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A pooled mean group analysis on aid and growth*

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Abstract

This paper uses the pooled mean group estimator and an extended annual dataset to examine the effectiveness of aid on growth. The results indicate a significant long-run impact of aid on growth, but conditioning aid on 'good' policy reduces the long-run growth rate.

Keywords: aid impact; economic growth; pooled mean group estimators

JEL classification: O11; O2; O43

1 Introduction

One of the key findings in the nexus between foreign aid and growth in real GDP per capita is that it is conditional on 'good' policy (Burnside and Dollar, 2000). Recent contributions (for example, Easterly et al., 2004 and Hansen and Tarp, 2001), have examined this relationship and found that this result is not robust to the introduction of additional data and alternative specifications. This paper contributes to this debate by exploring the validity of such findings using the pooled mean group (PMG) estimator developed by Pesaran et al. (1999). To investigate the influence of aid on growth, an annual dataset comprising of 46 countries spanning the period 1976-2004 was assembled.[1] Countries are also classified as low income if the real GDP per capita level (2000 constant prices) is less than US$1,900.

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[1] The cross-section and time series dimension of the dataset is chosen with an eye to obtain a balanced panel. Low income countries are Algeria, Bolivia, Botswana, Colombia, Cote d'Ivoire, Dominican Republic, Ecuador, Egypt, Gambia, Ghana, Guatemala, Haiti, Honduras, India, Indonesia, Kenya, Madagascar, Malaysia, Morocco, Nicaragua, Niger, Nigeria, Pakistan, Paraguay, Philippines, Senegal, Sierra Leone, Sri Lanka, Sudan, Swaziland, Thailand, Togo, and Zimbabwe. Middle income countries are Argentina, Chile, Costa Rica, El Salvador, Gabon, Jamaica, Korea Republic, Mexico, Peru, Trinidad and Tobago, Turkey, Uruguay, and Venezuela.

Besides being the first application of this methodology on aid and growth, there are other advantages for the choice of the PMG procedure. It allows for short-run heterogeneous dynamics but imposes a long-run homogeneous relationship for countries in the sample. Given that major aid-recipient counties are seen to be stuck in perpetual poverty trap, it is very likely that such a long-run relationship exists. However, there is little evidence to suggest their speed of adjustment to the long-run steady state should be the same. In a simplified neoclassical growth model, the speed of adjustment would be determined by the rate of technological progress and population growth.

2 Econometric Methodology and the Data

Following earlier studies, it is appropriate to estimate a standard growth equation in accordance with specification closely related to Burnside and Dollar (2000). In the process of assembling a more complete and balanced panel dataset, there are several differences on the treatment of variables on the right-hand side of the specification. First, the main indicators of macroeconomic policy are the government consumption to GDP, inflation and trade openness (measured by the sum of export and import to GDP). This is due to the lack of tax revenue for most countries for the period 1976-2004 on a consistent basis. To construct the policy variable, a standard growth equation, excluding any terms with aid, is estimated using pooled fixed effect estimator. The policy variable is given by:

$$Policy = 1.65 - 11.92 \times Government\ Consumption - 0.07 \times Inflation + 3.27 \times Openness.$$

Second, the political and institutional variables are chosen to obtain as many time series observations as possible. The existing literature has also focused on subjective measures of political and institutional risk like the International Country Risk Guide. To measure political and institutional quality, the contract-intensive money (CIM) ratio by Clague et al. (1999) was constructed. Furthermore, the CIM is readily available on a timely manner for a large number of countries. The state of financial development is proxied by the one year lag of M2 to GDP following earlier studies.

The aid-growth literature has traditionally focused on fixed effects or cross-sectional estimators. While the intercepts are estimated to differ across groups, the other coefficients and error

variances are constrained to be the same. Hansen and Tarp (2001) have used the generalized methods of moment (GMM) to address potential mis-specification and obtain consistent estimates in the presence of endogenous regressors. However, as Pesaran et al. (1999) argue, the GMM estimation procedure for dynamic panel model (for instance, Arellano and Bond, 1991) can produce inconsistent and misleading coefficients of the long-run coefficients unless they are truly identical. This problem is exacerbated when the time dimension of the panel is large. There are other advantages to the deployment of the PMG estimator. It is an intermediate estimator which allows the intercepts, short-run coefficients, and error variances to be different across groups, but the long-run coefficients are constrained to be homogeneous. There are good reasons to believe that the long-run equilibrium relationship amongst variables should be identical across groups, while the short-run dynamics are heterogeneous. This dynamic estimator is more likely to capture the true nature of the data. Finally, the null hypothesis of long-run slope homogeneity in the coefficients is tested using the Hausman test.

Assume the long-run growth relationship is given by:

$$\begin{aligned} y_{it} &= \theta_{0i} + \theta_{1i} CIM_{it} + \theta_{2i} \left(\frac{M2}{GDP} \right)_{it-1} + \theta_{3i} Policy_{it} + \theta_{4i} \left(\frac{Aid}{GDP} \right)_{it} \\ &\quad + \theta_{5i} (Aid \times Policy)_{it} + \alpha_{1i} t + u_{it}, \\ i &= 1, 2, ..., N; \; t = 1, 2, ..., T \end{aligned} \tag{1}$$

where y_{it} is real GDP per capita growth rate, CIM_{it} is the proxy for political and institutional quality, $\left(\frac{M2}{GDP}\right)_{it-1}$ is the proxy for financial development, and $Policy_{it}$, $\left(\frac{Aid}{GDP}\right)_{it}$ and $(Aid \times Policy)_{it}$ represent the policy, aid, and interactive term between aid and policy respectively. The variable t represents a time trend. Equation (1) will be estimated with and without the time trend.

Assume that all of these variables are $I(1)$ and cointegrated. This means u_{it} is an $I(0)$ process for all i and is independently distributed across t. They are also assumed to be distributed independently of the regressors. Suppose the maximum fixed lag of every variable is one, the autoregressive distributed lag, ARDL(1,1,1,1,1,1), model is:

$$
\begin{aligned}
y_{it} \quad = \quad & \mu_{it} + \delta_{10i} CIM_{it} + \delta_{11i} CIM_{it-1} + \delta_{20i} \left(\frac{M2}{GDP} \right)_{it-1} + \delta_{21i} \left(\frac{M2}{GDP} \right)_{it-2} + \qquad (2) \\
& \delta_{30i} Policy_{it} + \delta_{31i} Policy_{it-1} + \delta_{40i} \left(\frac{Aid}{GDP} \right)_{it} + \delta_{41i} \left(\frac{Aid}{GDP} \right)_{it-1} + \\
& \delta_{50i} (Aid \times Policy)_{it} + \delta_{51i} (Aid \times Policy)_{it-1} + \beta_{1i} t + \lambda_i y_{it} + \varepsilon_{it}.
\end{aligned}
$$

The error correction equilibrium representation is derived as:

$$
\begin{aligned}
\Delta y_{it} \quad = \quad & \phi_i [y_{it-1} - \theta_{0i} - \theta_{1i} CIM_{it} - \theta_{2i} \left(\frac{M2}{GDP} \right)_{it-1} - \theta_{3i} Policy_{it} - \theta_{4i} \left(\frac{Aid}{GDP} \right)_{it} \qquad (3) \\
& - \theta_{5i} (Aid \times Policy)_{it} - \alpha_{1i} t] - \delta_{11i} \Delta CIM_{it} - \delta_{21i} \Delta \left(\frac{M2}{GDP} \right)_{it-1} \\
& - \delta_{31i} \Delta Policy_{it} - \delta_{41i} \Delta \left(\frac{Aid}{GDP} \right)_{it} - \delta_{51i} \Delta (Aid \times Policy)_{it} + \varepsilon_{it},
\end{aligned}
$$

where $\theta_{0i} = \frac{\mu_{it}}{1-\lambda_i}$, $\theta_{1i} = \frac{\delta_{10i}+\delta_{11i}}{1-\lambda_i}$, $\theta_{2i} = \frac{\delta_{20i}+\delta_{21i}}{1-\lambda_i}$, $\theta_{3i} = \frac{\delta_{30i}+\delta_{31i}}{1-\lambda_i}$, $\theta_{4i} = \frac{\delta_{40i}+\delta_{41i}}{1-\lambda_i}$, $\theta_{5i} = \frac{\delta_{50i}+\delta_{51i}}{1-\lambda_i}$, and $\phi_i = 1 - \lambda_i$.

In addition, results attained using the mean group (MG) and the dynamic fixed effects (DFE) will be reported to facilitate comparison. Results will vary quite substantially across methodologies given that the MG procedure is the least restrictive, and thus potentially inefficient. The DFE allows for individual intercepts to vary across countries, and is similar to the GMM procedure.

3 Results

Table (1) presents results obtained from alternative estimators: MG, PMG, and DFE. The PMG computations were obtained using the Newton-Raphson algorithm without a common time trend. The constraint of common long-run coefficients (i.e. from MG to PMG) has yielded lower standard errors and slower speed of adjustment. This outcome is expected given that the MG estimators are known to be inefficient. The result reveals that aid/GDP and policy variables are significant and contribute positively to growth rate in the long-run. However, aid conditional on 'good' policy reduces the long-run growth rate. The addition of a linear time trend does not change this striking feature.

Being an ARDL model, the result may be sensitive to the choice of lag length. In what

follows, I impose a maximum lag length of one for the Akaike Information Criterion (AIC) and the Schwarz Bayesian Criterion to obtain optimal lag length for various variables. The negative result of aid reducing growth when coupled with 'good' policy is found to be robust. The Hausman test statistic confirms that the long-run homogeneous coefficient restrictions cannot be rejected at the 1% significance level. This indicates the presence of a long-run homogeneous relationship amongst the countries. In contrast to the PMG estimator, none of the aid-related variables are significant under the DFE estimator.

There is a high possibility that this result may be due to the inclusion of particular countries in the sample. Table (2) investigates this issue by splitting the original dataset into two broad sub-groups of countries: low income and middle income. Following Burnside and Dollar (2000), middle income countries had per capita GDP greater than US$1,900 (constant 2000 US dollars) in 1976.

There are several noteworthy findings. First, the coefficients for the interaction between aid/GDP and policy, across the two major sub-groups, are estimated to be negative. In particular, this negative effect is more perverse for middle income countries. The selective distribution of foreign aid conditional on the presence of sound policy environment is counter-productive. Second, the long-run coefficient of aid/GDP, estimated using the PMG estimator, is more substantial for middle income countries. This is evident from the long-run elasticity of 4.83% compared to the low income's 0.19%. Third, the speed of adjustment reflected by the convergence coefficients of low income country to permanent shock, say aid/GDP, is estimated to be faster than that of the middle income country. This suggests a jump-start in aid flow, in itself, may propel these economies on faster trajectory towards their long-run steady state growth rate.

Table (3) shows that the PMG results are robust to country sub-groups and to the choice of optimal lag order selected by the AIC. In comparison with low income countries, the allocation of foreign aid, by itself, to middle income countries will yield higher growth rate in the long-run.

4 Conclusion

This paper has explored the aid and growth nexus for a panel of 46 countries over the period 1976-2004. The novel feature is on the application of the PMG estimation procedure. This technique is suitable for panel dataset with large time dimension and the analysis of homogeneous long-run effects and speed of adjustment to the long-run. I found a long-run homogeneous relationship

amongst major aid-recipient countries. But, more importantly, the interaction of foreign aid with policy leads to lower growth in the long-run. This finding contradicts the results in Burnside and Dollar (2000), and is robust across sub-groups of countries.

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Appendix A: Description of variables and their source

Variable	**Explanation and source**
real GDP per capita growth	Annual percentage growth rate of GDP per capita based on constant local currency unit. Source: World Development Indicator, April 2006.
Government Consumption/GDP	General government final consumption expenditure (formerly general government consumption). Source: World Development Indicator, April 2006.
Inflation	Consumer price index changes. Source: International Financial Statistics.
Trade/GDP	The sum of export and import to nominal GDP. Source: World Development Indicator, April 2006.
Aid/GDP	Original series is Aid/GNI obtained from World Development Indicator. Conversion attained using corresponding series of GNI and GDP. Source: World Development Indicator, April 2006.
M2/GDP	Money and quasi-money. Source: International Financial Statistics.
CIM	Computed based on M2 and currency held outside banks following Clague et al. (1999). Source: International Financial Statistics.

Table 1: Baseline estimates, one lag (1,1,1,1,1,1)

Dependent variable: real GDP per capita growth	MG	PMG	Hausman test	DFE
Convergence coefficients	-0.98	-0.79		-0.83
	(0.05)***	(0.05)***		(0.04)***
Long run coefficients				
CIM	6.22	-1.72	1.63	2.75
	(6.44)	(1.69)		(1.22)**
$M2/GDP(lagged)$	-3.85	-1.91	0.11	-3.15
	(6.01)	(1.49)		(1.70)*
$Policy$	1.92	1.20	0.11	1.03
	(2.18)	(0.26)***		(0.32)***
Aid/GDP	22.21	0.24	0.49	0.13
	(31.41)	(0.10)**		(0.07)
$Aid \times Policy$	-4.27	-0.04	0.49	-0.01
	(6.04)	(0.02)**		(0.02)
		Joint	2.19	
Short run coefficients				
ΔCIM	12.87	9.11		-0.33
	(6.54)**	(5.49)		(1.14)
$\Delta M2/GDP$	-3.49	-9.19		-3.03
	(7.30)	(6.44)		(5.49)
$\Delta Policy$	-1.68	0.67		-0.11
	(1.20)	(1.11)		(0.25)
$\Delta Aid/GDP$	-15.25	20.24		0.18
	(14.55)	(14.64)		(0.06)***
$\Delta(Aid \times Policy)$	1.70	-5.45		-0.03
	(3.15)	(3.84)		(0.01)
No. of countries	46	46		46
No. of obs.	1242	1242		1242
Log-likelihood	-2937	-3181		-3551

Note: All equations include a constant country-specific term. Standard errors are in parentheses. For DFE estimates, the standard errors are heteroskedastic consistent.
*** significant at the 1% level; ** at the 5% level; * at the 10% level.

Table 2: Low income versus middle income sub-groups, one lag (1,1,1,1,1,1)

Dependent variable: real GDP per capita growth	Low income				Middle income			
	MG	PMG	Hausman test	DFE	MG	PMG	Hausman test	DFE
Convergence coefficients	-0.97	-0.82		-0.86	-1.02	-0.78		-0.91
	(0.06)***	(0.06)***		(0.03)***	(0.09)***	(0.10)***		(0.06)***
Long run coefficients								
CIM	5.87	0.20	0.61	2.51	6.84	-10.76	0.63	15.22
	(7.42)	(1.45)		(0.76)***	(24.22)	(9.71)		(11.15)
$M2/GDP(lagged)$	0.37	-1.23	0.06	-1.86	-28.93	-10.25	1.61	-10.75
	(6.67)	(1.56)		(1.25)	(15.21)*	(3.88)**		(3.26)***
$Policy$	0.99	0.91	0.00	0.43	5.76	4.28	0.17	2.98
	(1.76)	(0.27)***		(0.19)**	(3.65)	(0.49)***		(0.74)***
Aid/GDP	4.58	0.19	0.44	0.07	115.02	4.83	1.55	2.72
	(6.63)	(0.10)**		(0.04)*	(88.63)	(1.81)**		(0.82)***
$Aid \times Policy$	-0.59	-0.03	0.26	0.01	-23.95	-0.78	1.82	-0.42
	(1.10)	(0.02)**		(0.02)	(17.20)	(0.33)**		(0.15)**
		Joint	1.10			Joint	9.70	
Short run coefficients								
ΔCIM	5.22	2.61		-1.13	-34.30	-33.28		4.47
	(4.13)	(3.19)		(0.65)*	(37.86)	(39.94)		(24.31)
$\Delta M2/GDP$	0.00	0.00		0.00	0.00	0.00		0.00
	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)		(0.00)
$\Delta Policy$	-1.81	-0.70		-0.11	-1.33	1.38		-0.48
	(1.28)	(1.09)		(0.23)	(2.76)	(2.02)		(0.57)
$\Delta Aid/GDP$	-5.26	-5.23		0.13	-60.58	-7.45		-1.83
	(4.03)	(3.58)		(0.06)**	(100.01)	(61.99)		(0.92)**
$\Delta(Aid \times Policy)$	1.02	0.99		-0.02	8.11	-3.93		0.11
	(0.84)	(0.79)		(0.01)*	(19.61)	(13.14)		(0.15)
No. of countries	33	33		33	13	13		13
No. of obs.	924	924		924	364	364		364
Log-likelihood	-2144	-2315		-2585	-889	-960		-1072

Note: All equations include a constant country-specific term. Standard errors are in parentheses.
For DFE estimates, the standard errors are heteroskedastic consistent.
*** significant at the 1% level; ** at the 5% level; * at the 10% level.

Table 3: Alternative pooled estimates of the long-run policy, aid and (aid x policy): lag order selected by AIC

Countries	Variable	MG	PMG
All	Policy	1.49 (1.91)	1.28 (0.20)***
	Aid/GDP	9.32 (23.65)	0.22 (0.08)***
	(Aid x Policy)	-1.89 (4.47)	-0.03 (0.01)***
Low income	Policy	2.13 (1.26)*	0.85 (0.21)***
	Aid/GDP	2.54 (4.09)	0.16 (0.08)*
	(Aid x Policy)	-0.55 (0.69)	-0.02 (0.01)*
Middle	Policy	6.59 (2.49)**	2.76 (0.51)***
	Aid/GDP	60.97 (75.51)	3.08 (1.04)**
	(Aid x Policy)	-13.58 (15.37)	-0.49 (0.18)***

Note: Dependent variable: real GDP per capita growth. All equations include a constant country-specific term. Standard errors are in parentheses.
*** significant at the 1% level; ** at the 5% level; * at the 10% level.