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Abstract

The Pacific island countries (PICs) have been among the world's top ten recipients of official development assistance (ODA) on a per capita basis. This paper seeks to examine the effectiveness of external aid by undertaking a panel data study covering five countries in the South Pacific, namely Fiji, Samoa, Solomon Islands, Tonga and Vanuatu utilizing the annual data over a twenty-five year period.

Keyword(s): Pacific Islands, foreign aid, growth, panel cointegration, Pedroni tests

1. Introduction

Summarizing about three dozen cross-country studies on the utilization of official development assistance (ODA), popularly referred to as foreign aid[1] during the last 50 years, two surveys by Addison, Mavrotas and McGillvray (2005) and Cassen and Associates (1994) documented their findings on the relationship between aid and economic growth in developing countries. While Clemens, Radelet and Bhavnani (2004) indicated the existence of a positive relationship between aid and growth, a study by Rajan and Subramanian of IMF (2005) found no evidence of aid having either a positive or a negative effect on growth. Another study by Raghuram and Subramanian (2005) indicated that aid receiving countries would have been under the influence of the well known "Dutch disease effect", which is reflected in the appreciation of real exchange rate, adversely affecting the competitiveness of exports, thereby weakening their economic growth.

A World Bank study (1993) on Pacific island countries[2] (PICs) observed that PICs, despite high per capita aid, performed dismally in comparison to similarly placed island countries in the Caribbean and Indian Ocean regions. During 1970-1993, while per capita gross domestic product (GDP) in the Caribbean island countries grew at 2.8 percent per annum, the corresponding rate in ten PICs, for which comparable data are available, was only 1 percent. Poor growth in PICs marked by stagnation in per capita incomes in the midst of plentiful aid over two decades came to be looked upon as a "Pacific Paradox" (World Bank 1993). Following the findings of the World Bank study, reform programmes were initiated in several PICs in the late 1990s, with loans and technical assistances from international and bilateral funding institutions.

However, progress has been slow. Further, some PICs in the late 1990s went through economic and political crises of sorts. Against this background, an Australian non-government think-tank institution, the Centre for Independent Studies (CIS), issued a critical report with a provocative title: *Aid has failed in the Pacific* (Hughes 2003). The criticism is based on the observation that poor growth performance was due to ineffective use of aid during the past three decades, totaling about US$ 50 billion and that most of the aid money was spent on consumption by elites in the governments and bureaucracies, diverting funds from the intended purposes, as aid was fungible. Another report by CIS in 2004, this time with the title: *The Pacific is Viable* (Gosaraevski *et al*. 2004) laid considerable stress on reforms in aid delivery and implementation. A much more recent study by AusAid (2005), as part of exercises relating to a White Paper on Aid, observed that PICs were not on track to meet the Millennium Development Goals (MDGs), as they failed to register a per capita income growth rate above 2 percent per annum during the last ten years: (1995-2004), which was indicated as the required rate for reducing poverty, based on a WB study (Dollar and Kraay 2001). Closely on the heels of these studies came the announcement in March 2006

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[1] The term, official development assistance, is defined as pure grants and concessional flows from bilateral governments and their agencies as well as multilateral financing agencies to developing countries at low rates of interest with maturity periods of long term nature, all of them containing a grant element of at least 25 percent.

[2] The 14 Pacific island countries members, who along with two advanced countries of the region, Australia and New Zealand, constitute the official regional organization, known as the Pacific Islands Forum, are: Cook Islands, Fiji, Kiribati, Republic of Marshall Islands, Federated States of Micronesia, Nauru, Niue, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu. In addition, there are eight territories, being either possessions of or enjoying a free association status with major powers, including the United Kingdom and France. All the 22 entities form part of the Pacific Community with its Secretariat located in New Caledonia.

that the United States Millennium Challenge Corporation approved a five-year US $65.69 million Compact with Vanuatu. This provoked further criticism from Hughes and Sodhi (2006) that the US Government decision was not justifiable in the light of ineffective use of aid to PICs.

The CIS studies referred to earlier as well as the preparatory exercises for the Australian *White Paper on Aid to PICs* (2005) acknowledged that data deficiencies relating to the availability of reliable data, especially in terms of comparable time series prevented fuller analyses for undertaking a time-series and cross-sectional country analysis. Keeping in view the data constraints, a simple model is devised to test whether aid to PICs for raising their productive levels by assisting the development of physical infrastructures such as roads, ports and jetties has contributed to growth.

The rest of the paper is organized on the following lines: the second section gives a brief economic review of PICs; the third section outlines the methodology adopted for the study; the fourth section reports the results of the empirical analysis and the fifth and final section presents conclusions with policy implications.

2. Pacific Island Countries: A Brief Economic Review

The 14 PICs, which are formal members of the regional organization, known as Pacific islands Forum, are spread over the Pacific Ocean about some 10,000 kilometres (kms) from east to west and 5,000 kms, from north to south, with a combined exclusive economic zone (EEZ) of about 20 million sq. km. The total land area is just over 500,000 sq. km of which Papua New Guinea (PNG) accounts for 88%, and Fiji, Solomon Islands and Vanuatu for 11%, with the other 10 countries making up the remaining 1%. The population of the PICs is about seven million people, of which over five million are in PNG.

2.1 Constraints to Growth

There are serious constraints to growth and development, which stem forth from their geographical characteristics (Urwin 2004). These include:

- Remoteness and insularity: being located far from major markets and comprising widely dispersed multi-island micro-states, resulting in high international and domestic transportation costs, arising from both the distances to be covered and the low volume of cargo. Further, the development of even a small domestic market is constrained by distances between settlements and infrequent internal transport services.
- Susceptibility to natural disasters: being frequently affected by adverse climatic and other natural events that typically affect the entire population and economy.
- Small population size: being limited by small population size, it affects institutional capacity and increases unit costs of services, and also restricts the potential for private sector growth and investment.
- Limited diversification: having narrow resource base and small domestic markets necessarily result in being relatively un-diversified in production and exports, and also limits capacity in the private sector.
- Openness: relying heavily upon external trade and foreign investment to overcome inherent scale and resource limitations, which leaves states vulnerable to external economic and environmental shocks.

Urwin (2004) observed that economic development in PICs since their independence was characterized by the dominant role-play by large public sectors. Despite substantial aid, there has been a great variability in economic performance. Since 1998, some PICs for which GDP data are available, have suffered negative economic growth at some time excepting Samoa, Tonga and Tuvalu (Urwin 2004).

According to an IMF study (2005), the list of top 10 recipients of aid per capita (2000-2003 average in 2002 prices), was headed by Timor-Leste (US$ 260), included three PICs: Kiribati received US$180 (ranked third), Vanuatu US$170 (ranked fourth) and Solomon Islands US$140 (ranked sixth).

2.2 Aid and Growth Performance in PICs

Key indicators are given in Table 1, which includes information on aid inflows in terms of percentages of gross domestic product (GDP). Aid has provided substantial support to annual budgets. By adding to real resources, they contribute to lessening the potential inflationary pressures. However, growth in per capita incomes has been elusive. Hughes (2003) argued that aid funds, being fungible, were mostly used for maintaining large bureaucracies, with wages and salaries dominating the PICs' recurrent budgets. Thus, as aid money was diverted to consumption, less of the aid inflows were spent on income generating assets, not to mention about the neglect of maintenance of existing assets such as roads and jetties and ports. Budget allocations over a period in PICs indicate that the ratio between two components, one relating to recurrent expenditures, including wages and salaries and housekeeping expenses to the component, to capital expenditures, is 70 to 30, indicating that emphasis has been more on government consumption.

3. Methodology, Data and Empirical Results

The choice of modeling methodology for the panel analysis of aid effectiveness in PICs is highly constrained by the deficiency in the availability of consistent and absence of reliable time series of data. Most of the data on aid is in aggregated form. Data on various components of aid money, such as project aid, program aid and technical assistance, including consultancy services, are not available in respect of all PICs and for all the years under study. Lack of attention to building good statistical databases has been a common feature in all the island countries[3]. Since a majority of PICs attained independence in early 1980s, data series on national accounts begin only from 1982. Further, lack of data for a number of other relevant variables has also been a major handicap. Data series relating to investment expenditure, projects and other budget items including recurrent government expenditure on wages and salaries are not consistently available over the period either from *World Development Indicators* (WDI) published by the World Bank (2008) or from the country's own official sources. The only longer time series data available on a consistent basis from 1982 are in regard to three variables: GDP, aid in aggregated form without any

[3] Hughes (2006) comes down heavily upon this deficiency, by pointing out poor personnel policies, which contribute to jobs in the Bureau of Statistics being considered as dead ends to careers. Further, governments have created an environment of suspicion that statisticians were expected "to produce politically suitable data" (Hughes 2006: 3).

distinction between technical assistance and project or program aid, and earnings from exports of goods and services.

Table 1: Selected Key Indicators

	Population ('000) 2006	Per Capita GDP (Current Prices) in US$ 2006	Human Dev Index Ranking 2006	Aid per capita in US$ 2006	Aid % of GDP 1990	Aid % of GDP 2006
Cook Islands	22	2,651	NA	490.9	NA	28.0
Fiji	853	3,670	103	41.4	3.9	1.8
Fed States of Micronesia.	111	2,390	NA	981.0	NA	41.3
Kiribati	101	1,240	NA	203.3	22,5	18.6
Papua New Guinea	5,995	730	149	45.0	12.8	5.6
Republic of Marshall Islands.	65	2,980	NA	842.3	NA	28.5
Samoa	186	2,260	96	254.2	42.6	11.2
Solomon Islands	489	690	134	423.0	21.7	60.5
Tonga	102	2,300	85	215.2	26.3	9.0
Tuvalu	10	1,346	NA	260.0	47.2	45.0
Vanuatu	215	1,780	123	221.0	33.0	12.4

Source: World Bank (2008), UNDP (2008a and 2008b), UNESCAP (2004 and 2006)

All the data are drawn from a single source, namely WDI. Our simple model, which takes into account the data deficiencies seeks to test three hypotheses: (i) aid enhances productive capacities of the country, if aid money is spent on physical infrastructure projects including rural roads, ports and jetties; (ii) higher production and their movements from hinterlands in rural communities and remote islands to commercial centres and ports, which are facilitated by improved physical infrastructure, would lead to rise in traditional exports including copra and fish; and (iii) rise in exports would result in economic growth, as domestic markets are small.

3.1 Data Description

The study utilizes panel data covering a 25 year period (1982-2006) relating to five PICs, namely Fiji, Samoa, Solomon Islands, Tonga and Vanuatu. In our estimation procedure, we employ three variables: real per capita GDP (RGDP) in US dollars, aid as percent of GDP (AID) and exports of goods and services as percent of GDP (EXP). For our empirical study, we formulate the following functional relationship for panel investigation. All variables are transformed into logarithmic form prior to estimation.

$$RGDP = f(AID, EXP)$$
$$RGDP_t = \beta_0 + \beta_1 AID_t + \beta_2 EXP_t + \varepsilon_t \qquad (1)$$

where $RGDP$ = real GDP per capita (US dollar)
AID = aid (percent of GDP)
EXP = exports of goods and services (percent of GDP)
ε_t = white noise error term

Table 2: Panel Unit Root and Stationary Tests

	Test Statistics					
	LLC	**IPS**	**MW (ADF)**	**MW (PP)**	**HADRI**	**Conclusion**
			A: Level			
Model Specification: Individual Effects						
RGDP	1.110	1.656	8.200	8.488	3.831	-
	(0.866)	(0.951)	(0.609)	(0.581)	(0.000)	
AID	-1.275	0.336	2.067	7.050	2.906	-
	(0.101)	(0.631)	(0.995)	(0.720)	(0.000)	
EXP	-0.659	-1.032	12.620	4.846	3.850	-
	(0.254)	(0.151)	(0.245)	(0.901)	(0.000)	
Model Specification: Individual Effects and Individual Linear Trends						
RGDP	0.594	-0.869	9.436	18.431	3.557	-
	(0.724)	(0.192)	(0.491)	(0.048)	(0.000)	
AID	0.343	-0.582	11.411	10.553	3.127	-
	(0.634)	(0.80)	(0.326)	(0.393)	(0.000)	
EXP	-0.664	0.281	6.380	10.068	2.410	-
	(0.253)	(0.610)	(0.782)	(0.435)	(0.008	
			B: First Differences			
Model Specification: Individual Effects						
ΔRGDP	-6.674	-5.907	35.088	82.105	0.589	*I(1)*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.277)	
ΔAID	-4.057	-5.032	42.830	127.999	-0.457	*I(1)*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.676)	
ΔEXP	-5.368	-3.988	34.251	80.406	-0.424	*I(1)*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.664)	
Model Specification: Individual Effects and Individual Linear Trends						
ΔRGDP	-5.497	-4.420	24.410	70.677	1.212	*I(1)*
	(0.000)	(0.000)	(0.006)	(0.000)	(0.112)	
ΔAID	-6.013	-3.854	30.280	159.906	-0.621	*I(1)*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.739)	
ΔEXP	-4.803	-2.652	23.110	63.364	0.095	*I(1)*
	(0.000)	(0.004)	(0.010)	(0.000)	(0.462)	

Notes: IPS, LLC and HADRI indicated the Im *et al.* (2003), Levin et al. (2002) and Hadri (2000) panel unit root and stationary tests. MW (Fisher-ADF) and MW (Fisher-PP) denotes Maddala and Wu (1999) Fisher-ADF and Fisher-PP panel unit root test. The IPS, LLC, MW (Fisher-ADF) and MW (Fisher-PP) examines the null hypothesis of non-stationary while HADRI tests the stationary null hypothesis. The four variables were grouped into one panel with sample N=25, T=5. The parenthesized values are the probability of rejection. Probabilities for the MW (Fisher-ADF) and MW (Fisher-PP) tests are computed using an asymptotic χ^2 distribution, while the other tests follow the asymptotic normal distribution.

3.2 Panel Unit Root and Stationary Tests

In this study, we adopt the Maddala and Wu (1999), Hadri (2000), Levin *et al*. (2002) and Im *et al.* (2003) panel unit root and stationarity tests with a view to obtaining conclusive evidence in regard to the order of integration of the three data series under investigation. The null hypothesis of these tests is that the panel series has a unit root (non-stationary) except for the HADRI test. The HADRI test is similar to the KPSS type unit root test, with a null hypothesis of stationarity in the panel. As this procedure has become a standard practice in empirical work of panel analysis, detailed explanation of the tests is not presented here. Interested readers may refer to Maddala and Wu (1999), Hadri (2000), Levin *et al*. (2002) and Im *et al.* (2003) for a complete discussion on the procedure. The results, which are summarized in Table 2, show that the series of the variables, RGDP, AID and EXP are of an *I(1)* process and the pooled data are stationary in their first differences.

3.3 Panel Cointegration

In this study, we resort to Pedroni (1999, 2001, and 2004) and Kao (1999) panel cointegration tests. Pedroni considers seven different statistics, four of which are based on pooling the residuals of the regression along the within-dimension (panel test) of panel and the other three are based on pooling the residuals of the regression along the between-dimension (group test) of the panel. The within-dimension tests take into account common time factors and allow for heterogeneity across countries. The between-dimension tests are the group mean cointegration tests, which allow for heterogeneity of parameters across countries. Meanwhile, Kao (1999) proposed DF and ADF-type tests for ε_{it} where the null is specified as no cointegration. For our purposes, we only report the results of ADF-type tests. The details of these tests are discussed in Appendix 1.

From the panel cointegration results in Table 3, we find strong evidence to reject the null hypothesis of no cointegration for five out of the seven statistics provided by Pedroni (1999, 2001, and 2004). Similarly, we reject the null hypothesis of no cointegration using the ADF-type statistics from Kao panel cointegration tests (1999) suggesting that that the three-dimension model of twin deficits for the PICs is in fact cointegrated. Rejection of the null hypothesis of no cointegration between the *I(1)* series in the panel implies that the four variables do not drift apart in the long run steady state relationship. Despite the disparities in the individual countries the PICs in particular, we found RGDP, AID and EXP are cointegrated in the multi-country panel setting.

3.4 Panel Fully Modified OLS (FMOLS) Estimates

For obtaining the long run estimates of the cointegrating relationship, we adopt the Fully Modified OLS (FMOLS) procedure, following the work by Pedroni (2000). The FMOLS procedure accommodates the heterogeneity that is typically present in long run cointegrating relationships. The FMOLS estimator is described in Appendix 1.

The results from the FMOLS in Table 4 can be summarized as follows: First, the panel group regression shows that the coefficients of AID and EXP are positive and statistically significant. The magnitudes of the estimated coefficients of AID and EXP, whose signs are in accordance with theoretical expectations, denote the long run elasticity estimates of RGDP per capita with respect to AID and EXP.

Table 3 Panel Cointegration Results

A: Pedroni Residual Cointegration test	
Panel cointegration statistics (within-dimension)	
Panel v-statistic	-2.191 (0.036)
Panel PP type ρ-statistic	0.433 (0.363)
Panel PP type t-statistic	-2.971 (0.004)
Panel ADF type t-statistic	-3.191 (0.002)
Group mean panel cointegration statistics (between-dimension)	
Group PP type ρ -statistic	0.160 (0.393)
Group PP type t –statistic	-2.491 (0.017)
Group ADF type t- statistic	-2.487 (0.018)
B: Kao Residual Cointegration test	
ADF	-2.734 (0.003)

Notes: The number of lag truncations used in the calculation of the seven Pedroni statistics is 4 while Kao ADF statistic is 3. Probability values are in parentheses.

Second, the signs of the coefficients of AID in all estimated country equations are consistent with *a priori* expectations and are found statistically significant. In this sense an increase in aid would trigger an upward rise in growth in these countries. For example, one percent increase in AID for Fiji would contribute 0.24 percent to Fiji's RGDP per capita.

Third, the results also indicate a positive and significant relationship between exports and per capita income for all the countries. The results confirm that in all the island countries under study, an increase in EXP leads to an increase in RGDP per capita. The elasticity estimates range from 0.30 (Solomon Islands) to 0.92 (Tonga).

Table 4: Fully Modified OLS Estimates

Countries	**AID**	**EXP**
Fiji	0.240 (2.120)*	0.440 (3.350)*
Samoa	0.700 (2.860) *	0.660 (2.980)*
Solomon Islands	0.570 (3.180)*	0.300 (2.230)*
Tonga	1.840 (3.010)*	0.920 (10.410)*
Vanuatu	2.100 (2.910)*	0.350 (4.890)*
Panel Group	0.500 (6.170)*	0.560 (5.970)*

Notes: The values in parentheses are the t-statistics. Asterisk (*) shows significance at 5 percent level.

3.5 Granger Causality Tests

To test the interplay between the variables, we estimate a panel based vector error correction model (VECM) with a dynamic error correction term based on Holtz-Eakin *et al*. (1988, 1989). The empirical models are represented as follows:

$$\Delta RGDP_{it} = \pi_{1j} + \sum_{p=1}^{m} \pi_{11ip} \Delta RGDP_{it-p} + \sum_{p=1}^{m} \pi_{12ip} \Delta AID_{it-p} + \sum_{p=1}^{m} \pi_{13ip} \Delta EXP_{it-p} + \mu_{1i} ECT_{it-1} + \zeta_{1it} \quad (2a)$$

$$\Delta AID_{it} = \pi_{2j} + \sum_{p=1}^{m} \pi_{21ip} \Delta AID_{it-p} + \sum_{p=1}^{m} \pi_{22ip} \Delta RGDP_{it-p} + \sum_{p=1}^{m} \pi_{23ip} \Delta EXP_{it-p} + \mu_{2i} ECT_{it-1} + \zeta_{2it} \quad (2b)$$

$$\Delta EXP_{it} = \pi_{3j} + \sum_{p=1}^{m} \pi_{31ip} \Delta EXP_{it-p} + \sum_{p=1}^{m} \pi_{32ip} \Delta RGDP_{it-p} + \sum_{p=1}^{m} \pi_{33ip} \Delta AID_{it-p} + \mu_{3i} ECT_{it-1} + \zeta_{3it} \quad (2c)$$

where Δ is the lag operator, p denotes the lag length. Here all variables are as previously defined. Using the specification in Equation 2 allows one to test causality direction. For example, in short run AID does not Granger cause RGDP where, $H_0 : \pi_{12ip} = 0$ for all i and p while $\mu_{1i} = 0$ in Equation (2a)[4]. The rejection implies that AID influences RGDP. Similar analogous restrictions and testing procedure can be applied in testing the hypothesis that RGDP does not Granger cause movement in AID where the null hypothesis H_0: $\pi_{22ip} = 0$ for all i and p while $\mu_{2i} = 0$ in Equation (2b).

Table 5: Panel Granger Causality Results

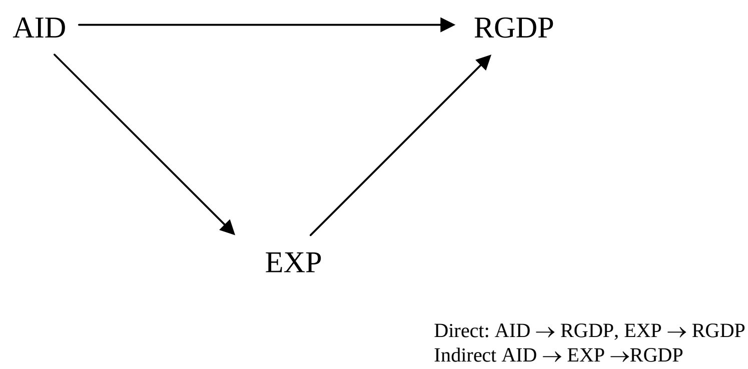
Dependent Variables	ΔRGDP	ΔAID	ΔEXP	ECT	
	χ^2-statistics (p-value)			Coefficient	t-ratio
ΔRGDP	-	12.810 (0.012)*	15.972 (0.003)*	-0.010	-1.204
ΔAID	7.740 (0.102)	-	5.508 (0.239)	-0.137	-2.881*
ΔEXP	2.677 (0.613)	12.845 (0.012)*	-	-0.039	-1.586

Notes: Parenthesized values are the probability of rejection of Granger non-causality. Δ is the first different operator. Estimations are based on the pooled data for 1982-2006 and 5 Pacific Island Countries (N=5, T=25) with three lags. Asterisk (*) shows significance at 5 percent level. All variables are transformed into logarithm form prior to estimation.

The results presented in Table 5 show that the coefficient of the error correction term (ECT) is not statistically significant in the equation with RGDP as dependent variable, indicating the absence of a long run causality relationship running from AID and EXP to RGDP. However, we note the existence of a significant short run causal relationship running from AID and EXP to RGDP, since the estimated coefficients of both the explanatory variables are found statistically significant. Results imply the short-run effectiveness of AID and EXP in generating the growth in the selected PICs.

[4] The F-test or Wald χ^2 of the explanatory variables (in first differences) indicates the short run causal effects ($\pi_{12ip} = 0$ for all i and p) while the long run causal (μ_{1i} =0) relationship is implied through the significance of the lagged ECT which contains the long run information.

Figure 1: Short Run Causality Direction



Note: AID → RGDP implies one-way causality.

In regard to the equation with AID as dependent variable, we find the existence of a long run relationship running from RGDP and EXP to AID. It confirms the normally held view that better growth performance on the part of the aid recipient countries tends to attract steady aid inflows from donors. In the third equation with exports as dependent variable, we note that there is only short-run linkage running from aid to exports. Thus, we obtain the finding confirming the existence in the short run of indirect causality from AID to RDGP through EXP. The directions of causal relationship are illustrated in Figure 1.

4. Conclusions and Policy Implications

Findings of various empirical studies on the nexus between external aid and economic growth during the last two decades differ across countries. In this paper, we focused on five selected PICs by undertaking a panel data analysis for the period from 1982 to 2006. The selected PICs are Fiji, Samoa, Solomon Islands, Tonga and Vanuatu, all of which have a very narrow range of exports with a high degree of import dependence on a wide spectrum of commodities, ranging from food and fuel to intermediate and capital goods.

As PICs suffer from serious data inadequacies, in terms of both quality and consistency, our study was confined to analysis of a set of limited data series. These include aid in aggregated form and exports of goods and services, both expressed as percentages of GDP, and real GDP per capita. We hypothesized that aid money, if devoted to investment expenditures including, physical infrastructures such as rural roads connecting hinterland to ports and jetties, would result in higher export earnings, ultimately leading to growth in per capita incomes. Accordingly, we devised a simple model for undertaking panel data analysis.

Results from the panel cointegration tests reveal that there is a significant, strong and positive association between real per capita income, aid and exports of goods and services in the multi-country panel setting. The FMOLS estimation results for the panel group confirm that aid and exports are directly associated and they positively and significantly influence real per capita income. In the specific country setting, an increase in aid or/and exports would trigger an upward rise in per capita income.

Panel Granger causality test results reveal the existence of direct short run causal relationship running from aid and export to growth in real GDP per capita, implying the effectiveness of these policy variables in generating growth in the selected PICs. Indirectly, aid influences growth through export, which further recognizes the importance of aid to PICs with narrow range of exports. The absence of a long-run Granger direct causal relationship between aid and growth points out to the generally held view that aid cannot be depended upon as a factor for promoting growth in the long run.

The policy implications are clear. The donors and the aid recipient PICs cannot and should not rely upon aid as the main factor for growth in the long run. No doubt, in the short run aid inflows supplement the inadequate domestic savings and enable PICs to invest in the much needed physical infrastructure, thereby enhancing productive capacities towards promoting exports of PICs. However, growth in the long run depends on a host of other factors. The latter include appropriate policies towards domestic resource mobilization and creation of a more conducive investment environment, including political stability. Aid helps the recipient countries only in the short run and is not a permanent remedy to compensate for an apparent lack of supporting factors influencing growth.

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Appendix 1: Cointegration and Fully Modified OLS

I. Pedroni panel cointegration test

There are in all seven panel cointegration tests. Detailed description of the formulae for the seven panel cointegration statistics, are given in Pedroni (1999: 660-661).

A. Within-dimension (panel tests):

a) Panel ν-Statistic
b) Panel Phillip-Perron (PP) type ρ -Statistics
c) Panel Phillips-Perron (PP) t -Statistic (non-parametric)
d) Panel Augmented Dickey Fuller (ADF) t -Statistic (parametric)

B. Between-dimension (group tests):

e) Group Phillip-Perron (PP) type ρ -Statistics
f) Group Phillips-Perron (PP) t -Statistic (non-parametric)
g) Group Augmented Dickey Fuller (ADF) t -Statistic (parametric)

These seven statistics are based on the estimated panel cointegration regression residuals of the likely cointegrating vector

$$RGDP_{i,t} = \alpha_i + \phi_i t + \beta_1 AID_{i,t} + \beta_2 EXP_{i,t} + \varepsilon_{i,t} \qquad \text{(A.1)}$$

varying across countries, thus permitting full heterogeneity (β_i), fixed effects (α_i) and individual specific deterministic trends ($\phi_i t$) across individual members of the panel. Pedroni (1999) shows that under appropriate standardization based on the moments of vector of Brownian motion function, each of these statistics converges weakly to a standard normal distribution when both the T and N of the panel grow large. The standardized distributions for the above mentioned seven panel and group statistics can be expressed in the form of

$$\frac{e_{N,T} - \mu\sqrt{N}}{\sqrt{\nu}} \Rightarrow N(0,1) \qquad \text{(A.2)}$$

where e_{NT} is the respective panel/group cointegration statistic and μ and ν are the expected mean and variance of the corresponding statistics. They are computed by Monte Carlo stochastic simulations and tabulated in Pedroni (1999, Table 2).

Kao panel cointegration test

Unlike Pedroni test, Kao (1999) test specifies cross-section specific intercepts and homogeneous coefficients on the first-stage regressors. In this case, we specified the panel regression model as

$$y_{it} = x_{it}^{'}\beta + z_{it}^{'}\gamma + \varepsilon_{it} \qquad \text{(A.3)}$$

where y_{it} and x_{it} are I(1) and non cointegrated. For $z_{it} = \{\mu_i\}$ Kao (1999) proposed DF and ADF-type unit root tests for ε_{it} where the null is specified as no cointegration.

The DF-type test can be calculated from this regression of:

$$\hat{\varepsilon}_{it} = \rho\hat{\varepsilon}_{it-1} + \nu_{it} \qquad \text{(A.4)}$$

while the augmented version of the pooled specification:

$$\hat{\varepsilon}_{it} = \rho\hat{\varepsilon}_{it-1} + \sum_{j=1}^{p}\varphi_j \Delta\hat{\varepsilon}_{it-j} + \nu_{itp} \qquad \text{(A.5)}$$

where $\hat{\varepsilon}_{it} = \tilde{y}_{it} - \tilde{x}_{it}\hat{\beta}$ and $\tilde{y} = y_{it} - \bar{y}_i$. The OLS estimate of ρ and the t-statistics are given as

$$\hat{\rho} = \frac{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{\varepsilon}_{it}\hat{\varepsilon}_{it-1}}{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{\varepsilon}_{it}^2} \text{ and } t_\rho = \frac{(\hat{\rho}-1)\sqrt{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{\varepsilon}_{it-1}^2}}{s_\varepsilon}.$$

In this case, $s_\varepsilon^2 = \frac{1}{NT}\sum_{i=1}^{N}\sum_{t=2}^{T}(\hat{\varepsilon}_{it} - \hat{\rho}\hat{\varepsilon}_{it-1})^2$. Under the null of no cointegration, Kao (1999) shows that following the statistics:

$$DF_\rho = \frac{\sqrt{N}T(\hat{\rho}-1)+3\sqrt{N}}{\sqrt{10.2}} \qquad \text{(A.6)}$$

$$DF_t = \sqrt{1.25}t_p + \sqrt{1.875N} \qquad \text{(A.7)}$$

$$DF_\rho^* = \frac{\sqrt{N}T(\hat{\rho}-1)\frac{3\sqrt{N}\hat{\sigma}_\nu}{\hat{\sigma}_{0\nu}^2}}{\sqrt{3+\frac{36\hat{\sigma}_\nu^4}{5\hat{\sigma}_{0\nu}^4}}} \qquad \text{(A.8)}$$

$$DF_t^* = \frac{t_\rho + \frac{\sqrt{6N}\hat{\sigma}_\nu}{2\hat{\sigma}_{0\nu}}}{\sqrt{\frac{\hat{\sigma}_{0\nu}^2}{2\hat{\sigma}_\nu^2}+\frac{3\hat{\sigma}_\nu^2}{10\hat{\sigma}_{0\nu}^2}}} \qquad \text{(A.9)}$$

where $\hat{\sigma}_\nu^2 = \hat{\Sigma}_{yy} - \hat{\Sigma}_{yx}\hat{\Sigma}_{xx}^{-1}$ and $\hat{\sigma}_{0\nu}^2 = \hat{\Omega}_{yy} - \hat{\Omega}_{yx}\hat{\Omega}_{xx}^{-1}$. For ADF can be constructed as:

$$ADF = \frac{t_{ADF} + \frac{\sqrt{6N}\hat{\sigma}_\nu}{2\hat{\sigma}_{0\nu}}}{\sqrt{\frac{\hat{\sigma}_{0\nu}^2}{2\hat{\sigma}_\nu^2}+\frac{3\hat{\sigma}_\nu^2}{10\hat{\sigma}_{0\nu}^2}}} \qquad \text{(A.10)}$$

where t_{ADF} is the t-statistics of ρ in equation A.5.

II. Fully Modified OLS Estimates

Following Pedroni (2000, 2001), we consider the following cointegrated system for panel data of

$$Y_{it} = \alpha_i + \beta_i X_{it} + \mu_{it} \qquad \text{(A.11)}$$

$$X_{it} = X_{i,t-1} + e_{it} \qquad \text{(A.12)}$$

where, $i = 1,2,...,N$ countries over the time period of $t = 1,2,...M$. In addition, $Z_{it} = (Y_{it}, X_{it})' \sim I(1)$ and $\zeta_{it} = (\mu_{it}, e_{it})' \sim I(0)$ with covariance matrix of $\Omega_i = \Omega_i^0 + \Gamma_i + \Gamma_i'$, where Ω_0^i is the contemporaneous covariance, Γ_i is the weighted sum of autocovariances while $\Omega_i = L_i L_i'$ in which L_i is the lower triangular decomposition of Ω_i.
For simplicity, we assume that Y = RGDP while X [AID and EXP] of Equation 1 and A.1 in this study. The panel FMOLS estimator for coefficient β is given as:

$$\beta_{FM}^* = N^{-1}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}(X_{it} - \bar{X}_{it})^2\right)^{-1}\left(\sum_{t=1}^{T}(X_{it} - \bar{X}_{it})Y_{it}^* - T\hat{\gamma}_i\right) \qquad \text{(A.13)}$$

where $Y_{it}^{*} = \left(Y_{it} - \overline{Y}\right) - \frac{\hat{L}_{21i}}{\hat{L}_{22i}} \Delta X_{it}$ and $\hat{\gamma}_i = \hat{\Gamma}_{21i} + \hat{\Omega}_{21i}^{0} - \frac{\hat{L}_{21i}}{\hat{L}_{22i}}\left(\hat{\Gamma}_{22i} + \hat{\Omega}_{22i}^{0}\right)$. Likewise, the associated t-statistics for the estimator can be constructed as: $t_{\hat{\beta}_{FM}^{*}} = N^{-1/2}\sum_{i=1}^{N} t_{\hat{\beta}_{FM,i}^{*}}$ where $t_{\hat{\beta}_{FM,i}^{*}} = (\hat{\beta}_{FM,i}^{*} - \beta_0)\left(\hat{\Omega}_{11i}^{-1}\sum_{t=1}^{T}(X_{it} - X_i)^2\right)^{1/2}$.

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