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Aid, Growth, and Non-Military Expenditures: Applying a Two-Way Fixed Effects Model with Robust Clustered Errors

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Abstract

Current research on the effect of foreign aid on economic growth yields mixed results. Several papers and meta studies conclude that aid has a significant positive growth effect, while others conclude that aid has a non-significant or zero growth effect. More recent research has focused on testing interaction terms that show the conditional positive effect of aid. To test these results, we apply a dynamic two-way fixed effects model with robust clustered errors. First we test the pure effect of aid on growth. Then we test non-military expenditures interacted with aid. We find both the pure and interacted effects to be positive, but neither the pure effect of aid on growth nor the interaction term is significant.

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Introduction

Foreign Aid

Foreign aid is a common method used by developed countries to improve the economic conditions and growth rates of less-developed countries (LDCs). Consequently, determining the effects of foreign aid on LDC economies is both pressing and crucial for economists and policy makers. If foreign aid does not have a significant positive impact, then developed countries providing foreign aid would be well served to reexamine their aid policies. If foreign aid is shown to directly improve LDC economies, then developed countries may find it in their interests to expand existing foreign aid expenditures. In a complex world, it is also possible that foreign aid acts to lubricate existing systems, enhancing both positive and negative outcomes. In that case, policy makers will have to use even greater scrutiny before allocating their aid dollars.

Current Research

There is an abundance of research addressing the relationship between foreign aid and economic growth. There are two dominant approaches to the question of aid effectiveness. First, early papers have attempted to identify the pure effect of aid on growth. This approach tests whether foreign aid has a direct effect on economic growth, controlling for all other growth-relevant factors. The second approach, in more recent literature, recognizes the overall mixed results from the early analyses and focuses on interaction terms that allow aid to have a positive effect. Analyses of interaction terms attempt to find variables that may moderate or condition the effect of aid on growth, like institutional arrangements or the presence of particular policies.

Pure Effects

Earlier meta studies have produced varying results. Doucouliagos and Paldam argue the effect has been insignificant, and as the amount of data and the number of estimates increase, the significance of the effect steadily declines. They conclude that after several decades of intense research, there is evidence that aid does not have any effect on growth (Doucouliagos and Paldam 2008).

Contrarily, Tseday Jemaneh Mekasha and Finn's meta study claims that when economic growth is used as an outcome indicator to assess aid effectiveness, the evidence shows that foreign aid, on average, has a positive and significant impact on economic growth (Mekasha and Tarp 2011).

Conflicting results of meta studies using the same dataset come from basic differences in meta-analysis. Specifically, methods of accounting for publication bias, which occurs if smaller studies report larger aid coefficients, lead to radically different results. Doucouliagos and Paldam employ a funnel asymmetry test to show that there is in fact publication bias in the study set they use (Doucouliagos and Paldam 2010). Managing publication bias and myriad other

methodological concerns can lead to meta studies with conflicting conclusions, as has been the case in the aid-growth meta study literature.

Modified Effects

Contrary to earlier papers, which focused on the pure effects of aid on growth, recent papers attempt to examine interaction terms that, when combined with foreign aid, lead to positive economic growth. The most cited subset of interaction-term papers uses a policy type index as an interaction term. The reason to use a policy type index is that foreign aid may improve economic growth when certain policies are in place, like limited trade barriers and controlled inflation rates. Absent of good policies, foreign aid may fail to realize positive economic growth.

Aid X Policy

Using a policy interaction, Craig Burnside and David Dollar find a positive and significant aid-growth effect when growth-promoting policies such as a weighted average of budget balance, inflation rate, and trade openness are in place, and a zero aid-growth effect when growth-prohibiting policies are in place (Burnside and Dollar 2000). Burnside and Dollar's analysis, however, suffers from simultaneity bias: In many cases, aid is distributed as a reward for effective policy implementation, rather than as a means to achieve effective policy. Since it is impossible to divide ex post and ex ante aid in current datasets, this issue is active in any regression using policy and aid as regressors. More simply, researchers cannot distinguish what aid was provided as a reward for growth and what aid was intended to spur growth, thus interfering with causal inference regarding total aid dollars.

Aid X Other Interactions

Several papers have tested non-policy interaction terms, including the following examples: Jakob Svensson's test of democracy (Svensson 1999), Patrick Guillaumont and Sylviane Guillaumont-Jeanneney's test of external vulnerability (Guillaumont and Guillaumont-Jeanneney 2001), Lisa Chauvet's test of political instability (Chauvet 2005), and Paul Collier and David Dollar's test of quality of institutions (Collier and Dollar 2002). Though some of the papers in this subset have identified positive growth effects from interaction terms, there is still a great deal of progress to be made in understanding the conditional impact of aid. Broadly defined terms like external vulnerability, political instability, and quality of institutions are difficult for aid-givers to measure and for policy makers to affect. For instance, improving the quality of institutions requires long-term, well-guided policies and investments. Additionally, once countries know what criteria are used to distribute aid, selection biases become prevalent as countries self-select toward different aid-rewarded development targets.

Methodology

To examine the effect of aid on growth, we use a two-way dynamic fixed effects model to test whether aid has a positive and significant pure effect (See Appendix 1). We then explore a possible interaction term that has short-term policy relevance: percent of government expenditures on non-military expenditures. We hope to accomplish two goals: First, to apply a current dataset and an untested model to explore the pure effect of aid on growth; and second, to test a previously untested interaction term that policy makers can easily modify.

Dataset

We used Bruce Bueno de Mesquita and Alastair Smith's Foreign Aid and Policy Concessions Dataset from the Journal of Conflict Resolution (Bueno de Mesquita and Smith 2007). We limited our dataset to 178 countries, all LDCs with total aid receipts greater than zero. Since we are only concerned with the effect of foreign aid receipts on the economic growth of LDCs, we only include aid recipient countries. We limit the years to 1960 through 2000 for two reasons: First, the creation of international finance and aid institutions like the IMF in 1944 and the World Bank in 1967 dramatically shifted the dynamics of foreign aid. Starting in 1960 allows us to analyze the modern era of foreign aid that began under Bretton Woods and has involved notable changes in the institutions moderating foreign aid and the amount of total aid transferred. Second, data for years prior to 1960 in our dataset include a critical amount of missing values in both observations and in countries that had not yet formed.

Measures of Growth

We use foreign economic aid receipts per capita from all contributing countries to represent foreign aid, and Gross Domestic Product (GDP) growth as a proxy for economic growth. There are many categories of foreign aid, including contingency packages, military aid, economic aid, disaster relief, and several others, but no dataset we found had aid divided between military and economic types. Identifying the specific aid categories may yield additional insight into the effect of aid, but the lines separating categories are often blurred in intent and even further muddled during implementation. For instance, it is nearly impossible to know what percent of aid intended for economic assistance is used for economic policies as opposed to bureaucratic waste or political payoffs. Due to the lack of data and unclear real-world distinction, we chose to use economic aid per capita as our measure of total aid. Per capita total aid was chosen to standardize aid by population and make interpretation of regression results directly interpretable. GDP growth is used as a proxy for economic growth. GDP was chosen over other indicators, like the Human Development Index (HDI), because of the prevalent use of GDP in related literature.

Regressors

The variables of interest in our dataset are GDP growth, foreign aid per capita, lagged GDP growth, regime type, and government crises. GDP growth and foreign aid per capita are World Bank data, set in current U.S. dollars. Regime type is categorical with 1 defined as the baseline, 2 defined as a civilian regime, 3 defined as a civilian-military regime, and 4 defined as a military regime. The government crises variable is an aggregate world-polity metric that measures the frequency of events in a given year that notably challenged an existing government. Crisis events range from attempted coups to interstate wars.

Issues

Two of our control variables (regime type and government crises) are difficult to categorize precisely. For instance, labeling a country that is either a military regime or a civilian-military regime may require normative judgments that in some cases are inconsistent with labels applied to other countries. Second, instances of missing data may be related to aid received. There may be theoretical endogeneity issues between countries refusing to report statistics to the World Bank and IMF and refusal or lack of foreign aid. Furthermore, the aid itself may come with reporting requirements and thereby result in better data on aid recipient countries.

Pure Effect of Aid on Growth

Our dataset is cross sectional time series (CSTS) panel data with country panels and year-level time series. This type of data is most commonly analyzed in the literature using fixed effects or random effects models. Suppose applying the pooled Ordinary Least Squares (OLS) method is unreasonable because the error term includes an unobserved variable of individual characteristics:

$$y_{it} = X_{it}\beta + u_{it} \text{ where } u_{it} = \alpha_i + \varepsilon_{it}$$

In this case, α is the individual's unobserved effect. Due to the existence of α , there is omitted variable bias across time periods. Thus, the general form of the regression is:

$$y_{it} = \beta_0 + X_{it}\beta + \alpha_i + u_{it},$$

This model can be approached two ways.

Random Effects: Used in the case where α is independent of $X_{it}\beta$ (this is the same as $E(\alpha_i | X_{it}\beta) = 0$). In other words, the omitted α varies between panels and has a zero expectation. In the random specification, one is typically interested in the between-panel variances.

Fixed Effects: There is no assumption of independence. In this case, no inference about a larger population can be made as only within-panel variance is examined. The results are specific to the panels used in the regression.

Two-Way Fixed Effects

Under two-way fixed effects, the error term takes the form:

$$u_{it} = \alpha_i + \nu_t + \varepsilon_{it}$$

A two-way model includes time invariant effects like temporal world shocks, and panel invariant effects such as country characteristics. With time-effects, the new model is:

$$y_{it} = \beta_0 + X_{it}\beta + \alpha_i + \nu_t + u_{it}$$

We use a Least-Squares Dummy Variable (LSDV) Model for two-way fixed effects. Doing so treats the unobserved effects of country and year as coefficients on the individual-specific dummy variables. We applied a Hausman specification test to distinguish between fixed and random effects; our results can be found Appendix 1.

LSDV Considerations

Within-Groups

An alternative two-way fixed effects approach is the within-groups model, which would center country and year by their means. Both models are consistent and efficient estimators of β s on non-dummy variables. Since we are not concerned with the individual country and year β s (which is not consistent under LSDV as $n \rightarrow \infty$), we chose LSDV because it is not necessary to transform the standard errors like it is using within-groups. Additionally, we chose LSDV because it produces a correct R^2 , a correct Sum of Squared Errors, and correct standard errors on our variables of interest. Additional discussion of LSDV considerations related to basic panel models is in Appendix 2.

Dynamic

We specify our model as dynamic by incorporating one-year time-lag variables. We lag foreign aid per capita for many reasons. We lag to avoid reverse endogeneity with GDP growth. If taken in the same year, GDP growth may predict foreign aid, as countries realizing economic growth may attract greater aid allocations. We also lag to avoid endogeneity between aid and growth due to aid dollars actually being included in GDP calculations, particularly for LDCs where aid is often a non-trivial portion of GDP. Furthermore, we believe that aid programs are not instantly effective, thus foreign aid affects future GDP growth rather than causes simultaneous growth.

Robust Clustered Errors

It is reasonable to assume that there is stronger correlation within panels than between panels. As a result, OLS is consistent, but the standard errors are biased by over dispersion. A more robust error that takes intra-cluster correlation into account is necessary. Unlike the standard variance estimator, robust errors do not assume a log-likelihood distribution. Stata's implementation of clustered robust errors relies on continuous sampling to generate standard errors that are sensitive to the panel covariance. To cluster robust errors, the scores are summed in each cluster and each cluster is used as a data point to estimate the robust errors. Our data has natural clustering within country panels, so we chose robust errors clustered by country.

Nickell Bias

Dynamic models pose a potential problem of Nickell Bias, which occurs when having a small t causes correlations between the observed value and the mean. Specifically, each observation is by definition included in the mean, which can cause problems in small samples. Using LSDV introduces the possibility of Nickell bias:

$$\bar{y}_{i,t-1} = y_{i,t-1} - \frac{1}{T_i} \sum_1^{T_i} y_{i,t-1}$$

By reorganizing the basic regression in terms of :

$$\bar{\varepsilon}_{i,t-1} = \varepsilon_{i,t-1} - \frac{1}{T_i} \sum_1^{T_i} \varepsilon_{i,t-1}$$

Thus, $E[\bar{y}_{i,t-1}, \bar{\varepsilon}_{i,t}] \neq 0$. Therefore, LSDV estimators of β are biased (Nickell 1981). There are several ways to address this bias, most notably the Anderson-Hsiao and Kiviet corrections. However, our t value is well beyond the minimum threshold above which LSDV is useable. According to Beck, “simulations show that with reasonable T 's (15 or 20) that Hurwicz bias is negligible and that OLS with FEs and LDVs performs just fine, outperforming AH and doing as well as Kiviet. So for [cross section time series] data, use OLS with LDV and fixed effects” (Beck 2005, 3). Consequently, our model is protected from Nickell Bias because we have well over 20 cases each in our country and year datasets (178 countries and 40 years).

Final Pure Effects Model

$$y_{it} = u + \alpha_i + \gamma_t + x_{1i,t-1}'\beta_1 + x_{2i,t-1}'\beta_2 + x_{3it}'\beta_3 + x_{4it}'\beta_4 + \varepsilon_{it}$$

y_{it} = GDP growth current US dollars α_i = set of dummy variables for countries

γ_t = set of dummy variables for years $X_{1i,t-1}$ = lagged foreign aid per capita current dollars

$X_{2i,t-1}$ = lagged GDP growth current dollars X_{3it} = government crises
 X_{4it} = contrast coded regime type ϵ_{it} = error terms

The left-hand side variable is GDP growth, our proxy for economic growth. The right-hand side of the equation includes the set of dummy variables for countries, the set of dummy variables for years, and three controls. We control for lagged GDP growth to isolate the effect of foreign aid on current GDP growth. GDP lagged a year removes variation due to GDP growth trends. We control for regime type because regime type has covariance beyond what is accounted for in country and time invariant effects, as “free and open” governments may receive more aid and may achieve higher GDP growth than “closed” governments. Likewise, we control for government crises as time-variant cross-year aid-influencing shocks, as governments in crisis may receive more aid and achieve lower GDP growth than governments not in crisis.

Results

We applied the dynamic two-way fixed effects LSDV model with robust clustered errors, producing the following output:

Table 1: Two-Way Fixed Effects Model (n = 3452)

	GDP Growth
Aid Per Capita	.0056 (.003)
Growth Lag	.152 (.0318)**
Government Crises	-1.539 (.281)**
Civilian Regime	2.262 (2.342)
Civilian-Military Regime	2.285 (2.281)
Military Regime	2.036 (2.331)

* indicates significant at 95% ** indicates significant at 99%

Our regression results as seen in Table 1 above mirror many of the findings in the earlier and recent literature in which other models are employed. Aid per capita was significant at the 6 percent level. If our results were more clearly significant at the 5 percent level, we would interpret the coefficient on foreign aid per capita as a .0056 dollar per capita increase in aid causing a 1 percent increase in GDP growth. However, since our results are only moderately significant, we cannot definitively conclude a positive growth relationship. As expected, government crises has a significant and negative relationship to growth, and lagged growth has a small positive significant effect.

The Modified Model: Testing Non-Military Expenditures as an Interaction Term

The pure-effects model does not show a significant aid effect, but interacting aid and non-military government expenditures per capita could result in significant aid effects. Non-military government expenditures offer a promising conditional relationship with aid and growth. Since government revenues and expenditures are fungible, a metric for non-military expenditures estimates how foreign aid is being spent. In countries with low non-military expenditures, foreign aid is likely used to finance non-development purposes like war or centralized policing. On the other hand, in countries with high non-military expenditures, foreign aid is likely used to finance economic development purposes like education, health, and capital investment. Therefore, it may be possible that aid is effective when non-military expenditures are high and ineffective when non-military expenditures are low.

In order to test non-military expenditures as an interaction term, we defined I_{it} as the product of non-military expenditures as a percent of total government expenditures and foreign aid per capita. The term I_{it} automatically indexes and ranks the combinations of non-military expenditures and foreign aid per capita. At one extreme of the ranked index are products of low non-military spending and low foreign aid per capita, and at the other extreme are products of high non-military spending and high foreign aid per capita. The modified model can thus be expressed as follows:

$$y_{it} = u + \alpha_i + \gamma_t + I_{it}'\beta_1 + x_{1it}\beta_2 + x_{2it}'\beta_3 + x_{3it}'\beta_4 + x_{4it}'\beta_5 + x_{5it}\beta_6 + \varepsilon_{it}$$

$$\text{where } I_{it} = x_{1it} \cdot x_{5it}$$

$$\text{where } I_{it} = x_{1it} \cdot x_{5it}$$

y_{it} = GDP growth, current US dollars α_i = Set of dummy variables for countries

γ_t = Set of dummy variables for years I_{it} = Lagged the interaction term

X_{2it} = Lagged GDP growth, current dollars X_{3it} = Government crises

X_{4it} = Contrast coded regime type X_{5it} = Lagged non-military expenditures

ε_{it} = Error terms

Results from Modified Model

We applied the dynamic two-way fixed effects LSDV model with robust clustered errors, incorporating the interaction term *iterm4*:

Table 2: Two-Way Fixed Effects with Interaction Term (n=1149)

	GDP Growth
Aid Per Capita	-.04 (.039)
Growth Lag	.122 (.062)
Government Crises	-2.222 (.619)**
Civilian Regime	3.801 (1.682)*
Civilian-Military Regime	3.436 (1.519)*
Military Regime	3.139 (1.866)*
Non-Military Expenditures	.008 (.038)
Interaction Term	.0004 (.0003)

* indicates significant at 95% ** indicates significant at 99%

We did not find the growth effect on the interaction term to be significant. As seen in Table 2 above, the coefficient on the interaction term is .0004685, which is not significant even at an alpha level of .10. The non-military regime now appears as a significant variable due primarily to the inclusion of the non-military expenditure variable. However, the non-military expenditure variable is not itself significant, which means there is no relevant practical interpretation of the interaction term coefficient. If our results had been significant and positive, we would have concluded that foreign aid has a positive growth effect when non-military expenditures are high. Instead, we cannot conclude that there is an interaction effect, which suggests that the effect of foreign aid on growth may not be conditional on non-military expenditures.

Discussion

Our results closely mirror those of the initial studies. Like much of the early analysis, we found foreign aid to be positive, but not significantly correlated with growth. In our model, aid was significant with an alpha level of .10. This is the combined effect of using two-way fixed effects, which reduces the model's explanatory power, and enhances problems of under-specification in the dataset.

The lack of consistent positive pure effects of aid has pushed current research to look for interaction terms to help tease out the conditional effects of aid. We explored the interaction between aid and non-military expenditures to see if aid is more effective in states that have a high degree of domestic investment. These results were also non-significant. It is possible the interaction was non-significant because of our lack of overall power and the underlying problem of poorly classified aid. Furthermore, there may be a maximum military expenditure threshold that is relatively size-invariant. If that is the case, level of percent of military expenditure may not be a meaningful statistic.

Unfortunately, publicly available aid datasets include various muddled and poorly identified aid categories. Even more concerning, there is no distinction made between ex post and ex ante aid. This means that any regression using left-hand side variables that could be ex

ante conditions for aid will suffer from simultaneity bias, and require an explanatory instrument. Due to the current lack of strong or reliable instruments, using two-stage instrumental variables will further weaken the explanatory power of the model.

Endogeneity problems arising from underspecified aid types need to be fixed. The best approach is to build a dataset with aid clearly divided into categories so that the effectiveness of different aid strategies can be examined. We believe that a better model of aid and how aid is distributed will drastically improve even the pure effects of aid on growth.

Conclusion

Our study highlights the challenge of measuring the effect of foreign aid on growth in part because aid is not well described in the current datasets. Instances in which aid is contingent on particular policies or processes, whether aid is provided up front, or even if the aid is related to other non-development goals, is poorly understood and rarely coded in existing datasets. Sorting out the amount of aid allocated for domestic investment versus the amount allocated for military expenditures is prohibitively difficult when one examines interrelated aid packages and tied requirements. Even more difficult to measure is where the money actually goes. A country receiving aid for domestic investment may reallocate funds currently spent for domestic investment to military related projects. The challenge in identifying aid types is not only a problem for researchers, but also for policy makers who attempt to improve economic conditions for target populations and countries.

The greatest challenge plaguing measurement of the effects of aid programs is that these programs tend to be large with many tertiary effects and layers. Thus, it may be characteristics of the data and measurement tools rather than the aid programs themselves that are responsible for our inability to detect effective outcomes of development aid. This problem lends support for growth efforts that attempt to combine more descriptive and fine-grained analysis of specific programs with larger-scale dataset work. It is much easier to understand the impact of a single, targeted, program, than to detect the impact of massive numbers of interrelated projects. It should be no surprise then that micro-financing, direct aid programs, new accountability standards, and stricter reporting are becoming increasingly popular with major aid donors like World Bank, the IMF, and USAID. Future research and policy will continue to struggle to find large-scale outcomes from aid. As micro lending and smaller-scale development work become more common, it becomes even more difficult to compare projects and develop a rubric for the creation of successful aid. Nonetheless, understanding the macro impacts of foreign aid is vital for policy makers and academics alike.

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