the importance of good policy environment, and Dalgaard et al. (2004) show that aid has been less effective in tropical areas than in other parts of the world.

The fourth generation of aid-growth analysis is more recent. This literature has been motivated by the neoclassic growth theory. Most studies in this strand conclude that aid exhibits a diminishing effect on growth and that the aggregate impact of aid on growth is non-existent (Hansen and Tarp 2001). In this strand, Arndt et al. (2010) argue that aid only augments physical capital investment and has no effect on productivity. The fourth-generation findings are mixed, leading to controversial debate. Within this same generation Rajan and Subramanian (2008) in revising the aid-growth nexus in cross-country regressions find no strong evidence of a positive effect, contrary to Arndt et al. (2010) who do find a positive effect with point estimates consistent with the theory.

2.2 Methodologies used in aid-growth literature

Aid-growth studies have used a wide variety of econometric techniques to identify and estimate the effect of aid on growth. Briefly, the econometric methods used to analyse aid-growth relation range from simple ordinary least square (OLS) and two stages least square (2SLS) applied to cross-sectional or timeseries techniques applied to country-case studies and panel regression methods. Limitations of the methods used are often a source of controversy with regard to their findings. Roodman (2007), testing the robustness of many influential aid-growth studies with regard to methodological choices, samples and periods of coverage, concludes that the results are extremely sensitive. This is common in most growth empirical studies (Levine and Renelt 1992; Sala-i-Martin 1997).

Endogeneity is one of the important criticisms against many aid-growth papers. The issue is acknowledged to be very complex in all growth regressions in general, and has in fact been raised by many authors (Clemens et al. 2004; Easterly et al. 2004; Dollar and Burnside 2000; Rajan and Subramanian 2008). Simple OLS applied to cross-country analysis fails to estimate consistently the effect of aid in the presence of endogeneity. Alternative methods such as instrumental variable-based methods (2SLS or GMM) are widely used to address this flaw. Many strategies have been developed to find a valid instrument for aid. The critical assumptions of exogeneity and exclusion restrictions valid instruments need to satisfy, also make the findings based on IV methods controversial.

Cross-sectional analysis also has many other limitations including the presence of outliers, measurement errors, low-quality data, omitted variables in the specifications, etc. (Rajan and Subramanian 2005). The increasing availability of panel data and methods to analyse such data has opened new routes for empirical research into the question of aid effectiveness (Arndt et al. 2010). Panel data have the advantage of addressing, to some extent, the problem of unobservable heterogeneity as they could acceptably account for country-fixed effects. Advanced estimation methods such as 2SLS and GMM applied to these types of data could be expected to solve many problems in aid effectiveness estimations (Burnside and Dollar 2000; Rajan and Subramanian 2005). However, the results from these studies could be fragile due to weaknesses such as the sample size and the potential persistence of weak instrument problems (Easterly et al. 2004). In fact, the use of internal instruments in GMM methods offers no guarantee of their strength or validity (Burnside and Dollar 2000; Bun and Windmeijer 2007; Arndt et al. 2010).

Again, measurement errors in the variable cannot be avoided with the use of internal instruments (Arndt et al. 2010). Another concern is the validity of moment conditions in the system GMM estimation (Hauk and Wacziarg 2009). Recently, Arndt et al. (2010) use the Rubin causal model for the first time at the macro level to show that aid has a positive and statistically significant causal effect on growth over the long run. This study uses an innovative tool that belongs to the programme evaluation literature and is widely used at the micro level.

3 Methodology and empirical strategy

3.1 Nonlinear models in empirical studies aid-growth studies

Most studies analyse the aid-growth relation in a linear setting, but there are also many that use a nonlinear modeling approach. The idea of nonlinearity in economics dates back to Hirschman (1958) and Adelman and Morris (1967), who argue that the interactions between social, economic, political and institutional changes are complex and result in different stages of development. In the growth literature, Azariadis and Drazen (1990) and later Howitt and Mayer-Foulkes (2002) argue that the cross-country growth process is highly nonlinear.

Despite theoretical support of the nonlinearity in many economic settings and its empirical appeal, it has for long time received scant attention in empirical studies. Constrained by the limitation of empirical tools available and the computation costs induced by these methods, most authors, instead of fully estimating a nonlinear form of theoretical models, prefer to apply some suitable transformation into a linear form, which is more convenient for estimation. Other approaches widely used to account for nonlinearity include the specification of nonlinear functional form estimated by nonlinear least squares. The most common approach is to enter a particular variable in quadratic form and estimate the equation using OLS. Most authors, estimating the nonlinear effect of aid on growth, have adopted this latter approach by including aid in quadratic form or aid interacted with other variables such as policy variables or geography variable (Mosley et al. 1987; Hadjicmichael et al. 1995; Burnside and Dollar 2000; Hansen and Tarp 2001).

Other appealing approaches for modelling nonlinearity are threshold regressions introduced and popularized by Tong (1983, 1990). They constitute an interesting alternative to deal with regression when the regression functions differ across all observations or across some discrete classes in the sample (Hansen 1999). The principle of threshold regressions is similar to the principle of change point or structural breaks models with the threshold variable equivalent to time (Hansen 1999, 2000). These are attractive because they allow for more flexible regression functional forms by splitting the sample with respect to some unknown thresholds values (Wang and Lin 2010).

In our empirical analysis we explore both the standard nonlinear approach using polynomial specifications and the threshold approach. We adopt this framework extended to non-dynamic panel model, with the exogenous threshold variable and covariates by Hansen (1999). In the next section, we describe the model, the estimation method and inference strategy.

3.2 Non-dynamic panel threshold model

Framework and setup

In this section, we describe the general econometric framework developed by Hansen (1999) that supports our empirical work. Following Hansen (1999), let us consider a panel dataset $\{y_{it}, q_{it}, x_{it} : 1 \leq i \leq n, 1 \leq t \leq T\}$. In this specification y_{it} is a scalar representing the dependent variable of interest; q_{it} is a scalar representing the threshold variable; x_{it} is a k vector of all control variables included in the regression. Country and time subscripts are, respectively, i and t. In the general setting of the model, the threshold variable can potentially be the same as the dependent variable ('self-threshold', Tong 1990) or an exogenous/endogenous variable. Typically the threshold model can be rewritten as follow:

$$\mathrm{y_{it}} = \mu_\mathrm{i} + \beta'_1 \mathrm{X_{it}} \mathrm{I}_{(\mathrm{q_{it}} \leq \gamma)} + \beta'_2 \mathrm{X_{it}} \mathrm{I}_{(\mathrm{q_{it}} > \gamma)} + \mathrm{e_{it}} \qquad (1)$$

This is a compact form. Intuitively it can be written as two regressions:

$$y_{it} = \begin{cases} \mu_i + \beta'_1 x_{it} + e_{it} & \text{if} \quad q_{it} \leq \gamma \\ \mu_i + \beta'_2 x_{it} + e_{it} & \text{if} \quad q_{it} > \gamma \end{cases} \qquad (2)$$

In this expression, the sample is divided into two regimes distinguished by different regression slopes β_1 and β_2; $I(.)$ is the indicator function that defines the sample splitting. The term μ_i is a permanent but unobserved fixed effect. It captures cross-sectional unobserved heterogeneity due to differences in technology between countries and also all other determinants of the variability in y_{it} not already controlled in x_{it}. There are several reasons why at this point we assume the presence of fixed effect. First, the econometric of the threshold panel we are using is valid only under the assumption of fixed effect. Second, we argue that the fixed effect is more plausible than the random effect as the latter implies a zero correlation ($cov(X_{it}, \mu_i) = 0$) between the unobserved effect μ_i, the variable in the right-hand side. Rajan and Subramanian (2008) and many other researchers have empirically shown that aid is affected by several factors such as the historical relationship between the donor and recipient. Since we do not capture these relations, they can be viewed as being included in the unobserved fixed effect. The idiosyncratic errors of the model are denoted by e_{it} with the usual assumption that they are independent and identically distributed normal. This is a simple specification form for the case of one single threshold. Equation (1) can easily be extended to allow for the presence of two, three or multiple thresholds. In case of *m* thresholds, the model will have *m*+1 regimes or regression functions or regime dependent slopes.

In order to identify the regression slope, Hansen (1999) assumes that both x_{it} and q_{it} must be time variant. This constraint is not excessively restrictive. In fact the inclusion of the fixed effect μ_i already accounts for all time invariant factors that could possibly explain the variability in the dependent variable. Also, technically all the time invariant variables are dropped after the within-transformation commonly used to eliminate the fixed effect. The panel threshold framework developed by Hansen (1999) does not apply to a dynamic panel. Our right-hand side variable will include the initial income which is slightly different from the lag dependent variable. Seo and Shin (2010) address this gap by adapting the GMM estimation techniques for a dynamic panel estimation to the threshold panel regression methods advanced by Hansen (2000) and Caner and Hansen (2004).

Furthermore, the most important limitation of Hansen's model is that all regressors and the threshold variable are required to be exogenous. Thus, there is a gap in the theoretical literature when the threshold variable q_{it} is endogenous and/or there are some endogenous variables among the covariates x_{it}. Caner and Hansen (2004) propose an attempt to consider endogenous regressors but only for cross-sectional data. The authors propose a modified version of the method in Hansen (1999) which is 2SLS-like method that estimates a first step equation for the endogenous variable and their fitted values in the threshold regression. Kourtellos et al. (2007) also address the issue of endogenous threshold variable for cross-sectional data. Wang and Lin (2010) extend the results and propose a two-stage bias correction method to estimate the parameters of panel threshold model with endogenous threshold variables across different specifications. Seo and Shin (2010) also examine the same issue for dynamic threshold panel.

We first test for the endogeneity of aid in the growth regression. If there is not enough evidence against the null of exogeneity, we can proceed to the threshold analysis using Hansen's methods (1999). Also, a suitable selection and specification of our covariates and the threshold variable could minimize the possible effect of endogeneity.

Estimation

Based on the assumption discussed above, Hansen (1999) suggests a concentrated least square estimation of the endogenous threshold γ after the elimination of individual effect μ_i as usual. This estimation consists of the minimization of the sum of squared error function:

$$\hat{\gamma} = \underbrace{argmin}_{\gamma} S_1(\hat{\gamma}) = \hat{e}_{it}(\hat{\gamma})' * \hat{e}_{it}(\hat{\gamma}) \quad (3)$$

The implementation of this minimization problem and the estimation of the parameters follow a grid search approach as described in the steps below:

(i) Eliminate the smallest and the largest $\eta\%$ values on the threshold variable q_{it} and search for the optimal value of γ among the remaining values.

(ii) Estimate for each of the remaining values the regression after removing individual effect. The value of γ which yields the smallest sum of squared errors (SSE) is the optimal threshold.

(iii) With the $\widehat{\gamma}$, split the data and use OLS to estimate regression parameters.

Empirically, the number of regressions to be performed in the grid search can rise exponentially with the sample size, making the estimation computationally costly. Instead of searching over the entire values of the threshold variable, a commonly-used shortcut that yields approximately an identical result, is to loop over specific quantiles between the $\eta\%$ and $(1-\eta)\%$ quantiles. For convenience, Hansen (1999, 2000) suggests that it might be desirable to impose some restrictions on the threshold variable in order to obtain a minimum percentage of observation ($\tau\%$) in each regime.

Testing and inference

After the estimation of the endogenous threshold $\widehat{\gamma}$, it is necessary to test whether or not the threshold effect is significant. The null hypothesis of this test is written as $H_0 : \beta_1 = \beta_2$. Hansen (1999) shows that the statistic for this test is:

$$LR_0(\gamma) = \frac{S_0 - S_1(\hat{\gamma})}{\hat{\sigma}^2} \text{ With } \hat{\sigma} = \frac{1}{n(T-1)} S_1(\hat{\gamma}) \tag{4}$$

Since the distribution of this test statistic under the null is not a classic distribution, the suggestion would be to construct the p-value of this test using bootstrap procedure. The bootstrap p-values are asymptotically valid. Due to the panel nature of the data, special attention is needed in drawing up the bootstrap sample. As suggested in Hansen (1999, 2000) the easiest approach is to treat all the explanatory variables as constant and the countries as clusters. The regression residuals under the null hypothesis are used as the empirical distribution for bootstrapping. Once the bootstrapped sample is drawn randomly with replacement, the bootstrapped dependent variable is generated under the null hypothesis with the sampled residuals and holding the other covariates and the threshold variables constant. The bootstrapped likelihood ratios are computed by repeating this procedure a number of times. The bootstrapped p-value of the test of threshold effect is then computed as the percentage of draws for which the simulated statistic exceeds the actual.

The confidence intervals for γ is formed with the no rejection region of the test $H_0 : \gamma_0 = \gamma_1$ using the likelihood ratio test:

$$LR_1(\gamma) = \frac{S_1(\gamma) - S_1(\hat{\gamma})}{\hat{\sigma}^2} \tag{5}$$

Hansen (1999, 2000) proposes an asymptotic distribution to the threshold parameter, showing that under the null hypothesis, the test statistics $LR_1(\gamma)$ converge to a random variable ξ with distribution:

$$P(\xi \leq x) = \left(1 - \exp\left(-\frac{x^2}{2}\right)\right)^2 \quad (6)$$

The asymptotic p-value for the significance of the threshold estimated is:

$$p_n = 1 - \left(1 - \exp\left(-\frac{LR_1(\gamma_0)^2}{2}\right)\right)^2 \quad (7)$$

The associated no rejection region can be graphically represented by drawing a flat line at $c(\alpha) = -\log(1 - \sqrt{1-\alpha}$ with $(1-\alpha)$ the desired confidence level. It corresponds to the values of the likelihood that lie beneath the flat line. The slopes β_1 and β_2 have asymptotic normal distribution provided that the errors are normally iid. This can be used for inference. The other regression slopes are unaffected and the usual normal asymptotic distribution can be applied for inference. The framework described above could be extended to two, three and multiple thresholds. Determination of the number of thresholds could be done by following a sequential approach of testing one threshold against none; two thresholds against one; and so on. It might also be acceptable to arbitrarily set an upper limit to the maximum number of thresholds to be explored. The upper limit is suggested by the number of dips in the graph of the likelihood ratio for the first threshold.

3.2 Empirical model, data source and descriptive statistics

Empirical strategy

Our empirical strategy to analyse the effectiveness of aid is described as follow. First, we select the dependent variable, the potential threshold variables and the set of other control variables to be included in the different models. Our dependent variable is the growth rate of GPD per capita. Among the covariates, ODA as a per cent of GPD is a key variable. It is important to notice that we only allow the aid variable to have different regression slopes across regimes because this is the focus of our analysis. The other covariate regression coefficients are regime independent. Thus, the regression function in model (1) can be written as follows:

$$Growth_{it} = \mu_i + \delta' f(aid_{it}, q_{it}) + \beta X_{it} + e_{it} \quad (8)$$

where f represents a nonlinear function between aid_{it} and the threshold q_{it} with $\delta' f(aid_{it}, q_{it}) = \delta' aid_{it} \times q_{it}$ in the case of the standard polynomial approach and $\delta' f(aid_{it}, q_{it}) = \delta'_1 aid_{it} I_{(q_{it \leq \gamma})} + \delta'_2 aid_{it} I_{(q_{it > \gamma})}$ in the cases of the threshold approach. The set of additional control variables is X_{it}.

We try various threshold variables. The first natural threshold variable we consider is ODA/GDP. The second set of threshold variables is intended to capture macroeconomic policies. Burnside and Dollar (2000), followed by several authors, suggest three main policy variables, namely 'trade openness' as a measure of trade liberalization, 'inflation' as a measure of monetary policy and 'budget surplus or fiscal balance' as a measure of fiscal policy. They construct a policy index as the weighted average of these three single policy variables with the weight reflecting the impact of each single policy variable on growth. Since the aim of our analysis is to find potential thresholds of either aid or policy, we decide to try separately each of the policy variables commonly applied instead of using an index. This choice is based on the fact that we think that the thresholds identified based on these policy variables separately will have explicit content as they come from actual data rather than thresholds identified from an index.

Also, we prefer not use the Sachs and Warner (1995) openness measure as is done in many studies because this is a dummy variable and will not yield any hidden thresholds. Instead, we apply another appealing and widely used trade openness proxy—trade share computed as the ratio of exports plus imports to GDP. The other thresholds considered are the inflation and the budget deficit/surplus.

Most of our candidate threshold variables could be potentially endogenous in the growth regression. The major concern is on the variable ODA/GDP, which many previous studies, especially within fourth-generation analyses, assume to be endogenous in growth regression. It is important to recall that the econometric framework identified earlier does not allow for endogenous threshold. To minimize this issue, we follow the literature on the GMM estimation approach that widely uses lagged variables instead of contemporaneous variables in regressions as an instrument. Although policy variables are also likely to be endogenous, Burnside and Dollar (2000) and many other scholars find no evidence that would support this fact for their index. Based on this, we use the contemporaneous value of the policy variable.

The choice of the other covariates is motivated by the extended theoretical and empirical literature on aid effectiveness. Following Burnside and Dollar (2000), Denkabe (2004) and several other authors, we include broad money as per cent of GDP one period-lagged to control for financial development, the logarithm of initial income to account for the convergence hypothesis in growth models. Since our preferred estimation method is panel fixed-effect, the inclusion of regional dummies, ethnic fractionalization, as used in most past aid studies, will be inconclusive because these variables are time invariant. By employing a fixed-effect estimation method, it is likely that we eliminate the influence of geography factors and all other time invariant factors.

Our empirical strategy is described as follows. For each threshold variable, we start with a linear model and assume exogeneity of aid, ignoring the non-dynamic structure of the model. This model serves as a benchmark. We employ a simple OLS and panel fixed-effect to estimate the equation. Next, we consider the issue of potential endogeneity of aid and deriving our instrument from past studies, we re-estimate the model using instrumental variables methods. Then we formally test the exogeneity assumption using the Hausman test. We also use the Arellano-Bond GMM estimation for a panel dynamic model to address the dynamic structure of the model due the presence of initial income among the left-hand side variables. We follow the same steps as described above for the model with polynomial specifications. Finally we apply the threshold model framework.

For a robustness check, we analyse four variants of the model depending on the control variable added. In the first specification we control only for inflation as the policy variable; the second specification controls for trade openness. The third controls simultaneously for inflation and trade openness and the last specification, budget/deficit surplus, as third policy variable. In all estimations we include dummy variables of each of the 4-year subperiods to capture the effects of time.

3.3 Data source and descriptive statistics

Most of the variables used in this analysis are from the Word Development Indicators (WDI 2012). The initial dataset contains all of Africa's 53 countries and covers the period from 1960 to

2012. Although 23 countries had to be dropped because of missing data, the remaining 30 provide a fair geographical representation of African economies.[1]

Following earlier empirical studies on aid-growth, we average our data over 4-year periods, to eliminate the incidence of cycle, lag and sequential effect in aid disbursement and to capture the evolution of trends.[2] Table 1 presents some basic descriptive statistics on the variables used later in the econometric estimation. The computed statistics are un-weighted across all the countries and all the 4-year time periods. An analysis of the table shows diverging growth experiences among the countries and over time periods. Also the benefit of aid varies significantly over time and among recipients. The threshold candidates and other control variables also exhibit important variation.

Table 1: Descriptive statistics on the key variables

Variable	Min	25-q	Median	75-q	Max	Mean	Sd
GDP/capita growth (annual %)	-7.61	-0.87	1.21	2.81	10.14	0.98	2.99
ODA received (% of GDP)	0.08	2.96	8.29	13.83	45.81	9.48	8.09
Initial log GDP per capita	4.63	5.48	5.88	6.92	8.59	6.17	0.96
Log M2/ GDP	2.15	2.86	3.15	3.51	4.60	3.23	0.52
Log (1+inflation)	-0.03	0.03	0.08	0.12	0.88	0.12	0.14
Log openness (% of GDP)	2.43	3.71	4.02	4.40	5.23	4.05	0.52
Budget deficit/surplus (%)	-9.47	-3.31	-1.87	-0.31	17.9	-0.94	4.80

Note: Unweighted descriptive statistics across all countries and all 4-yr time periods during the years 1980-2007.

Source: See text.

4 Results

4.1 Aid-growth regressions with a linear specification

We start with a model where we assume aid as exogenous and estimate the model using OLS and panel fixed-effect estimator. The results are presented in Table 2. Qualitatively, the results of the OLS estimations are similar to those of the panel fixed-effect estimations, but the overall quality of the panel fixed-effect estimation is higher. This can be explained by the fact that certain important growth determinants are not included in the specifications, either because they were country-specific or we did not have sufficient observations.

In the first three specifications and both for the OLS and the panel fixed-effect regressions, we find no evidence of a significant effect of ODA on economic growth. This result is in line with several earlier studies such as those by Burnside and Dollar (2000), Collier and Dollar (2002) and Rajan and Subramanian (2008), to name a few. These studies also find that unconditional aid has no significant effect on growth. As we control for fiscal policy in addition to inflation and trade openness, aid becomes positively associated with high growth. However, this result is weakened because the sample size drastically drops from 210 to 69 due to a large number of missing values in the budget deficit/surplus variable. The main conclusion from Table 2 on linear specification estimation is that there is no strong evidence that aid has a significant effect on growth. Evidence of a positive effect and significance appears only when both monetary, trade and budget and

[1] For a list of the countries included in the analysis, see Appendix Table A1.

[2] Previous studies that used this approach include Burnside and Dollar (2000), Denkabe (2004); Selaya and Thiele (2010) and others.

fiscal policy are simultaneously controlled for. This result also suggests that the non-existence of aid's positive effect on growth from the first six regressions might not be robust.

Other important results from Table 2 concern the effect of policy variables on growth. As expected, trade openness has a positive impact on growth and inflation hurts growth. Both results are consistent with past literature, as Fischer (1993), and Bruno and Easterly (1998) also observe a negative association between inflation and growth. An overall rising of price, the result of bad monetary policies, will likely be translated into a slowdown of the whole economy. We also find evidence of a conditional convergence among countries, given that the estimated coefficient of initial income is negative and significant for most models. All these results are consistent with theoretical predictions and findings from many previous empirical studies but with the understanding that the magnitude of these coefficients might not be the same.

There are at least two issues that could be argued against the results of Table 2. First, one can argue that ODA is potentially endogenous in the growth regression and this may affect the validity of the results. Although endogeneity of aid is acknowledged in most recent aid studies, there is no consensus within the empirical evidence on endogeneity of aid. For instance, Lensink and White (2001) and Burnside and Dollar (2000) consider the potential simultaneity bias due to the endogeneity of aid but fail to find evidence of a significant difference between OLS and IV results. Loxley and Sackey (2008) also find no evidence of endogeneity of aid in growth regressions for African countries, arguing that donors might have criteria not necessarily reflected in economic indicators. Conversely, Easterly et al. (2004), Hansen and Tarp (2001) and Rajan and Subramanian (2008) all advocate for appropriately addressing the endogeneity of aid, as well as policy variables.

Table 2: Aid-growth regressions with linear specification (OLS and OLF-fixed effect)

Dep.=	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP growth/capita	OLS a	FE-OLS a	OLS b	FE-OLS b	OLS c	FE-OLS c	OLS d	FE-OLS d
ODA/GDP	0.01	0.03	-0.01	-0.03	-0.01	-0.03	0.15**	0.18**
	(0.04)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.07)	(0.07)
Log initial GDP/capita	0.24	-3.95***	-0.13	-4.36***	-0.14	-4.45***	0.75	-12.21***
	(0.31)	(0.95)	(0.35)	(0.83)	(0.34)	(0.77)	(0.51)	(2.86)
Log lagged M2/GDP	0.67	0.33	0.56	0.06	0.54	0.10	1.91**	-2.75
	(0.46)	(1.10)	(0.45)	(0.93)	(0.45)	(0.94)	(0.75)	(1.88)
Log (1+inflation)	-1.80	-5.26***			-1.33	-3.74**	2.63	-15.52*
	(1.38)	(1.54)			(1.41)	(1.76)	(6.04)	(8.76)
Log trade openness			1.13**	4.27***	1.07**	3.95***	0.05	5.03***
			(0.47)	(0.74)	(0.47)	(0.89)	(0.57)	(1.42)
Budget deficit/surplus							0.19*	0.10
							(0.11)	(0.10)
Constant	-3.69*	23.47***	-5.75***	9.32	-5.21**	11.55*	-10.46***	67.11***
	(1.93)	(4.87)	(2.09)	(5.57)	(2.06)	(5.69)	(3.49)	(19.18)
Observations	210	210	210	210	210	210	69	69
R-squared	0.192	0.331	0.210	0.409	0.213	0.428	0.368	0.709
No. of countries	30	30	30	30	30	30	27	27
F	6.7***	27.4***	6.7***	34.1***	6.1***	34.7***	3.4***	44.7***
Corr (U, Xb)	.	-0.875	.	-0.818	.	-0.821	.	-0.974

Note: Number of 4-yr time periods is 7 (1980–2007); All standard errors (reported in parentheses) are robust; *** p<0.01, ** p<0.05, * p<0.1. Constant and 4-yr period time dummies are included in all regressions.

Source: See text.

Following the latter group, and to be conservative, we address the potential endogeneity of aid from two perspectives. We use instrumental variables and employ both two stages least square (2SLS) and GMM estimators. We follow the literature in selecting the instruments for aid (Dalgaard et al. 2004) and use internal instruments based on the regressors, including the lag of aid, the lag of aid squared, the lag of the policy variables and their interaction with aid, the lag of population and its interaction with the lag of the policy variables. The results are presented in Table 3. The Shea partial R-squared denotes a relatively good quality of first stage regression. The Sargan-Hansen over-identification fails to reject the null that the instruments are valid. The weak identification test rejects the null that the equations are under-identified. Most importantly, the Hansen endogeneity test does not confirm the presence of endogeneity of aid in the regression. The results of the model addressing the endogeneity of aid are qualitatively similar to the OLS/OLS-FE results. This observation parallels the strand of the aid-growth literature that fails to find support of endogeneity of aid, at least based on the set of instruments used. Overall, the effect of aid is positive but significant only when we simultaneously control for the three policy variables at the expense of the sample size. The three policy variables have the expected and intuitive signs.

Table 3: Aid-growth regressions with linear specification (2SLS fixed-effect and GMM IV fixed-effect)

Dep. =	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP growth/capita	2SLS a	GMM IV a	2SLS b	GMMIV b	2SLS c	GMMIV c	2SLS d	GMMIV d
ODA/GDP	0.18	0.15	0.16	0.12	0.14	0.09	0.38***	0.38***
	(0.12)	(0.12)	(0.10)	(0.10)	(0.09)	(0.09)	(0.07)	(0.05)
Log initial GDP/capita	-3.00	-2.51	-3.31*	-3.01*	-3.49**	-3.33**	-18.41***	-19.00***
	(2.00)	(1.97)	(1.69)	(1.59)	(1.57)	(1.47)	(2.36)	(2.02)
Log lagged M2/GDP	-0.69	-1.03	-0.81	-1.12	-0.59	-0.85	-1.75	-1.00
	(1.13)	(1.05)	(0.98)	(0.97)	(0.96)	(0.90)	(2.41)	(1.33)
Log (1+Inflation)	-3.11	-3.76*			-3.02	-3.57*	8.45	9.29***
	(2.20)	(2.10)			(2.11)	(1.97)	(6.12)	(3.09)
Log trade openness			1.74	1.79	1.78	1.58	2.44	3.25***
			(1.43)	(1.35)	(1.38)	(1.28)	(1.66)	(1.11)
Budget deficit/surplus							-0.13*	-0.15**
							(0.07)	(0.06)
Observations	180	180	180	180	180	180	32	32
R-squared	0.294	0.314	0.309	0.329	0.341	0.362	0.834	0.821
Shea Partial R2	0.12	0.12	0.15	0.15	0.18	0.18	0.98	0.98
No. of countries	30	30	30	30	30	30	11	11
F-Stat	6.2***	8.4***	6.7***	7.2***	6.5***	7.4***	14.9***	403.0***
P Endog	0.273	0.273	0.397	0.397	0.575	0.575	0.859	0.859
P Hansen J	0.156	0.156	0.154	0.154	0.0665	0.0665	0.295	0.295
P Weak IV	0.005	0.005	0.000	0.000	0.000	0.000	0.000	0.000

Note: Number of 4-yr periods is 7 (1980–2007); All standard errors (in parentheses) are robust; *** p<0.01, ** p<0.05, * p<0.1. Constant and time dummies are included in all regressions. In each regression instruments include the lag: of aid, of aid squared, of the policy variable in the specification and its interaction with aid, initial income and population. 2SLS stands for IV-two stages least square and GMMIV stands for two step GMM-IV. Shea Partial R2 is the adjusted R2 of the first regressions. P Endog stands for p-value for endogeneity test, P Hansen J stand for p-value of the Sargan-Hansen over-identification test and P Weak IV stands for the p-value for weak identification test.

Source: See text.

Table 4: Aid-growth regressions with linear specification (GMMDIFF and GMMSYS)

Dep. = GDP growth /capita	(1) GMM DIFF a	(2) GMM SYS a	(3) GMM DIFF b	(4) GMM SYS b	(5) GMM DIFF c	(6) GMM SYS c	(7) GMM DIFF d	(8) GMM SYS d
ODA/GDP	0.01	0.02	0.05	0.02	0.00	0.00	0.17	0.17**
	(0.05)	(0.04)	(0.08)	(0.06)	(0.06)	(0.06)	(0.18)	(0.07)
Log initial GDP/capita	-4.01	0.70	-3.61	0.65	-5.21*	0.67	-9.96	1.70
	(2.45)	(0.51)	(3.12)	(1.06)	(2.75)	(0.78)	(6.32)	(1.64)
Log lagged M2/GDP	-1.32	0.90	-0.32	0.88	-0.76	0.49	-2.45	0.40
	(2.30)	(0.90)	(1.76)	(1.56)	(2.10)	(1.38)	(2.61)	(3.22)
Log (1+inflation)	-6.78**	1.91			-3.76	-1.72	-19.28	-10.36
	(3.21)	(4.48)			(5.79)	(5.26)	(18.91)	(21.82)
Log trade openness			2.06	0.42	2.14	0.09	3.81	-0.45
			(3.46)	(1.53)	(2.47)	(1.87)	(4.80)	(1.60)
Budget deficit/surplus		-7.98***		-9.14		-6.35	0.09	-7.92
		(2.72)		(8.46)		(6.95)	(0.17)	(5.66)
Observations	180	210	180	210	180	210	42	69
No. of countries	30	30	30	30	30	30	21	27
WaldChi2	184.3***	77.3***	177.0***	83.9***	229.6***	95.4***	25.2***	45.1***
P Hansen J	0.998	1	1.000	1	1.000	1	0.996	1
P Sargan	0.315	0.008	0.023	0.002	0.019	0.000	0.110	0.249
P AR2	0.0408	0.0195	0.0350	0.0211	0.0273	0.0181	0.336	0.257

Note: Number of 4-yr time periods is 7 (1980–2007); All standard errors (in parentheses) are Windmeijer (2005) two-step GMM estimators bias-corrected (WC);*** p<0.01, ** p<0.05, * p<0.1. Constant and time dummies are included in all regressions. In each regression, instruments include lag of order 2 to 7 of explanatory variables. GMMDIFF stands for two steps GMM difference and GMM stands for two steps GMM-system. P Endog stands for p-value for endogeneity test, P Hansen J stand for p-value of the Sargan-Hansen test of over-identification restrictions (robust, but weakened by many instruments). P Sargan stands the Sargan test of over-identification restrictions (not robust, but not weakened by many instruments). P AR2 stands for Arellano-Bond test for AR (2) in first differences.

Source: See text.

The second potential issue in the OLS/OLS-FE results is related to the dynamic structure of the models. In fact, the right-hand side of the regression equations contains the initial GPD per capita. Removing the country-fixed effect by taking the difference, as is usually done in OLS fixed estimations, introduces a correlation between the initial income and the new error terms making standard estimators inconsistent (Denkabe 2004; Arellano and Bond 1991). Correcting only for the endogeneity of aid is not enough for a consistent estimation. The GMM estimator introduced by Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998) can potentially be used to address both endogeneity and correlation problems. It is widely used in empirical growth literature as well as aid-growth literature. There are two versions of the estimator: GMM difference and GMM system. The latter tends to be preferred as it has better small-sample properties. For robustness we consider both versions and present the results in Table 4. Qualitatively accounting simultaneously for the endogeneity and the dynamics effect in the growth models does not change the results for the OLS and the instrumental variable estimations. The effect of aid is positive but not significant.

4.2 Aid-growth regressions with nonlinear specifications

ODA/GDP as threshold variable

Searching for polynomial effect with respect to ODA/GDP: Following earlier empirical literature to address nonlinearity in aid-growth regression, we estimate the polynomial specification by including the quadratic term of aid as an additional aid variable in the regression. As in the linear specification we successively consider the OLS/OLS-FE estimators, then address potential endogeneity *y* using 2SLS/GMM-IV estimators and finally account for dynamic effect using GMM-DIFF and GMM-SYS estimators. The results of the OLS/OLS-FE are shown in Table 5. The results of the other estimations are given in Appendix Tables A2 and A3.

The introduction of the squared term of aid does not improve the significance of the effect of aid on growth. In all specifications, except (8) which includes all policy variables as regressors at the expense of the sample size, the effect of aid remains non-significant as in the linear specification. Thus, even with the polynomial specification, aid still has no significant effect on growth. Also, the models using instrumental variable methods fail to identify any significant evidence of diminishing returns as the quadratic term of aid is non-significant in most specifications. The earlier findings of a positive effect of trade openness; negative effect of inflation and evidence of convergence are still observed.

Table 5: Aid-growth regressions with polynomial term with ODA (OLS and OLF-fixed effect)

Dep. = GDP growth/capita	(1) OLS a	(2) FE-OLS a	(3) OLS b	(4) FE-OLS b	(5) OLS c	(6) FE-OLS c	(7) OLS d	(8) FE-OLS d
ODA/GDP	0.04	0.06	0.00	-0.03	-0.01	-0.07	0.11	0.39*
	(0.09)	(0.13)	(0.09)	(0.14)	(0.10)	(0.13)	(0.15)	(0.19)
ODA/GDP squared	-0.08	-0.08	-0.03	-0.01	0.00	0.10	0.10	-0.42
	(0.25)	(0.31)	(0.25)	(0.34)	(0.26)	(0.31)	(0.35)	(0.37)
Log initial GDP/capita	0.30	-3.80***	-0.10	-4.35***	-0.14	-4.64***	0.62	-12.15***
	(0.38)	(1.16)	(0.41)	(1.21)	(0.42)	(1.08)	(0.62)	(2.70)
Log lagged M2/GDP	0.67	0.27	0.57	0.06	0.54	0.16	1.92**	-3.25*
	(0.46)	(1.22)	(0.45)	(1.05)	(0.45)	(1.06)	(0.76)	(1.59)
Log (1+inflation)	-1.69	-5.12***			-1.34	-3.88**	2.65	-16.56*
	(1.44)	(1.60)			(1.47)	(1.84)	(5.94)	(9.00)
Log trade openness			1.12**	4.26***	1.07**	4.00***	0.09	4.23***
			(0.47)	(0.78)	(0.47)	(0.90)	(0.56)	(1.39)
Budget deficit/surplus							0.19*	0.09
							(0.11)	(0.10)
Constant	-4.26	22.50***	-5.93**	9.26	-5.19*	12.54*	-11.97**	70.67***
	(2.71)	(5.23)	(2.62)	(6.48)	(2.72)	(6.29)	(4.96)	(17.22)
Observations	210	210	210	210	210	210	69	69
R-squared	0.193	0.331	0.210	0.409	0.213	0.429	0.368	0.718
F	6.1	25.8***	6.1***	31.5***	5.5***	37.0***	3.0*	45.4***
Corr (U, Xb)	.	-0.873	.	-0.818	.	-0.824	.	-0.978
No. of countries		30		30		30		27

Note: Number of 4-yr time periods is 7 (1980–2007); All standard errors (in parentheses) are robust; *** p<0.01, ** p<0.05, * p<0.1. Time dummies are included in all regressions.

Source: See text.

Searching for threshold effect with respect to ODA/GDP: So far, we find no evidence of a significant effect of aid on growth in either linear and quadratic specifications of aid. We also find no evidence of endogeneity for ODA in the growth regressions. In addition, the results of both the instrumental variable and the GMM estimations are qualitatively similar to the OLS and panel OLS-fixed effect estimations. These results justify the use of the Hansen (1999) panel threshold model. For each specification (models 1-4 as in the linear and polynomial cases), we explore the existence of a threshold effect similar to nonlinearity but without explicit functional form. We test sequentially the presence of one and two endogenous thresholds among the values of ODA/GDP lagged after removing the outlier values. Then, we move to the point estimate and the confidence interval of the thresholds. Finally, using the identified thresholds, we estimate the regime dependent on and the regime independent of coefficients of the regressions. Table 6, giving the results of the test for the presence of thresholds with ODA/GDP as the threshold variable, shows the value of the F- statistics for the presence of one and two thresholds along with their bootstrapped (500) p-value for the different specifications.

Table 6: Testing for threshold effect and estimation (threshold variable: ODA/GDP in per cent)

	(1)	(2)	(3)	(4)
Single threshold				
γ_1	1.5	1.5	1.5	8.1
F_1	9.4*	10.5*	11.2*	49.1***
Double threshold				
γ_2	17.2	17.2	17.2	14.8
F_2	5.3	5.8	5.1	23.8*

Source: See text.

Table 7: Aid-growth regressions with threshold effect (threshold variable: lag ODA/GDP)

Variables	(1) FE-OLS	(2) FE-OLS	(3) FE-OLS	(4) FE-OLS
ODA/GDP with ODA_1 ≤ γ_1	1.48***	1.41***	1.42***	0.58***
	(0.32)	(0.45)	(0.39)	(0.13)
ODA/GDP with ODA_1> γ_1	0.02	-0.03	-0.03	0.19***
	(0.03)	(0.04)	(0.04)	(0.04)
Log initial GDP/capita	-4.23***	-4.63***	-4.73***	-11.44***
	(0.95)	(0.84)	(0.76)	(2.22)
Log lagged M2/GDP	0.55	0.28	0.33	-1.26
	(1.09)	(0.95)	(0.96)	(1.83)
Log 1+ average inflation	-5.32***		-3.80**	-24.34***
	(1.53)		(1.76)	(6.44)
Log average trade openness		4.28***	3.96***	3.96**
		(0.73)	(0.87)	(1.54)
Average budget deficit/surplus				0.10
				(0.11)
Constant	24.48***	10.27*	12.54**	60.16***
	(4.42)	(5.47)	(5.52)	(15.18)
Observations	210	210	210	69
No. of countries	30	30	30	27
R-squared	0.359	0.437	0.457	0.787
F	45.05***	84.57***	92.08***	35.35***
Corr (U,Xb)	-0.875	-0.820	-0.822	-0.968

Note: Number of 4-yr time periods is 7 (1980–2007); All standard errors (in parentheses) are robust; *** p<0.01, ** p<0.05, * p<0.1. Constant and 4-yr period time dummies are included in all regressions.

Source: See text.

We find relatively weak evidence for the presence of one single threshold value for for almost all the specifications. Appendix Figure A2 shows the likelihood ratio between the threshold model and the linear model for different potential thresholds. The figure also provides information on the potential existence of more thresholds. Hansen (1999) argues that the dips can suggest potential thresholds. A look at the Figure for specifications (1)–(4) reveals that there are two major dips. The first dip, around the value of 1.5 per cent of the threshold variable corresponds to the first identified threshold. The second dip is suggestive of the presence of a second threshold. However, the LR test does not support this evidence as the p-values are much larger. For the remainder of the analysis with ODA/GDP as the threshold variable, we focus our attention on the single threshold model (Table 7). Although the LR test fails to identify a second significant threshold for most specifications, we take a conservative approach and briefly discuss the results of double threshold models in Appendix Table A4.

The point estimate of the first threshold across the first three specifications is about 1.5 per cent lagged net ODA/GDP. The threshold is relatively higher for the last specification where we control for budget deficit/surplus. However because of the significant drop in the sample size, we focus our interpretation on the first three models. In all cases, the coefficient of aid in the lower regime is significantly higher than in the upper regime. This is also evidence of the presence of a threshold effect, which implies that the contemporaneous effect of aid on growth differs, depending the level of past aid receipts. The finding suggests that when past levels of ODA/GDP are below 1.5 per cent, the effect of ODA on economic growth is positive and significant. The magnitude of the coefficient for the lower regime remains almost the same, exhibiting robustness to the addition of control variables. Thus, when the ODA ratio to GDP is lower than 1.5 per cent, an increase in aid receipts is associated with a significant increase in growth. When the ODA ratio to GDP is greater than 1.5 per cent, it is unclear whether any additional increases in ODA/GDP will produce growth.

Compared to the results from the linear and the polynomial models, the threshold analysis provides some insights as to why the overall effect of ODA was insignificant despite the control for several factors. The result is somewhat in line with the diminishing returns of an implicit threshold of aid largely noted in the aid-growth literature (Hansen and Tarp 2001).The point estimates of the threshold are relatively low. Only 7 per cent of the estimation samples constituting five countries—Algeria, Gabon, Mauritius, Nigeria and Tunisia—have a lag of aid receipts less than 1.5 per cent. The average growth of countries in the lower regime is 2.2 per cent which is significantly higher than the average growth of 0.9 per cent for countries above the thresholds. A graphical representation of the confidence interval shows a relatively large interval and suggests some uncertainty of the threshold value and the proper division into classes. Another interesting feature of the threshold model is that the control variables maintain their sign, as in the linear and in polynomial specifications, with those signs consistent with the theoretical predictions.

We include the estimation for the double threshold in Appendix Table A4. The point estimate of the second threshold is 17.2 per cent in specifications (1)-(3) and 14.8 per cent in specification (4). Even with the double threshold model, the effect of ODA on growth is positive for the lower regime (≤1.5 per cent). In the middle regime with ODA/GDP between 1.5 and 17.2 per cent, the effect appears to be non-positive or even significantly negative. Overall aid has no marginal effect on growth for very high levels of past aid receipts.

In summary, it appears that the effect of foreign aid on growth is not significant when using linear and polynomial specifications. However, the effect of aid on growth is not uniform across the entire sample. Using a threshold model by splitting the country-time sample according to some endogenously determined thresholds of ODA/GDP, indicates that additional aid, in the face of lower levels of earlier aid receipts, will have a contemporaneous positive and significant effect on growth. However, there is no evidence that more aid will marginally increase growth when earlier levels of aid receipts have been high. Also, instead of promoting growth, the continuously high allocation of aid appears to have a negative effect. These results inspire us to ask the question why the effect of aid on growth is unclear. We investigate this issue by examining the effect of aid conditional to selected policy variables: inflation as proxy for monetary policy and trade openness as proxy for trade policies and budget surplus/deficit as proxy for fiscal and budget policy.

Inflation as threshold variable

Searching for polynomial nonlinear effect with respect to inflation: We run versions of the previous growth regressions but include an interaction term between ODA/ GDP and the inflation to explore the effect of aid conditional on monetary policy. As before, we first consider the simple OLS and the panel fixed-effect estimators. Next we address the potential endogeneity of aid interacted with inflation and the dynamic structure of the model. The results of the OLS and panel fixed-effect estimations are presented in Table 8. The results of the IV and the dynamic panel estimations which are presented in Appendix Tables A5 and A6, respectively, for robustness are qualitatively similar to the OLS/panel fixed-effect results.

Overall, we find in all specifications that the coefficient of aid turns to positive and significant in several models. More importantly, the coefficient of aid interacted with inflation is persistently negative and significant in most estimations. These results suggest that aid has a positive effect on growth under a good monetary policy environment, but that high inflation hampers aid's positive effect on growth in African countries. This might also suggest the presence of an implicit threshold with respect to inflation which splits the effect of aid on growth into a positive impact or a non-positive or insignificant outcome, depending on the sample. This result is also evident when we address potential endogeneity using instrumental variable and account for the dynamic aspect of the model using GMM difference and system estimations.

Table 8: Aid-growth regressions with polynomial term with inflation (OLS and OLF-fixed effect)

Dep. =	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP growth/capita	OLS a	FE-OLS a	OLS b	FE-OLS b	OLS c	FE-OLS c	OLS d	FE-OLS d
ODA/GDP	0.08	0.06	0.03	0.03	0.06	0.02	0.40***	0.41***
	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)	(0.06)	(0.09)	(0.12)
ODA/GDP X inflation	-0.36**	-0.16	-0.22***	-0.28**	-0.39**	-0.24	-1.83***	-1.52**
	(0.17)	(0.19)	(0.08)	(0.11)	(0.17)	(0.20)	(0.55)	(0.58)
Log initial GDP/capita	0.47	-3.65***	-0.02	-3.93***	0.08	-4.02***	1.39***	-9.22***
	(0.34)	(1.02)	(0.35)	(0.76)	(0.37)	(0.80)	(0.50)	(2.56)
Log lagged M2/GDP	0.67	0.15	0.52	-0.23	0.53	-0.18	2.19***	-3.10*
	(0.46)	(1.03)	(0.45)	(0.87)	(0.46)	(0.84)	(0.73)	(1.75)
Log (1+inflation)	2.33	-3.39			3.23	-0.91	18.69***	8.31
	(2.61)	(3.18)			(2.61)	(3.32)	(5.23)	(11.88)
Log trade openness			1.07**	4.14***	1.17**	4.08***	0.21	3.98***
			(0.47)	(0.76)	(0.46)	(0.81)	(0.50)	(1.41)
Budget deficit/surplus							0.13	0.13
							(0.11)	(0.11)
Constant	-5.86**	21.83***	-6.14***	7.96	-7.7***	8.70	-20.71***	51.43***
	(2.36)	(5.73)	(2.11)	(5.40)	(2.47)	(6.32)	(4.26)	(15.22)
Observations	210	210	210	210	210	210	69	69
R-squared	0.214	0.335	0.231	0.438	0.239	0.438	0.488	0.741
F	6.706	21.88	6.666	39.52	6.079	36.73	4.917	60.22
Corr (U, Xb)	.	-0.867	.	-0.797	.	-0.801	.	-0.965
No. of countries		30		30		30		27

Note: Number of 4-yr time periods is 7 (1980–2007); All standard errors (in parentheses) are robust; *** p<0.01, ** p<0.05, * p<0.1. Constant and time dummies are included in all regressions.

Source: See text.

Searching for threshold effect with respect to inflation rate: We search for the existence of a potential endogenous threshold level of inflation that could introduce aid's differential effect on growth. The same approach is applied as previously described in the methodology section. Table 9, showing the results of the threshold effect test, indicates weak evidence of the presence of one threshold with the value of the threshold varying across specifications. The inflation threshold is between 8.1 and 22.8 per cent, depending on the specification of the model. Except for Model (4) with limited data points, there is only one major dip in the Figures on the likelihood ratio (Appendix Figure A3). This suggests the presence of only one single threshold; the possible second threshold is not significant in most specifications.

The results for the model on the single threshold are given in Table 10. Across all models, the effect of aid on growth in the upper regime as defined by the inflation threshold is significantly negative. It is empirically widely recognized that high inflation leads to a slowdown of economic activity. Our finding does not imply that aid has a negative effect on growth under bad monetary policies, but suggests instead that any potential positive effect of aid on growth might fade under high inflation. It is also possible that the effect of aid on growth might not be sufficient to offset the negative impact of high inflation.

Table 9: Testing for threshold effect and estimation (threshold variable: inflation)

	(1)	(2)	(3)	(4)
Single threshold				
γ_1	13.9	14.2	22.8	8.1
F_1	4.25	10.5*	11.2*	49.1***
Double threshold				
γ_2	2.96	8.09	25.4	14.8
F_2	0.948	3.28	5.1	23.8*

Source: See text.

Table 10: Aid-growth regressions with threshold effect (threshold variable: inflation)

Variables	(1) FE-OLS	(2) FE-OLS	(3) FE-OLS	(4) FE-OLS
ODA/GDP with inflation $\leq \gamma_1$	0.08	0.01	0.00	0.40***
	(0.05)	(0.04)	(0.04)	(0.08)
ODA/GDP with inflation$> \gamma_1$	-0.01	-0.15***	-0.14**	0.15**
	(0.04)	(0.04)	(0.06)	(0.05)
Log initial GDP/capita	-3.55***	-3.90***	-3.96***	-10.69***
	(1.00)	(0.72)	(0.72)	(2.65)
Log lagged M2/GDP	0.07	-0.14	-0.11	-1.25
	(0.96)	(0.77)	(0.76)	(1.56)
Log 1+ average inflation	-3.52		-0.99	-23.31***
	(2.15)		(2.60)	(6.70)
Log average trade openness		4.41***	4.32***	8.05***
		(0.72)	(0.81)	(1.31)
Average budget deficit/surplus				0.07
				(0.09)
Constant	21.43***	6.43	7.25	41.66**
	(5.62)	(5.18)	(5.99)	(16.66)
Observations	210	210	210	69
No. of countries	30	30	30	27
R-squared	0.351	0.459	0.460	0.811
F-Stat	22.34***	31.06***	34.76***	24.16***
Corr (U, Xb)	-0.865	-0.781	-0.785	-0.953

Note: Number of 4-yr time periods is 7 (1980–2007); All standard errors (in parentheses) are robust; *** p<0.01, ** p<0.05, * p<0.1. Constant and 4-yr period time dummies are included in all regressions.

Source: See text

Trade openness as threshold variable

Searching for polynomial nonlinear effect with respect to trade openness: As previously, we run each version of the aid-growth regressions to include an interaction term of ODA/ GDP and the trade openness variable to capture the nonlinear effect of aid on growth conditional to trade policies. The results of OLS and panel fixed effect are shown in Table 11. The results of the models addressing endogeneity as well as the results of the dynamic models are also presented in Appendix Tables A7 and A8 as a robustness check. The effect of aid on growth in most cases is insignificant. The effect of the interaction is positive and significant in some cases, suggesting that the effect of aid is strengthened under good trade policies.

Table 11: Aid-growth regressions with polynomial term with openness (OLS and OLF-fixed effect)

Dep. = GDP growth/capita	(1) OLS a	(2) FE-OLS a	(3) OLS b	(4) FE-OLS b	(5) OLS c	(6) FE-OLS c	(7) OLS d	(8) FE-OLS d
ODA/GDP	-0.10	-0.66**	0.34	0.04	0.31	-0.06	0.19	-0.59
	(0.15)	(0.27)	(0.21)	(0.27)	(0.21)	(0.26)	(0.36)	(0.39)
ODA/GDP X openness	0.03	0.16**	-0.08*	-0.02	-0.08	0.01	-0.01	0.19*
	(0.03)	(0.06)	(0.05)	(0.06)	(0.05)	(0.06)	(0.09)	(0.10)
Log initial GDP/capita	0.18	-4.02***	-0.22	-4.37***	-0.21	-4.45***	0.73	-10.95***
	(0.32)	(0.87)	(0.34)	(0.84)	(0.35)	(0.77)	(0.61)	(2.84)
Log lagged M2/GDP	0.59	0.19	0.70	0.07	0.68	0.10	1.94**	-5.05**
	(0.47)	(0.99)	(0.46)	(0.94)	(0.47)	(0.94)	(0.88)	(2.30)
Log (1+inflation)	-1.86	-5.47***			-0.80	-3.78**	2.77	-15.29*
	(1.40)	(1.56)			(1.43)	(1.76)	(6.31)	(8.56)
Log trade openness			1.93***	4.39***	1.83**	3.89***	0.16	4.38***
			(0.72)	(0.83)	(0.72)	(1.01)	(1.06)	(1.48)
Budget							0.19	0.14
							(0.11)	(0.10)
Constant	-3.03	24.52***	-8.84***	8.87	-8.26***	11.79*	-10.87**	69.97***
	(2.14)	(5.10)	(3.05)	(5.62)	(3.08)	(5.90)	(4.77)	(18.28)
Observations	210	210	210	210	210	210	69	69
R-squared	0.194	0.362	0.221	0.409	0.222	0.428	0.368	0.728
F	6.093***	30.36***	6.217***	30.72***	5.766***	35.96***	2.996***	49.46***
Corr (U, Xb)	.	-0.852	.	-0.819	.	-0.820	.	-0.972
No. of countries		30		30		30		27

Note: Number of 4-yr time periods is 7 (1980–2007); All standard errors (in parentheses) are robust; *** p<0.01, ** p<0.05, * p<0.1. Constant and time dummies are included in all regressions.

Source: See text.

Searching for threshold effect with respect to trade openness: The results of the polynomial specification with the interaction between aid and trade openness did not reveal any significant effects of aid on growth. We now search for a threshold effect. Each of the four specifications is tested. As shown in Table 12 and illustrated in Appendix Figure A4, there is evidence of a threshold effect with respect to trade openness for all. The first threshold appears around the trade ratio value of approximately 47.5 per cent. There is no clear value for the second threshold, as it varies significantly across specifications. In the first model where we do not directly control for trade, the second threshold appears to be lower than the first; in the other model it is significantly higher. We limit the rest of the analysis to the single threshold model.

In all specifications, the effect of aid is not significantly lower for trade openness than for the first threshold. For a relatively high trade ratio, the effect becomes positive and significant in three of the four models. Surprisingly in model 2, where we specifically control for trade openness, the effect of aid is negative, possibility because much of the effect is captured in the trade variable. Given the importance of trade in spurring growth, our finding suggests that in a rather closed economy, foreign aid is likely not to have much effect on growth, while under strong trade policies, the effect of aid on growth would be more apparent.

Table 12: Testing for threshold effect and estimation (threshold variable: openness)

	(1)	(2)	(3)	(4)
Single threshold				
γ_1	47.5	48.6	47.5	41.2
F_1	20.4***	17.4****	9.0**	100.9***
Double threshold				
γ_2	24.2	74.4	74.4	161.4
F_2	13.6**	9.6**	13.4**	20.0**

Source: See text.

Table 13: Aid-growth regressions with threshold effect (threshold variable: openness)

Variables	(1) FE-OLS	(2) FE-OLS	(3) FE-OLS	(4) FE-OLS
ODA/GDP with openness $\leq \gamma_1$	-0.08	0.02	-0.09	0.03
	(0.06)	(0.05)	(0.06)	(0.04)
ODA/GDP with openness> γ_1	0.08**	-0.10***	0.02	0.32***
	(0.04)	(0.03)	(0.05)	(0.05)
Log initial GDP/capita	-3.57***	-4.23***	-4.12***	-9.01***
	(0.96)	(0.76)	(0.82)	(2.09)
Log lagged M2/GDP	0.15	0.18	0.02	-6.85***
	(0.95)	(0.98)	(0.88)	(2.07)
Log 1+ average inflation	-5.24***		-3.97**	-13.09***
	(1.72)		(1.81)	(4.15)
Log average trade openness		4.91***	3.31***	4.90***
		(0.76)	(0.91)	(1.29)
Average budget deficit/surplus				0.05
				(0.11)
Constant	21.73***	5.49	12.32*	61.21***
	(5.59)	(5.30)	(6.04)	(12.72)
Observations	210	210	210	69
No. of countries	30	30	30	27
R-squared	0.390	0.435	0.452	0.834
F-Stat	25.02***	33.04***	26.89***	111.9***
Corr (U. Xb)	-0.826	-0.805	-0.797	-0.966

Note: Number of 4-yr time periods is 7 (1980–2007); All standard errors (in parentheses) are robust; *** p<0.01, ** p<0.05, * p<0.1. Constant and 4-yr period time dummies are included in all regressions.
Source: See text.

Budget deficit/surplus as threshold variable

Searching for polynomial nonlinear effect with respect to budget deficit/surplus: Throughout the analysis, when the budget surplus/deficit is controlled for, the effect of aid is positive and frequently significant. This observation leads us to explore the nonlinear effect of aid on growth with respect to budget and fiscal policies. Budget deficits appear in our sample frequently. Out of the 69 valid data points in the country-period sample, 52 are negative, suggesting the predominance of budget deficit. To check whether high budget deficits alter aid's effect on growth, we run a growth regression and include an interaction term of ODA/GPD with the budget surplus/deficit variable. The results of the OLS and panel fixed-effect are presented in Table 14. As a robustness check, we also present the results of the instrumental variable and dynamic panel estimation in Appendix Tables A9 and A10. The main finding from this analysis is the strong evidence of a positive effect of ODA/GPD variable on growth. However the interaction term of aid with the budget deficit/surplus variable is insignificant.

Table 14: Aid-growth regressions with polynomial term with budget deficit/surplus (OLS and OLF-fixed effect)

Dep. = GDP growth /capita	(1) OLS a	(2) FE-OLS a	(3) OLS b	(4) FE-OLS b	(5) OLS c	(6) FE-OLS c	(7) OLS d	(8) FE-OLS d
ODA/GDP	0.16**	0.31***	0.14**	0.22***	0.14**	0.22***	0.07	0.23***
	(0.06)	(0.06)	(0.05)	(0.08)	(0.06)	(0.06)	(0.05)	(0.05)
ODA/GDP X bdg surp /def	0.00	0.01	0.00	0.01	0.00	0.01	-0.02	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Log initial GDP/capita	1.17**	-12.88***	0.91*	-12.96***	0.93*	-12.81***	0.30	-12.90***
	(0.55)	(2.82)	(0.54)	(3.53)	(0.55)	(3.01)	(0.52)	(3.01)
Log lagged M2/GDP	1.56*	-2.43	1.46*	-3.32	1.49*	-3.69*	2.13***	-3.77
	(0.81)	(3.05)	(0.82)	(2.41)	(0.81)	(1.80)	(0.78)	(2.22)
Log (1+inflation)	2.03	-14.33			1.61	-16.74*	2.41	-16.93*
	(6.08)	(8.87)			(6.60)	(9.29)	(5.97)	(9.37)
Log trade openness			0.67	4.70**	0.64	5.39***	0.37	5.44***
			(0.56)	(1.79)	(0.59)	(1.31)	(0.63)	(1.71)
Budget surplus/deficit							0.35**	-0.02
							(0.14)	(0.17)
Constant	-14.2***	90.18***	-12.3***	73.77***	-12.5***	72.30***	-11.2***	72.89***
	(3.74)	(21.05)	(3.93)	(22.16)	(3.60)	(20.04)	(3.41)	(19.55)
Observations	69	69	69	69	69	69	69	69
No. of countries		27		27		27		27
R-squared	0.301	0.659	0.307	0.666	0.308	0.715	0.414	0.715
F	3.456***	6.613***	3.633***	30.20***	3.199***	69.11***	2.696***	75.33***
Corr (U, Xb)	.	-0.983	.	-0.980	.	-0.978	.	-0.978

Note: Number of 4-yr time periods is 7 (1980–2007); All standard errors (in parentheses) are robust; *** p<0.01, ** p<0.05, * p<0.1. Constant and time dummies are included in all regressions. Bdg surp /def stands for budget surplus/deficit.

Source: See text.

Searching for threshold effect with respect to budget deficit/surplus: The threshold models identify two relatively similar thresholds (Table 15). The first threshold is detected for a value of budget deficit/surplus of -5.1 per cent for most specifications while the second threshold is about -5.9 per cent. The graphical confidence interval depicted in Appendix Figure A4 suggests that both thresholds belong to the same range. Thus we restrict the analysis to the single threshold model, and the results are given in Table 16.

Table 15: Testing for threshold effect and estimation (threshold variable: budget deficit/surplus)

	(1)	(2)	(3)	(4)
Single threshold				
γ_1	-5.1	-4.6	-5.1	-5.1
F_1	33.7***	29.8***	35.8***	32.0***
Double threshold				
γ_2	-6.3	-5.9	-5.9	-5.9
F_2	55.8***	103.4***	86.5***	89.4***

Source: See text.

Table 16: Aid-growth regressions with threshold effect (threshold variable: budget deficit/surplus)

Variables	(1) FE-OLS	(2) FE-OLS	(3) FE-OLS	(4) FE-OLS
ODA/GDP with budget def/surp $\leq \gamma_1$	0.26***	0.16*	0.17***	0.17***
	(0.05)	(0.08)	(0.05)	(0.05)
ODA/GDP with budget def/surp $> \gamma_1$	0.40***	0.29***	0.31***	0.31***
	(0.07)	(0.06)	(0.05)	(0.05)
Log initial GDP/capita	-12.09***	-12.75***	-12.05***	-12.08***
	(3.26)	(3.86)	(3.24)	(3.32)
Log lagged M2/GDP	-3.52	-3.70**	-4.53***	-4.54***
	(2.20)	(1.61)	(1.22)	(1.34)
Log 1+ average inflation			-19.01**	-19.09**
			(8.63)	(8.89)
Log average trade openness	-16.94**	4.18***	4.94***	4.95***
	(7.89)	(1.22)	(1.20)	(1.25)
Average budget deficit/surplus				-0.01
				(0.11)
Constant	88.43***	75.40***	71.82***	71.95***
	(22.35)	(24.41)	(20.21)	(20.81)
Observations	69	69	69	69
No. of countries	27	27	27	27
R-squared	0.718	0.716	0.765	0.765
F	31.27***	56.31***	78.82***	84.16***
Corr (U, Xb)	-0.982	-0.980	-0.977	-0.977

Note: Number of 4-yr time periods is 7 (1980–2007); All standard errors (in parentheses) are robust; *** p<0.01, ** p<0.05, * p<0.1. Constant and time dummies are included in all regressions. Bdg surp /def stands for budget surplus/deficit.

Source: See text.

The finding of the threshold is in line with the results of the quadratic specification. The effect of aid on growth is much stronger for a low budget deficit than a high deficit. An possible explanation for such results could be that aid receipts, in the face of a high budget deficit, are targeted to deficit financing. On the other hand, if the budget deficit is low, it offers an appropriate environment for an effective aid inflow.

6 Conclusion and policy implications

In a recent a paper, Arndt et al. (2010) argue that the aid-growth literature is yet to make a full circle. The controversial findings across several generations and the dependency of many developing nations on foreign aid call for a more in-depth exploration of the puzzle. As more data and new methods are available, it might be possible to find a consensus to the question of aid effectiveness. This is necessary both from the supply and the demand sides. Donors want the assurance that every dollar they spend in the developing countries has some positive impact. They certainly want to understand what works, what doesn't work, and why. On the demand side, recipient countries want to understand and isolate the contribution of the international community and their own efforts to sustain economic growth.

In this paper we revisit the aid-growth literature in the context of African economies using a nonlinear modeling framework. We start the analysis in the standard linear setting as a benchmark, and find little evidence of aid effectiveness. This result is consistent with the literature, as several previous studies have also come to the conclusion that aid does not seem to have an unconditional marginal effect on growth. We also find that no evidence of the endogeneity of aid in the context of African economies. The threshold analysis helps to shed some light on the question why we fail in the linear setting to find a significant effect of aid on growth.

Using lagged aid receipts as threshold variables, we identify two regimes defined as the threshold of past aid allocations. In the lower regime, the effect of aid on growth is significantly positive, while in the upper regime the effect is insignificant. This result is similar to the diminishing-returns results already noted in the literature, but now with an explicit threshold. The size of the identified thresholds is relatively low (1.5 per cent) and only few countries are actually within this aid-effective regime. Caution should be exercised with this threshold for at least two reasons. First, the threshold is determined on the basis of historical data and thus should not necessarily be used for inference. The main message of our study is that given the sample we have at hand, aid has a diverging effect on growth, which is dependent on a threshold defined by the level of past aid receipts. Second, the confidence interval of the threshold seems relatively large and suggests some uncertainty in the sample splitting and country classification.

Using policy variables as threshold variables, we find that good macroeconomic policy does matter for the effectiveness of aid and that in an economy where sound monetary policies translate into low inflation rates, aid's effect on growth will likely be stronger. Our finding does not imply that aid has a negative effect on growth under bad monetary policy but rather that any potential positive effect could be eroded by high inflation. It is also possible that the effect of aid on growth might not be robust enough to offset the negative effect of high inflation on growth. We also find that the effect of the interaction between aid and trade openness is positive and significant, suggesting that the effect of aid on growth is stronger under good trade policy, as well as being more apparent. Sound budget and fiscal policies also play an important role in fostering aid's effect on growth. Consequently, a good environment for the effective impact of aid inflows could be characterized as having low inflation, small budget deficit and relatively good level of trade openness. This would be almost the perfect macroeconomics environment for all countries contemplating sustained economic growth in general.

Based on our finding of the evidence of aid's diminishing returns with a relatively low threshold of past aid and the importance of good macroeconomics policies for an aid-effective economic environment, we can formulate the following implications. First, aid is important for many African economics, but aid should focus on quality rather than massive quantity. Both donors and recipients should strengthen macroeconomic management of aid recipient countries for a higher return of aid. Most donors have already taken this route and our study suggests that such policies should be pursued. An interesting future research would be to analyse the effect of this conditional aid on improving macroeconomics environment Africa.

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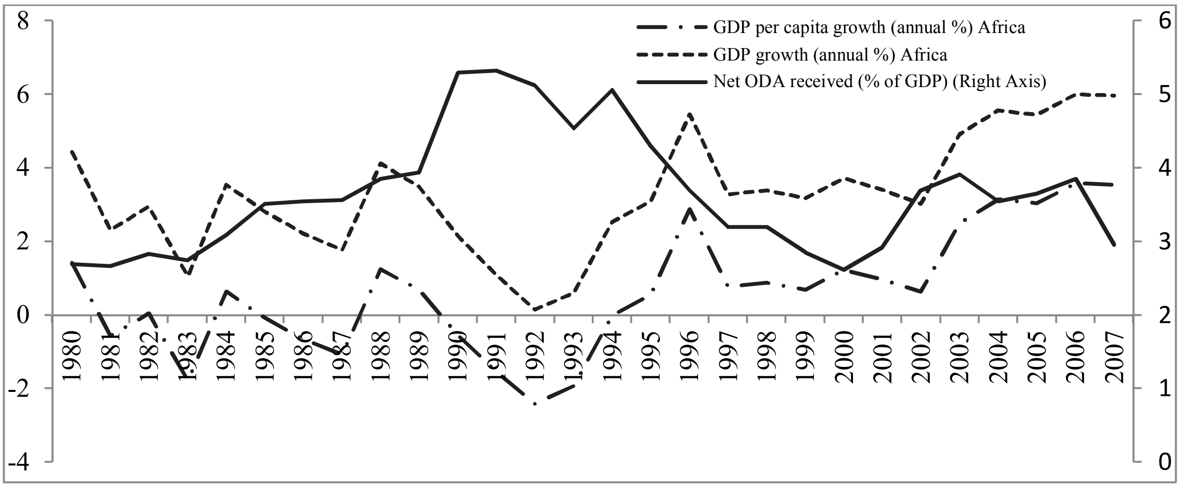
Appendix

Appendix Figure A1: GDP per capita growth and GDP growth in Africa



Source: Authors' computation based on WDI (2012) data.

Appendix Table A1: List of countries include in the analysis

Algeria	Benin	Botswana	Burkina Faso	Burundi	Cameroon	Chad
Cote d'Ivoire	Egypt	Ethiopia	Gabon	Gambia, The	Ghana	Kenya
Lesotho	Madagascar Nigeria	Mali	Mauritius	Morocco	Nigea	
Rwanda	Senegal Tunisia Uganda	Sierra Leone Zambia	Sudan	Swaziland	Togo	

Source: Authors' own construct.

Appendix Table A2: Aid-growth regressions with polynomial term with ODA (2SLS fixed-effect and GMM IV fixed-effect)

Dep. = GDP growth/capita	(1) 2SLS a	(2) GMMIV a	(3) 2SLS b	(4) GMMIV b	(5) 2SLS c	(6) GMMIV c	(7) 2SLS d	(8) GMMIV d
ODA/GDP	-0.37	0.45	-0.04	0.03	-0.19	-0.07	0.18	0.48*
	(0.98)	(0.38)	(0.32)	(0.24)	(0.40)	(0.29)	(0.44)	(0.27)
ODA/GDP squared	1.72	-0.87	0.51	0.01	0.72	0.25	0.61	-0.32
	(3.01)	(0.93)	(0.81)	(0.52)	(0.96)	(0.64)	(1.32)	(0.79)
Log initial GDP/capita	-3.92	-1.50	-3.94**	-4.12**	-4.84**	-4.45**	-18.02***	-19.62***
	(2.86)	(2.49)	(1.94)	(1.88)	(2.02)	(2.09)	(2.33)	(2.00)
Log lagged M2/GDP	-0.40	-1.21	-0.54	-0.45	0.05	-0.15	-1.62	-0.76
	(1.62)	(1.14)	(1.08)	(0.97)	(1.16)	(1.00)	(2.34)	(1.59)
Log (1+inflation)	-5.16	-2.17			-4.47	-5.13**	14.19	5.89
	(4.73)	(2.88)			(2.74)	(2.53)	(16.63)	(9.41)
Log trade openness			1.79	2.75**	2.22*	2.15*	2.29	3.72***
			(1.39)	(1.30)	(1.30)	(1.24)	(1.72)	(1.12)
Budget							-0.10	-0.19**
							(0.10)	(0.09)
Observations	180	180	180	180	180	180	32	32
R-squared	0.302	0.306	0.249	0.362	0.302	0.369	0.838	0.812
Shea Partial R2	0.022	0.163	0.124	0.154	0.107	0.144	0.998	0.998
No. of countries	30	30	30	30	30	30	11	11
F-Stat	2.111**	6.208 ***	5.500***	6.600***	5.334****	6.288***	11.660***	42.720***
P Endog	0.125	0.767	0.239	0.880	0.537	0.664	0.806	0.806
P Hansen J	0.671	0.0970	0.203	0.0272	0.0743	0.0244	0.319	0.319
P Weak IV	0.968	0.001	0.023	0.001	0.177	0.009	0.000	0.000

Note: Number of 4-yr time periods is 7 (1980–2007); All standard errors (in parentheses) are robust; *** p<0.01, ** p<0.05, * p<0.1. Constant and time dummies are included in all regressions. In each regression, instruments include lag: of aid, of aid squared, of the policy variable in the specification and its interaction with aid, initial income and population. 2SLS stands for IV-two stages least square and GMMIV stands for two step GMM-IV. Shea Partial R2 is the adjusted R2 of the first regressions. P Endog stands for p-value for endogeneity test, P Hansen J stand for p-value of the Sargan-Hansen over-identification test and P Weak IV stands for the p-value for weak identification test.

Source: See text.

Appendix Table A3: Aid-growth regressions with polynomial term with ODA (GMMDIFF and GMMSYS)

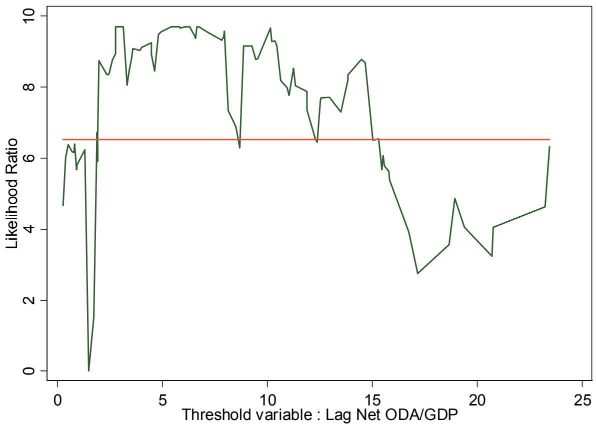
Dep. = GDP growth /capita	(1) GMM DIFF a	(2) GMM SYS a	(3) GMM DIFF b	(4) GMM SYS b	(5) GMM DIFF c	(6) GMM SYS c	(7) GMM DIFF d	(8) GMM SYS d
ODA/GDP	-0.10	0.04	0.05	-0.07	0.01	-0.11	0.73**	0.18
	(0.20)	(0.20)	(0.31)	(0.17)	(0.24)	(0.21)	(0.34)	(0.27)
ODA/GDP squared	0.24	-0.06	-0.15	0.14	-0.06	0.26	-1.14*	0.04
	(0.50)	(0.51)	(0.60)	(0.39)	(0.55)	(0.49)	(0.63)	(0.88)
Log initial GDP/capita	-6.36**	0.70	-3.75	0.31	-6.41**	0.47	-8.78	2.46
	(2.55)	(0.87)	(3.23)	(0.97)	(2.69)	(0.88)	(6.76)	(1.74)
Log lagged M2/GDP	-0.18	0.34	-0.27	-0.44	-1.02	0.09	-4.35	-0.93
	(1.53)	(1.72)	(1.39)	(1.25)	(2.23)	(1.30)	(3.22)	(3.94)
Log (1+Inflation)	-3.23	0.64			-2.19	0.37	-29.99*	-1.19
	(5.43)	(5.54)			(7.06)	(5.01)	(17.07)	(23.77)
Log trade openness			4.35	0.59	3.22	0.02	5.99	0.50
			(5.49)	(1.88)	(3.21)	(1.60)	(5.03)	(2.07)
Budget							-0.07	0.12
							(0.18)	(0.19)
Constant		-5.77		-3.13		-3.23		-12.75*
		(5.64)		(8.15)		(6.84)		(7.32)
Observations	180	210	180	210	180	210	42	69
No. of countries	30	30	30	30	30	30	21	27
WaldChi2	298.9***	92.96***	175.1***	100.6***	490.6***	126.4***	161.8***	38.13***
P Hansen J	0.999	1	1.000	1	1.000	1	1.000	1
P Sargan	0.372	0.00605	0.0778	0.00197	0.0252	0.000371	0.145	0.205
P AR2	0.0242	0.0253	0.0283	0.0226	0.0417	0.0248	0.259	0.360

Notes: Number of 4-yr time periods is 7 (1980–2007); All standard errors (reported in parentheses) are Windmeijer (2005) two-step GMM estimators bias-corrected (WC);*** p<0.01, ** p<0.05, * p<0.1. Constant and time dummies are included in all regressions. In each regression, instruments include lag of order 2 to 7 of explanatory variables. GMMDIFF stands for two steps GMM difference and GMM stands for two steps GMM-system. P Endog stands for p-value for endogeneity test, P Hansen J stand for p-value of the Sargan-Hansen test of over-identification restrictions (robust, but weakened by many instruments). P Sargan stands the Sargan test of over-identification restrictions (Not robust, but not weakened by many instruments). P AR2 stands for Arellano-Bond test for AR (2) in first differences.

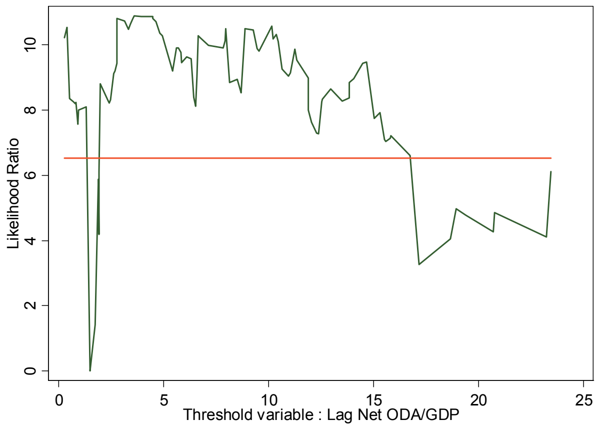
Source: See text.

Appendix Figure A2: Representation of the likelihood and the confidence interval in single threshold: lagged ODA/GDP

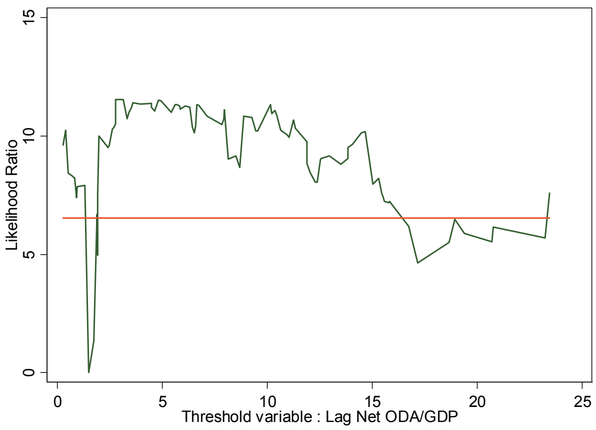
Model (1)



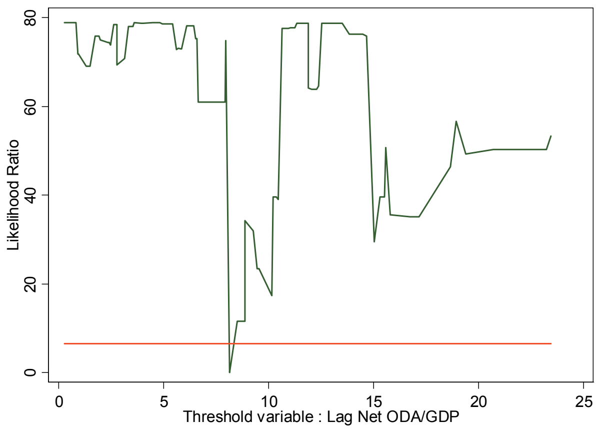
Model (2)



Model (3)



Model (4)



Source : Computed by authors based on data WDI (2012).

Appendix Table A4: Aid-growth regressions with double threshold effect (threshold variable: lag ODA/GDP)

	(1)	(2)	(3)	(4)
Variables	FE-OLS	FE-OLS	FE-OLS	FE-OLS
ODA/GDP with ODA_1 ≤ γ_1	1.34***	1.28***	1.29***	0.34**
	(0.34)	(0.46)	(0.41)	(0.15)
γ_1 ≤ODA/GDP with ODA_1 ≤ γ_1	-0.02	-0.07**	-0.06**	-0.00
	(0.03)	(0.03)	(0.03)	(0.08)
ODA/GDP with ODA_1> γ_2	0.05	-0.00	0.01	0.09
	(0.04)	(0.05)	(0.05)	(0.10)
Log initial GDP per capita (constant 2000)	-4.25***	-4.59***	-4.60***	-11.19***
	(0.99)	(0.81)	(0.74)	(2.80)
Log lagged money and quasi money (M2)/GDP	0.66	0.30	0.32	-2.53
	(1.10)	(0.98)	(0.98)	(1.87)
Log 1+ average inflation			-3.63**	-19.64**
			(1.76)	(7.93)
Log average trade openness	-5.45***	4.28***	3.91***	7.23**
	(1.49)	(0.74)	(0.87)	(2.69)
Average Budget deficit/surplus				0.08
				(0.11)
Constant	24.05***	9.74*	11.65*	50.28**
	(4.88)	(5.71)	(5.82)	(19.74)
Observations	210	210	210	69
No. of countries	30	30	30	27
R-squared	0.374	0.452	0.470	0.741
F	39.49	77.07	87.90	106.0
Corr (U,Xb)	-0.869	-0.814	-0.814	-0.963

Note: Number of 4-yr time periods is 7 (1980–2007); All standard errors (in parentheses) are robust; *** p<0.01, ** p<0.05, * p<0.1; Constant and 4year period time dummies are included in all regressions:

Source: See text.

Table A5: Aid-growth regressions with polynomial term with inflation (2SLS fixed-effect and GMM IV fixed-effect)

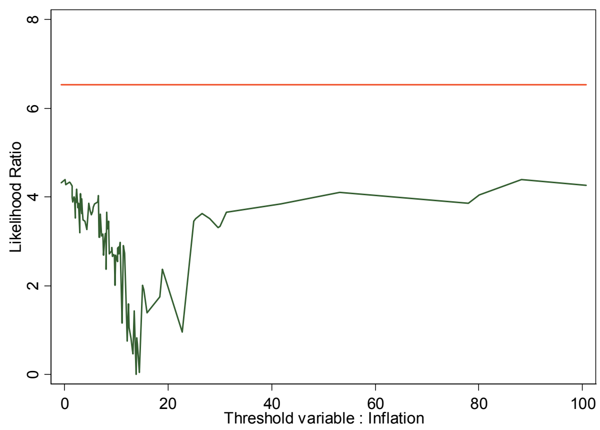
Dep. = GDP growth/capita	(1) 2SLS a	(2) GMMIV a	(3) 2SLS b	(4) GMMIV b	(5) 2SLS c	(6) GMMIV c	(7) 2SLS d	(8) GMMIV d
ODA/GDP	0.17	0.05	0.20*	0.11	0.20**	0.20**	0.43***	0.46***
	(0.14)	(0.09)	(0.11)	(0.08)	(0.10)	(0.08)	(0.08)	(0.07)
ODA/GDP X inflation	0.04	0.07	-0.45**	-0.14	-0.62*	-0.50*	-0.45	-1.03**
	(0.53)	(0.33)	(0.23)	(0.17)	(0.35)	(0.30)	(0.68)	(0.52)
Log initial GDP/capita	-3.13	-3.96***	-2.75*	-3.79***	-2.70	-2.61**	-17.07***	-16.08***
	(2.21)	(1.50)	(1.55)	(1.24)	(1.65)	(1.30)	(3.18)	(2.41)
Log lagged M2/GDP	-0.61	-0.29	-0.92	-0.82	-1.06	-1.38*	-2.04	-2.43
	(1.13)	(0.88)	(0.98)	(0.90)	(0.92)	(0.78)	(2.54)	(1.57)
Log (1+inflation)	-3.65	-5.75			4.21	5.82	15.21*	21.05***
	(6.46)	(4.41)			(4.68)	(3.93)	(9.06)	(6.80)
Log trade openness			2.01	2.42*	2.47*	2.33*	1.95	2.52**
			(1.39)	(1.25)	(1.35)	(1.20)	(1.70)	(1.18)
Budget							-0.10	-0.08
							(0.09)	(0.07)
Observations	180	180	180	180	180	180	32	32
R-squared	0.292	0.330	0.367	0.378	0.371	0.359	0.835	0.819
Shea Part R2A	0.149	0.208	0.188	0.316	0.267	0.384	0.989	0.989
Shea Part R2B	0.153	0.156	0.218	0.233	0.306	0.309	1.000	1.000
No. of countries	30	30	30	30	30	30	11	11
F-Stat	5.50***	7.48***	6.89***	7.16***	6.30***	6.73***	12.76***	63.53***
P Endog	0.380	0.547	0.753	0.649	0.395	0.394	0.750	0.750
P Hansen J	0.137	0.0849	0.106	0.103	0.143	0.259	0.387	0.387
P Weak IV	0.009	0.002	0.001	0.000	0.001	0.000	0.000	0.000

Note: Number of 4-yr time periods is 7 (1980–2007); All standard errors (in parentheses) are robust; *** p<0.01, ** p<0.05, * p<0.1. Constant and time dummies are included in all regressions. In each regression, instruments include lag of aid, lag of aid squared, the lag of the policy variable in the specification and its interaction with aid, initial income and population. 2SLS stands for IV-two stages least square and GMMIV stands for two step GMM-IV. Shea Partial R2 is the adjusted R2 of the first regressions. P Endog stands for p-value for endogeneity test, P Hansen J stand for p-value of the Sargan-Hansen over-identification test and P Weak IV stands for the p-value for weak identification test.

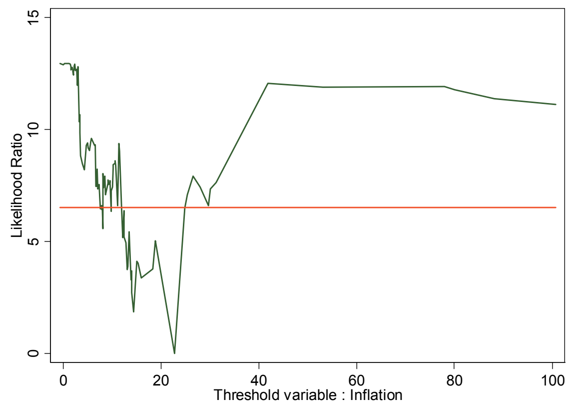
Source: See text.

Appendix Figure A3: Representation of the likelihood and the confidence interval in a single threshold: inflation

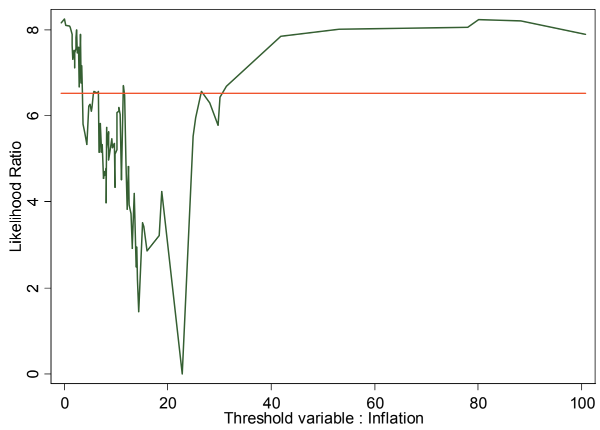
Model (1)



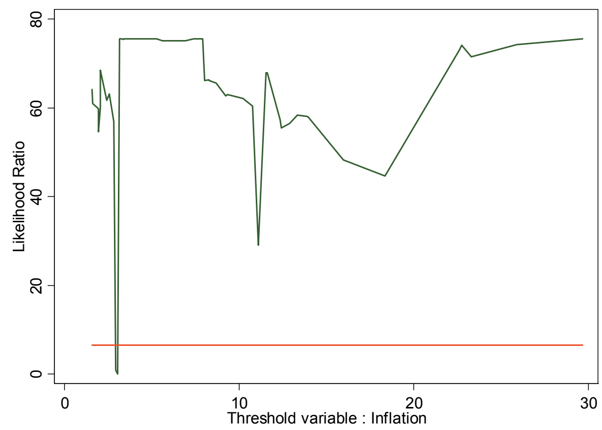
Model (2)



Model (3)



Model (4)



Source: Computed by authors based on data WDI (2012).

Appendix Table A6: Aid-growth regressions with polynomial term with inflation (GMMDIFF and GMMSYS)

Dep. = GDP growth /capita	(1) GMM DIFF a	(2) GMM SYS a	(3) GMM DIFF b	(4) GMM SYS b	(5) GMM DIFF c	(6) GMM SYS c	(7) GMM DIFF d	(8) GMM SYS d
ODA/GDP	0.13	0.14*	0.13	0.04	0.04	0.12	0.45**	0.51**
	(0.09)	(0.08)	(0.12)	(0.08)	(0.20)	(0.08)	(0.19)	(0.21)
ODA/GDP X inflation	-0.23	-0.68	-0.46**	-0.22	-0.13	-0.55	-0.98	-2.13
	(0.24)	(0.44)	(0.19)	(0.24)	(0.33)	(0.47)	(1.54)	(2.19)
Log initial GDP/capita	-2.61	1.86**	-4.12	0.81	-4.94*	1.49**	-9.93*	2.95
	(2.29)	(0.80)	(2.57)	(1.06)	(2.92)	(0.70)	(5.51)	(1.85)
Log lagged M2/GDP	-0.61	-2.37	-0.06	-0.14	-0.08	-1.15	-3.91	1.01
	(1.68)	(1.91)	(1.02)	(1.65)	(1.26)	(2.10)	(3.58)	(3.76)
Log (1+inflation)	-3.10	5.64			-3.79	5.94	0.27	15.92
	(4.12)	(6.38)			(5.03)	(5.45)	(25.37)	(38.91)
Log trade openness			1.94	0.24	3.45	0.02	1.29	0.99
			(4.21)	(1.58)	(7.63)	(1.20)	(4.99)	(1.87)
Budget							-0.04	-0.04
							(0.22)	(0.16)
Constant		-4.89		-6.09		-6.84		-27.26**
		(3.88)		(6.97)		(6.06)		(12.01)
Observations	180	210	180	210	180	210	42	69
No. of countries	30	30	30	30	30	30	21	27
WaldChi2	176.0***	96.13***	221.3***	79.89***	220.6***	142.4***	291.4***	39.72***
P Hansen J	0.999	1	1.000	1	1.000	1	0.996	1
P Sargan	0.0753	0.0211	0.0508	0.000653	0.0187	0.00393	0.139	0.0691
P AR2	0.0553	0.0839	0.0376	0.0242	0.0723	0.0641	0.640	0.300

Note: Number of 4-yr time periods is 7 (1980–2007); All standard errors (in parentheses) are Windmeijer (2005) two-step GMM estimators bias-corrected (WC);*** p<0.01, ** p<0.05, * p<0.1. Constant and time dummies are included in all regressions. In each regression, instruments include lag of order 2 to 7 of explanatory variables. GMMDIFF stands for two steps GMM Difference and GMM stands for two steps GMM-System. P Endog stands for p-value for endogeneity test, P Hansen J stand for p-value of the Sargan-Hansen test of over-identification restrictions (robust, but weakened by many instruments). P Sargan stands the Sargan test of over-identification restrictions (not robust, but not weakened by many instruments). P AR2 stands for Arellano-Bond test for AR (2) in first differences.

Source: See text.

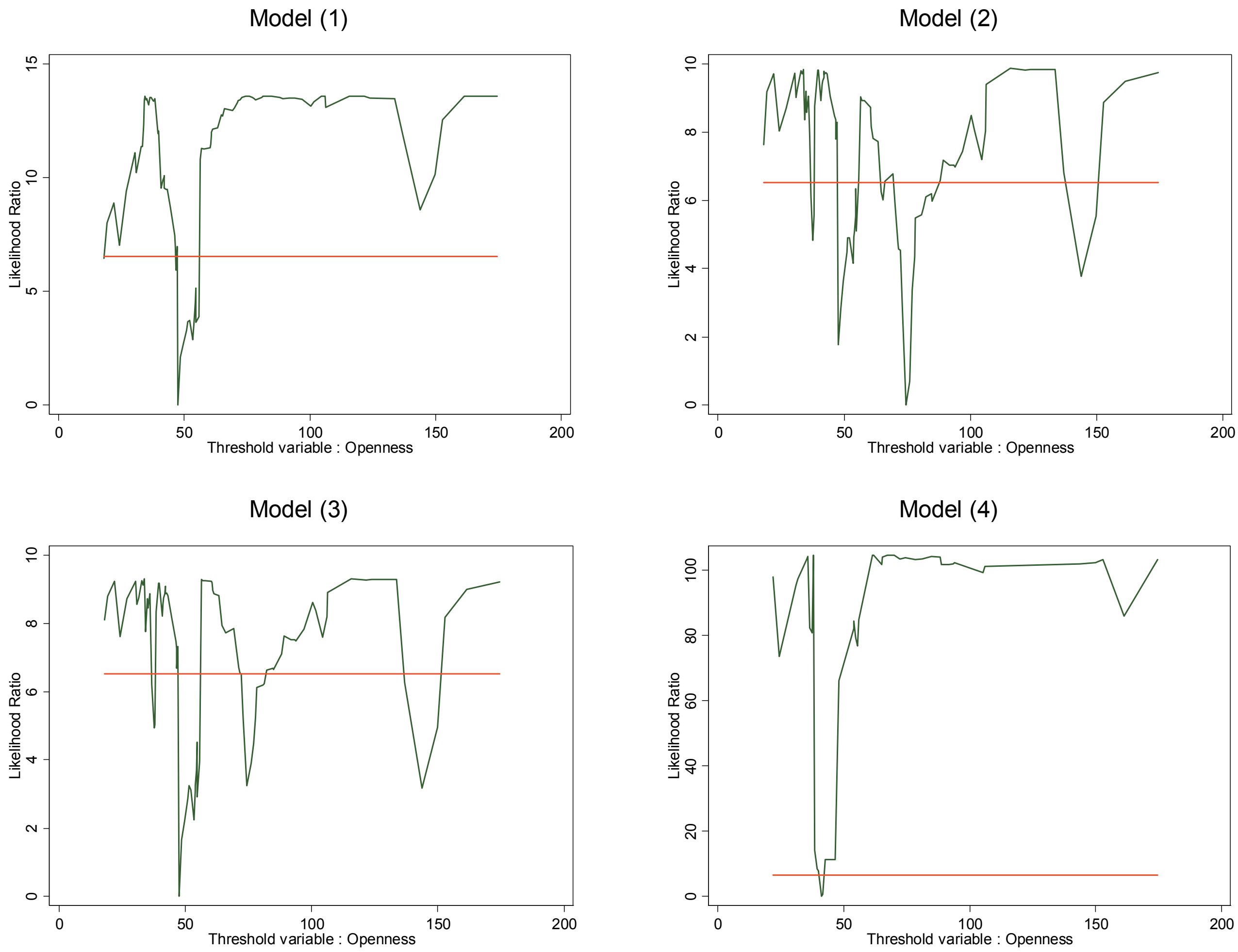
Appendix Table A7: Aid-growth regressions with polynomial term with openness (2SLS fixed-effect and GMM IV fixed-effect)

Dep. =	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP growth/capita	2SLS a	GMMIV a	2SLS b	GMMIV b	2SLS c	GMMIV c	2SLS d	GMMIV d
ODA/GDP	-0.26	-0.11	-0.00	0.04	-0.15	0.14	-0.50*	-0.40*
	(0.63)	(0.41)	(0.66)	(0.41)	(0.60)	(0.38)	(0.29)	(0.23)
ODA/GDP X openness	0.08	0.03	0.04	0.00	0.06	-0.02	0.21***	0.18***
	(0.12)	(0.08)	(0.14)	(0.09)	(0.13)	(0.09)	(0.07)	(0.06)
Log initial GDP/capita	-3.89*	-4.98***	-3.43**	-4.44***	-3.93***	-4.16***	-17.18***	-16.66***
	(2.07)	(1.31)	(1.64)	(1.27)	(1.52)	(1.17)	(2.29)	(1.99)
Log lagged M2/GDP	-0.27	0.13	-0.77	-0.64	-0.41	-0.31	-3.68	-3.82***
	(1.10)	(0.84)	(0.98)	(0.87)	(0.93)	(0.82)	(2.40)	(1.17)
Log (1+inflation)	-3.99*	-4.65***			-3.51*	-4.01**	6.34	4.04
	(2.17)	(1.70)			(2.00)	(1.73)	(5.65)	(3.05)
Log trade openness			1.59	2.69**	1.74	2.57**	1.46	1.04
			(1.51)	(1.33)	(1.51)	(1.31)	(1.78)	(1.24)
Budget							-0.14*	-0.21***
							(0.08)	(0.06)
Observations	180	180	180	180	180	180	32	32
R-squared	0.355	0.341	0.320	0.362	0.369	0.382	0.853	0.839
Shea Part R2 A	0.167	0.419	0.180	0.358	0.236	0.413	0.990	0.990
Shea Part R2 B	0.228	0.444	0.214	0.362	0.268	0.412	0.990	0.990
No. of countries	30	30	30	30	30	30	11	11
F-Stat	6.786***	7.183***	6.202***	6.579***	6.148***	6.645***	16.66***	67.17***
P Endog	0.971	0.620	0.569	0.895	0.661	0.935	0.985	0.985
P Hansen J	0.408	0.409	0.125	0.0837	0.0379	0.0717	0.365	0.365
P Weak IV	0.159	0.000	0.0157	0.000	0.004	0.000	0.000	0.000

Note: Number of 4-yr time periods is 7 (1980– 2007); All standard errors (in parentheses) are robust; *** p<0.01, ** p<0.05, * p<0.1. Constant and time dummies are included in all regressions. In each regression, instruments include lag of aid, lag of aid squared, the lag of the policy variable in the specification and its interaction with aid, initial income and population. 2SLS stands for IV-two stages least square and GMMIV stands for two step GMM-IV. Shea Partial R2 is the adjusted R2 of the first regressions. P Endog stands for p-value for endogeneity test, P Hansen J stand for p-value of the Sargan-Hansen over-identification test and P Weak IV stands for the p-value for weak identification test.

Source. See text.

Appendix Figure A4: Representation of the likelihood and the confidence interval in single threshold: lagged openness



Source: Computed by authors based on data WDI (2012).

Appendix Table A8: Aid-Growth regressions with polynomial term with openness (GMMDIFF and GMMSYS)

Dep. = GDP growth /capita	(1) GMM DIFF a	(2) GMM SYS a	(3) GMM DIFF b	(4) GMM SYS b	(5) GMM DIFF c	(6) GMM SYS c	(7) GMM DIFF d	(8) GMM SYS d
ODA/GDP	-0.22	-0.06	-0.26	0.22	0.03	-0.15	-0.76	-0.06
	(0.31)	(0.25)	(0.44)	(0.29)	(0.30)	(0.44)	(0.88)	(0.64)
ODA/GDP X openness	0.06	0.02	0.06	-0.05	-0.00	0.04	0.22	0.06
	(0.07)	(0.05)	(0.11)	(0.07)	(0.07)	(0.11)	(0.21)	(0.16)
Log initial GDP/capita	-7.23***	0.63	-2.93	0.28	-6.55**	0.74	-7.66	1.39
	(2.31)	(0.62)	(3.11)	(0.60)	(2.54)	(1.09)	(5.81)	(1.34)
Log lagged M2/GDP	0.39	0.25	-0.79	0.37	-0.28	0.35	-3.33	1.04
	(1.63)	(0.74)	(1.44)	(0.72)	(1.44)	(1.07)	(3.92)	(1.41)
Log (1+inflation)	-4.42	-0.44			-1.63	-1.96	-18.72**	-1.62
	(4.07)	(2.61)			(4.60)	(7.83)	(8.62)	(16.79)
Log trade openness			3.94*	1.21	3.22	-0.80	3.12	-0.25
			(2.19)	(1.03)	(2.02)	(2.79)	(3.76)	(1.90)
Budget							0.07	0.16
							(0.17)	(0.12)
Constant		-4.97		-8.14*		-2.35		-9.73
		(3.72)		(4.47)		(9.16)		(6.73)
Observations	180	210	180	210	180	210	42	69
No. of countries	30	30	30	30	30	30	21	27
WaldChi2	135.0***	89.32***	302.2***	84.83***	330.7***	70.90***	121.5***	42.38***
P Hansen J	0.998	1.000	1.000	1	1.000	1	0.998	1
P Sargan	0.311	0.000350	0.0406	0.00302	0.0241	4.55e-05	0.111	0.228
P AR2	0.0320	0.0167	0.0141	0.0205	0.0400	0.0159	0.268	0.326

Note: Number of 4-yr time periods is 7 (1980– 2007); All standard errors (in parentheses) are Windmeijer (2005) two-step GMM estimators bias-corrected (WC);*** p<0.01, ** p<0.05, * p<0.1. Constant and time dummies are included in all regressions. In each regression, instruments include lag of order 2 to 7 of explanatory variables. GMMDIFF stands for two steps GMM difference and GMM stands for two steps GMM-system. P Endog stands for p-value for endogeneity test, P Hansen J stand for p-value of the Sargan-Hansen test of over-identification restrictions (robust, but weakened by many instruments). P Sargan stands the Sargan test of over-identification restrictions (not robust, but not weakened by many instruments). P AR2 stands for Arellano-Bond test for AR (2) in first differences.

Source: See text.

Appendix Table A9: Aid-Growth regressions with polynomial term with deficit/Surplus (2SLS fixed-effect and GMM IV fixed-effect)

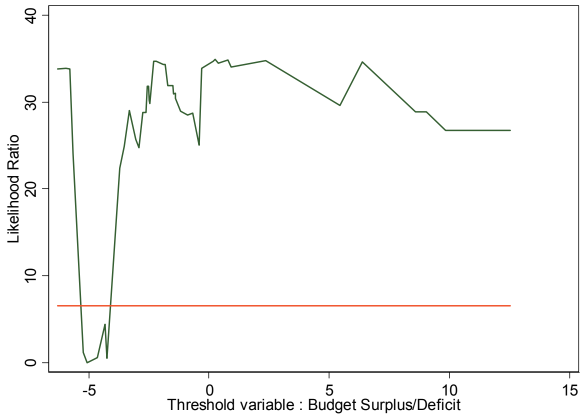
Dep. =	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP growth /capita	2SLS a	GMMIV a	2SLS b	GMMIV b	2SLS c	GMMIV c	2SLS d	GMMIV d
ODA/GDP	0.40***	0.48***	0.15	0.26***	0.35***	0.32***	0.36***	0.32***
	(0.14)	(0.07)	(0.14)	(0.09)	(0.08)	(0.07)	(0.08)	(0.07)
ODA/GDP X budget	-0.01	-0.00	0.01	0.04**	-0.01	-0.01**	-0.01	-0.01
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Log initial GDP/capita	-17.07***	-18.79***	-13.09***	-12.05***	-17.33***	-17.73***	-17.64***	-18.00***
	(2.66)	(2.17)	(3.33)	(2.89)	(2.41)	(1.96)	(2.54)	(2.11)
Log lagged M2/GDP	-0.70	-0.74	-3.00	-4.33*	-1.06	-1.05	-1.23	-1.02
	(2.67)	(1.43)	(2.89)	(2.38)	(2.59)	(1.72)	(2.66)	(1.64)
Log (1+inflation)	12.35*	11.75***			10.81	13.16***	10.20	11.17***
	(6.62)	(4.21)			(6.61)	(2.84)	(7.94)	(3.49)
Log trade openness			5.99*	5.68***	2.01	2.91**	2.06	3.05**
			(3.30)	(2.08)	(1.63)	(1.19)	(1.80)	(1.20)
Budget							-0.07	-0.09
							(0.13)	(0.10)
Observations	32	32	63	63	32	32	32	32
R-squared	0.826	0.814	0.654	0.564	0.831	0.818	0.835	0.822
Partial R2 A	0.549	0.586	0.335	0.505	0.923	0.962	0.975	0.975
Partial R2 B	0.724	0.747	0.437	0.498	0.909	0.934	0.990	0.990
No. of countries	11	11	21	21	11	11	11	11
F-Stat	17.69***	222.3***	10.00***	11.38***	15.30***	31.79***	12.61***	31.65***
P Endog	0.136	0.311	0.551	0.452	0.798	0.993	0.810	0.810
P Hansen J	0.327	0.255	0.289	0.223	0.164	0.267	0.198	0.198
P Weak IV	0.011	0.019	0.074	0.000	0.000	0.000	0.000	0.000

Note: Number of 4-yr time periods is 7 (1980– 2007); All standard errors (in parentheses) are robust; *** p<0.01, ** p<0.05, * p<0.1. Constant and time dummies are included in all regressions. In each regression, instruments include lag of aid, lag of aid squared, the lag of the policy variable in the specification and its interaction with aid, initial income and population. 2SLS stands for IV-two stages least square and GMMIV stands for two step GMM-IV. Shea Partial R2 is the adjusted R2 of the first regressions. P Endog stands for p-value for endogeneity test, P Hansen J stand for p-value of the Sargan-Hansen over-identification test and P Weak IV stands for the p-value for weak identification test.

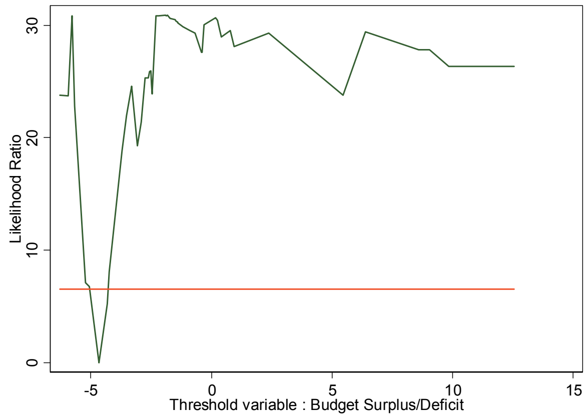
Source: See text.

Figure A5: Representation of the likelihood and the confidence interval in single threshold: budget deficit/surplus

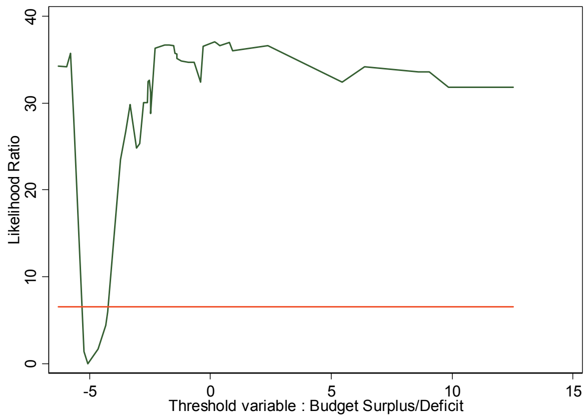
Model (1)



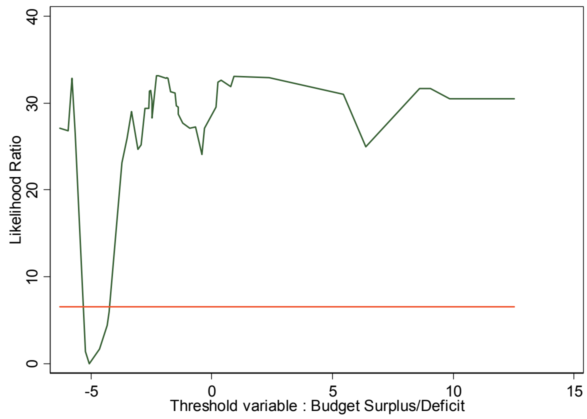
Model (2)



Model (3)



Model (4)



Source: Computed by authors based on data WDI (2012).

Appendix Table A10: Aid-growth regressions with polynomial term with budget deficit/surplus (GMMDIFF and GMMSYS)

Dep. =GDP growth /capita	(1) GMM DIFF a	(2) GMM SYS a	(3) GMM DIFF b	(4) GMM SYS b	(5) GMM DIFF c	(6) GMM SYS c	(7) GMM DIFF d	(8) GMM SYS d
ODA/GDP	0.29***	0.15	0.33**	0.18***	0.26**	0.18**	0.26**	0.10
	(0.07)	(0.09)	(0.14)	(0.07)	(0.11)	(0.07)	(0.11)	(0.10)
ODA/GDP X budget deficit	0.00	-0.00	0.00	-0.01	-0.00	-0.00	0.00	-0.02*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Log initial GDP/capita	-16.88***	0.91	-15.92**	1.84	-12.12**	2.01	-13.06**	0.92
	(5.59)	(2.22)	(6.58)	(1.68)	(5.51)	(2.21)	(5.96)	(1.56)
Log lagged M2/GDP	-2.03	2.11	-3.76	1.58	-1.58	1.16	-1.41	2.08
	(2.93)	(2.73)	(2.91)	(2.73)	(1.86)	(3.86)	(2.08)	(1.34)
Log (1+inflation)	-13.16*	7.92			-19.01**	-1.79	-18.57**	1.07
	(7.85)	(15.98)			(9.69)	(11.20)	(9.28)	(13.31)
Log trade openness			0.61	0.50	1.84	0.55	1.85	0.07
			(5.35)	(0.89)	(4.02)	(0.95)	(4.25)	(1.15)
Budget							-0.09	0.36*
							(0.22)	(0.21)
Constant		-12.10*		-17.84**		-17.44**		-11.25*
		(6.34)		(8.13)		(7.57)		(6.71)
Observations	42	69	42	69	42	69	42	69
No. of countries	21	27	21	27	21	27	21	27
WaldChi2	280.6***	35.58***	213.7***	33.81***	140.5***	46.41***	128.4***	34.61***
P Hansen J	1.000	1.000	0.999	1	1.000	1	1.000	1.000
P Sargan	0.0685	0.136	0.192	0.159	0.126	0.164	0.103	0.141
P AR2	0.841	0.346	0.889	0.301	0.292	0.303	0.247	0.540

Note: Number of 4-yr time periods is 7 (1980– 2007); All standard errors (in parentheses) are Windmeijer (2005) two-step GMM estimators bias-corrected (WC);*** p<0.01, ** p<0.05, * p<0.1. Constant and time dummies are included in all regressions. In each regression instruments include lag of order 2 to 7 of explanatory variables. GMMDIFF stands for two steps GMM difference and GMM stands for two steps GMM-system. P Endog stands for p-value for endogeneity test, P Hansen J stand for p-value of the Sargan-Hansen test of over-identification restrictions (robust, but weakened by many instruments). P Sargan stands the Sargan test of over-identification restrictions (not robust, but not weakened by many instruments). P AR2 stands for Arellano-Bond test for AR (2) in first differences.

Source: See text.