Estimating aid-growth equations: the case of Pacific Island countries

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Abstract

The seminal and controversial work of Burnside and Dollar (2000) has been the basis for many subsequent empirical works on the growth effects of overseas development aid. This paper argues that the specifications used in these works are not consistent with the data and techniques used. We propose a modified production function in which total factor productivity depends on time as well as the aid ratio. Our empirical results show that the effect of aid on the steady state growth rate is insignificant in the selected Pacific Island countries. These countries are of interest because they receive the largest aid in per capita terms.

Keywords: Aid, growth, Burnside and Dollar, GETS, Pacific Island Countries.

JEL Classifications: O11, O23, C53

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1. Introduction

There has been considerable interest in the effect of overseas development aid on the growth rates of the developing countries. Many econometric works have estimated the aid-growth relationships following the seminal but controversial work of Burnside and Dollar (2000) in which they found that aid is more growth effective in countries that meet the conditionality conditions of the large aid giving agencies like the IMF and World Bank. The main conditionality requirements are good governance and good economic policies which generally need longer periods to implement effectively. However, Easterly, Levine and Roodman (2003) have argued that the Burnside and Dollar results are sensitive to the definitions of the variables, extended data and alternative specifications. They concluded that their criticisms reduce confidence in Burnside and Dollar's finding that aid promotes growth in countries with sound policies. But they did not rule out that aid may have some positive effect on the growth rate.

A weakness in the Burnside and Dollar approach is that it is not obvious on which type of growth model their specifications of the growth-aid relationships are based. This was also pointed out by Easterly, Levine and Roodman. We have also reservations on the consistency between the specifications used in Burnside and Dollar and may subsequent empirical works that followed Burnside and Dollar methodology. Irrespective of which growth theory is used (exogenous or endogenous) to derive a specification such as in Burnside and Dollar, it seems that what can actually be estimated with annual time series data or 3 to 4 year growth rates in the panel data models is only a production function. Unless growth rates over twenty years are more are used, the left hand side dependent variable, viz., the growth of output, is unlikely to be representative of the steady state growth rate. If this is accepted, only a production function can be estimated with such short periods of data. Therefore, the growth equations cannot be steady state growth equations. Specifications that fail to recognise this are unreliable because they have serious misspecification biases because they ignored factor inputs in the specifications; see Rao (2007a) for further discussion. The main objective of this paper is to show the usefulness of one such simple modification to estimate properly the steady state growth effects of aid.

This paper is organised as follows. Section two reviews a few empirical works on the growth effects of aid in the Pacific Island countries (PICs). We present empirical results on the effects of aid on growth with our modified production function for selected PICs. Finally, conclusions and limitations are stated in section four.

2. Empirical Work on PICs

Empirical works on the growth effects of aid in PICs have used different approaches and techniques. This is a welcome feature because if different models and methods give similar conclusions, our confidence in their conclusions will increase. However, at the outset, it should be pointed out that the techniques and specifications used in these papers are less than satisfactory and their conclusions differ. Confusion in these works—and in several other similar studies—is due to a lack of realisation that with country specific time series data, it is possible only to estimate a production function or its augmented variants. Many investigators mistake that they are actually estimating a growth equation. This is so because the dependent variable is transformed into the rate of growth of output due to unit roots in the variables. In virtually all empirical works of this nature it is not known whether their specifications are based on the exogenous Solow (1956) model or endogenous growth models of the Romer (1986) and others. As noted earlier no matter which model is used, it is possible only to estimate a production function or its augmented version with annual data because annual frequencies are too short to estimate steady state growth equations. It is possible to derive the steady state growth rate implied by the endogenous models with the estimated parameters of the augmented production function; see Rao (2007b) where estimates of the steady sates growth rates have been derived for selected Asian countries. In the Solow type exogenous growth models the state growth rate is directly estimated as the coefficient of trend in the production function. However, it is possible to modify the Solow model by assuming that total factor productivity (TFP) depends, besides on trend, on other variables like aid etc. The scope for such modifications is limited because the individual effects of several such growth factors cannot be accurately estimated due to multi-colinearity between the variables.[2]

We shall review Feeny's (2005) work on PNG, Jayaraman and Choong (2006) on Fiji, Pavlov and Sugden (2006) and Brindly (2004) on selected Pacific Island countries.[3] This is followed by reviews of Gounder (2001) and Rao and Takirua (2006) and a recent paper by Hansen and Headey (2007).

2.1 Feeny (2005)

Feeny (2005) examined the growth effects of overseas development aid, for brevity aid henceforth, with the bounds test approach in a very comprehensive manner. Although there is some awareness that he is actually estimating an augmented production function, his did not include in the specification the two basic factor inputs viz., capital and labour. However, he has used the investment ratio as a proxy for capital and a time trend as a proxy for employment; see Rao, Singh and Gounder (2007) for some problems caused by investment ratio as a proxy for capital. Neither is satisfactory because investment ratio is not a good proxy for capital and a deterministic trend is mainly used to capture the rate of technical progress (TFP), not employment, in the production functions. The specification of his long run equation in the levels of the variables in his Table 2, contrary to his assertion that the dependent variable is the rate of growth of output, takes the following general form.

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[2] Hoover and Perenz (2004) have pointed out that there are more than 80 potential growth determinants to select from for estimating cross section regressions although the theoretical underpinnings for selecting some of these growth determinants are not always clear. Similarly, Easterly, Levine and Roodman (2003), commenting on the quality of specifications in the cross section studies, have observed that "This literature has the usual limitations of choosing a specification without clear guidance from theory, which often means there are more plausible specifications than there are data points in the sample".

[3] We have ignored several papers on Fiji which are not on the effects of aid, but use similar *ad hoc* specifications to show that a single variable like tourism or defense expenditure or credit creation causes growth in Fiji.

$$\ln Y = a_0 + a_1 \ln INV + a_2 \ln TRADE + a_3 GOV$$
$$+ a_4 SAP + a_5 T + a_6 \ln AID + a_7 CRISIS \qquad (1)$$

where Y is GDP and INV is the ratio of investment to GDP (a proxy for capital), $TRADE$ is the ratio of exports plus imports to GDP, GOV is an index of the quality of governance and SAP takes the value 1 during periods when PNG undertook World Bank structural adjustment, T is trend—a combined proxy for labour and TFP— AID is ratio of aid to GDP and $CRISIS$ is a dummy variable which captures the impacts of shocks not captured by the other explanatory variables; see Feeny (2005) for details.

He finds that only the project aid component of total aid has any significant (at 10% level) positive effects on the growth rate. The elasticity of output with respect to project aid is high at about 1.3. Many of his other variables, especially total aid and the proxy for capital (investment ratio), are found to be insignificant. The coefficient of investment ratio in all his equations is negative indicating that it is not a good proxy for the missing capital variable.[4] All in all, in spite of some hard work and data collection, Feeny's conclusion that project aid has a significant effect on the level of output is not reliable. Therefore, it is necessary to re-examine the validity of this conclusion with a properly specified production function and its augmented versions.

2.2 Jayaraman and Choong (2006)

Jayaraman and Choong (2006) have a good survey of the growth and aid literature but essentially it is a naïve application of the controversial Burnside and Dollar (2000) panel data model to time series data. As in Burnside and Dollar an interactive aid-policy variable has been used. The good policies variable is proxied with the ratio of recurrent government expenditure to total government expenditure. We shall denote this ratio simply as *RATIO*. One would expect a negative coefficient for this variable. Their

[4] For the pitfalls in using the investment ratio as a proxy for capital see Rao, Singh and Gounder (2007).

estimated cointegrating equation, with an additional non-linear aid variable for the period 1970 to 2002 for Fiji is:

$$\begin{aligned}\ln y \;=\; & 33.95 \ln AID \;-3.94\ln AID^{2} \;-125\ln RATIO \\ & +69.09\ln(AID\times RATIO)-0.46\ln RFX \qquad (2)\end{aligned}$$

where y is per capita GDP, *AID* is per capita aid, *RATIO* is the ratio of recurrent government expenditure to total government expenditure and *RFX* is the real exchange rate.

Note that this specification, as in Feeny (2005), does not include capital and labour because the authors do not show much awareness that they can only estimate an augmented production function with annual data. Consequently, this misspecified equation seems to have given some implausible results. Firstly, contrary to the expectation, the coefficient of the *AID* and *RATIO* (proxy for good policy) interactive term is positive. One would expect that higher recurrent government expenditure would have a negative growth effect. Secondly, the correct derivation of the elasticity of output with respect to aid should have been:

$$\frac{\partial \ln y}{\partial \ln AID} = 33.95-7.88\ln AID+69.09RATIO \qquad (3)$$

Jayaraman and Choong ignore *RATIO* (last term above) in their derivation of (3). Equation (3), when correctly derived with the last term, implies that the elasticity of per capita income with respect to per capita aid is 299.88, meaning that a 1% increase in per capita aid will increase per capita incomes by about 300%.[5] This is an incredible finding. Furthermore, this elasticity increases with *RATIO*, which is equally implausible.

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[5] In 2002, *AID* was \$62.62 and *RATIO* was 75.26%. Their log values, respectively, are 4.1313 and 4.3209.

2.3 Pavlov and Sugden (2006)

Pavlov and Sugden (2006) and Brindly (2004) are similar in structure and their specifications are essentially based on the Burnside and Dollar (2000) equations and panel data methodology. Pavlov and Sugden differ from Feeny and Jayaraman and Choong in that they have used simple panel data approach but ignore the panel unit root and cointegration tests and techniques; see Murthy (2007) for an excellent exposition of panel data methods. Pavlov and Sugden's data includes seven PICs with three year rates of growth for the period 1982 to 2004. Since one period lagged value for the explanatory variables were used, there are 49 observations.[6]

Pavlov and Sugden have estimated with OLS two regressions in which the rate of growth of output is the dependent variable. The explanatory variables are: (1) real effective exchange rate (REER), (2) a multiplicative term of fixed exchange rate and real exchange rate (FixedFX×REER), (3) domestic budget financing which is proxied with the ratio of budget deficit to GDP, (4) lending to private sector measured as the ratio of credit to the private sector to GDP, (5) export ratio, (6) World Bank's Country Policy and Institutional Assessment (CPIA) index, (7) an ethnic diversity index, (8) governance index, (9) the ratio of overseas population to domestic population, (10) an index of political freedom, (11) the initial level of GDP, (12) ratio of aid to GDP (ODA) and (13) the square of ODA. They also estimated separately regressions to measure the effect of aid from Australia. Although the selection of the explanatory variables are justified by citing references to many empirical works stimulated by Burnside and Dollar.

Pavlov and Sugden have also estimated the parsimonious versions of their initial regressions (with 11 explanatory variables) by deleting insignificant and correlated

[6] Since the rates of growth of the variables were used for each country there are 8 panels of 3 year averages (e.g., growth rate during1982-1984 etc.,) for the period 1982-2004. However, since the lagged values for some explanatory variables are used, for 7 countries there are 49 panels. The seven countries in this study are: Cook Islands, Fiji, Kiribati, Samoa, the Solomon Islands, Tonga and Vanuatu.

variables. We shall use these parsimonious equations to summarise their main findings. However, in these compact equations with 8 explanatory variables, only 4 variables were significant and these are: World Bank's CPIA, lending to the private sector and aid and its square. Although it should have been desirable to estimate another shorter equation with only these 4 significant variables, their main conclusion, from the aforesaid equations with 8 explanatory variables, is that aid has a significant and positive effect on growth but this effect starts to decrease when the aid ratio reaches about 50% of GDP and becomes zero at 100%. The only country close to the maximum effect of aid is Kiribati where the average aid ratio is 48%. Therefore, it may be said that at the current levels, aid has a positive growth effect in all the seven PICs. Their estimated marginal effect of aid implies that when aid ratio increases by 1%, growth rate increases by 0.42%. Pavlov and Sugden also found that Australian aid has a higher growth effect. A 1% increase in aid from Australia contributes 1.2% to the growth rate. Although these findings appear to be reasonable and pleasing to the donors, further work is necessary because of the weaknesses in the Burnside and Dollar type specifications.[7]

2.4 Brindly (2004)

The approach of Brindly (2004) is closer in spirit to Burnside and Dollar (2000). However, as he has pointed at the outset in the abstract "... while there is statistical support for the hypothesis that aid works in a good policy/institutional environment, its economic significance is marginal. [He] then goes on to show that aid has not been as effective in the Pacific Island countries as compared to the rest of the developing world, even when taking account of factors such as institutional quality, initial income, and country size". In this respect Brindly differs from the previous works that found significant effects for aid and is in agreement with the observations of Hughes (2003) and the findings of Rao and Takuria (2006) for Kiribati.

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[7] Furthermore, as Easterly, Levine and Roodman (2004) have noted, the original Burnside and Dollar specifications are highly sensitive to alternative definitions of the variables and inclusion and exclusion of other explanatory variables.

A simplified version, ignoring the relevant subscripts for cross section specifications, of the basic relationship of Brindly is:

$$\Delta \ln G = f(y, a, p, z, g) \qquad (4)$$

where $\Delta \ln G$ is growth in real per capita GNI, y is the natural logarithm of initial GNI, "a" is the ratio of aid to GNI, "p" reflects the quality of institutions, "z" is a vector of other variables that may plausibly affect growth rates and "g" is a fixed time effect. Brindly also noted that aid flows may be endogenous and as such 2SLS estimates were examined. He has also introduced three multiplicative terms to test if the effects of aid depend on fulfilling the conditionality conditions of the IMF and World Bank. These conditionality effects are tested with multiplicative terms of aid and institutions, policy and a region specific dummy Pacific.

His data for 109 countries are 9 four-year period averages from 1966-1969 to 1998-2001 giving 658 (instead of 981) observations due to the non availability of data for some countries for all the 9 panels. The Pacific Island countries included are Fiji, Federated States of Micronesia (FSM), Kiribati, Marshall Islands, Papua New Guinea (PNG), Samoa, Solomon Islands, Tonga and Vanuatu. However, due to paucity of data the number of observations included for these PICs are as follows: FSM (4 observations), Fiji (8 observations), Kiribati (4 observations), Marshall Islands (1 observation), PNG (7 observations), Samoa (4 observations), Solomon Islands (5 observations), Tonga (4 observations), and Vanuatu (4 observations).

Results with OLS are reported in his Tables 3. Estimates with GLS and 2SLS are only briefly discussed. The effect of aid on growth in the baseline equation in Table 3, without the multiplicative variables, was found to be negative and insignificant. In his preferred equation (3.4) the coefficients of Aid, Aid × Institutions and Aid × Pacific (dummy variable) were all significant. The estimates of their coefficients, respectively, are: 5.92, 8.34 and -6.55. However, the institutions variable was negative, except for Samoa, and ranges from -0.748 for Solomon Islands to 0.48 for Samoa. Therefore, the overall effect of aid is almost insignificant for many PICs. GLS estimate of this equation implied even lower effect for aid on growth. 2SLS estimates of these equations were not robust and sensitive to the choice of instrumental variables. These are not reported.

Brindly then introduced vulnerability variables (remoteness, natural disasters, limited access to external capital and limited size etc.) into the specification and the estimates are given in Table 5. Results in this table use three vulnerability measures viz., a composite vulnerability index (CVI), an economic vulnerability index (EVI) and a general vulnerability index (VI); see Brindly for the construction of these indices and their sources. Both OLS and GLS have been used. In all the six equations in Table 5 the coefficients of Aid, Aid × Institutions, Aid × Pacific (dummy variable) and the vulnerability indices were all significant except in equation 5.1 where CVI was insignificant and in equation 5.3 where the coefficient of Aid was insignificant. However, in none of the equations the coefficient of Aid was large enough to offset the negative effects of Aid × Institutions and Aid × Pacific (dummy variable). Therefore, it may be concluded that the effect of Aid on the growth rate of PICs is negligibly small or even negative.

Brindly's conclusions are noteworthy because they have implications for further work on the growth-aid relationship of PICs and his two main conclusions are:

> "We are, unfortunately, left with an unsatisfying gap in our argument; while the Pacific does appear to have received substantially more aid, and generated less economic growth from it than the rest of the developing world, this paper has been unable to isolate the reasons for this. On the basis of the empirical estimates presented it does not seem to be the result of low institutional quality, as our model does at least take some account of this. Nor does it appear to be due to the relatively small population size of most of the PICs, as this effect is separately accounted for in our model. And finally, published measures of vulnerability – economic and environmental – also appear to be unable to explain the differences." (p. 26).

> "As Roodman [*2003*] notes, the idea that aid works in a good policy environment is an appealing one, with its combination of realism and optimism. However, while this study

> supports this conclusion in terms of statistical significance, it finds that the effect of aid on growth is small compared to the size of the aid flows required to generate this growth.
>
> ".......... the effect of an equivalent increase in aid for a PIC is less than that for other developing countries, even taking account of factors such as the quality of institutions and country size issues." (pp. 27-28).

Brindly's work is noteworthy for the quality of analysis and techniques employed. Although his work and the earlier works have followed, by and large, the seminal approach of Burnside and Dollar (2000), in our view the main weakness in all these approaches is the specification of the growth equation. Since either annual data or averages over 3 to 4 years have been used, the rate of growth in these works is not the steady state growth rate. As pointed out earlier one can only estimate the production function with such data. Since none of these specifications include factor inputs, it is not known the extent to which misspecification biases have affected parameter estimates. Secondly, while Pavlov and Sugden and Brindly have used panel data they have ignored the standard panel data econometric techniques. While the econometric techniques used by Feeny and Jayaraman and Chung for their time series data are quite appropriate, the major weakness in these works is due to the aforesaid specification weaknesses.

2.5 Gounder (2001)

Grounder (2001) estimated an aid-growth relationship for Fiji using various types of aid viz., grant aid, loans and technical cooperation aid for the period 1968 to 1996. She found that total aid and its components have significant impact on growth in Fiji. Although she has used the Solow (1956) model and showed some awareness that the estimated equation is a production function, she has added a number of other variables, following Khan and Reinhart (1990), in a rather *ad hoc* manner and like many others by simply treating them as shift variables. Furthermore, in spite of an elaborate attempt there is confusion on her ARDL specification and derivation of the long run determinants of growth. It is well known that in the Solow model the only long run determinant of the rate of growth of per worker income is the growth rate of technical progress which is given by the coefficient of time in the production function. It is also not clear how her error correction term (ECM) is specified, estimated and tested because no details are given. Her results showed that aid as total and in its various components have a significant impact on the growth rate in Fiji. However, due to the technical and specification weaknesses it is difficult to accept her findings.

2.6 Rao and Takuria (2006)

Rao and Takuria (2006) found that aid has a negative growth effect on the growth rate of Kiribati. As in Gounder, the effects of aid on growth are captured by adding aid as a shift variable into the production function. The estimated equation, with the GETS and NL2S-IV method, is as follows.

$$\begin{aligned}
\Delta \ln y &= \underset{(1.28)}{2.93} - \underset{(-4.31)^{*}}{0.04T} - \underset{(5.56)^{*}}{0.73}(\ln y_{t-1} + \underset{(1.96)^{*}}{0.65}\ln k_{t-1} - \underset{(-2.46)^{*}}{0.07}\ln AID_{t-1}) \\
&\quad + \underset{(3.36)^{*}}{0.44}\Delta \ln y_{t-1} - \underset{(-4.49)^{*}}{3.69}\Delta \ln k_{t-2} - \underset{(-3.53)^{*}}{0.338}Dum90 - \underset{(-1.81)^{**}}{0.31}\Delta \ln AID \qquad (5)
\end{aligned}$$

$$\overline{GR}^{2} = 0.455;\ SER = 0.150;\ \text{Sargan's } \chi^{2}(4) = 2.716[.606]$$

where y is per worker GDP, T is time, k is per worker capital Aid is the ratio of aid to GDP and Dum 90 is a dummy variable for a break in the intercept due to breaks in the trends of many variables. $\overline{GR}^{2}$ is the Pesaran and Smith adjusted measure of correlation coefficient and the Sargan test is for the choice of instruments.

The main merit of this specification is that there is explicit awareness that what is estimated is actually a production function. The results show that technical progress in Kiribati has been negative and aid simply reduced the efficiency of production. Furthermore aid has also a negative effect on the short run growth of output. Rao and Takuria explain the negative effects of aid because aid seems to have created a dependence culture and aid money is mostly spent on consumption goods which consequently created little capacity in the economy. A weakness in this approach is that aid has been added to the production function as a shift variable. Therefore, in this paper the effects of aid on the growth rate of output are not captured. In other words only the level effects of aid are estimated.

2.7 Hansen and Headey (2007)

Hansen and Headey is a more recent work and take a different approach. They are interested in estimating the short run macroeconomic effects instead of the long run growth effects in the works surveyed above. They have used the VAR approach for this purpose and examined how aid affects the external (imports) and domestic components of demand of 22 small developing countries. These effects are also known as the absorption (net imports) and expenditure effects (government budget deficit net of aid).

Hansen and Headey discuss elegantly various macroeconomic effects of aid through absorption and expenditure effects; see section 2 of their paper. One such effect is of interest here viz., the effect of aid on investment and productivity enhancing factors like skills through improvements in education and health. The equation used for estimation is the standard equilibrium condition in the short run macroeconomic models. For simplicity we suppress the cross section country and time subscripts. With this simplification this equation is:

$$Y = C + I + X - M + R \qquad (6)$$

where Y is GDP, C is total consumption (the sum of household consumption and government consumption), I is gross fixed capital formation, X is exports of goods and services, M is imports of goods and services while R is inventory investment. The above can be expressed in growth rates as follows:

$$\begin{aligned} y &= c + i + x - m + r \\ &= d + x - m + r \qquad (7) \\ where\, d &= c + i \text{ and } y = \frac{\Delta Y}{y},\ c = \frac{\Delta C}{Y} \ldots etc \end{aligned}$$

Similarly aid flow is measured as $a = \Delta aid/Y$.

Hansen and Headey have selected five variables for the VAR model viz., output (y), aid (a), expenditure (d), exports (x) and a measure of natural disasters (W). Inventory investment is ignored because for many countries it was zero and imports are dropped because it can be ignored due to the income identity; see equation (6) in Hansen and Headey. Much of the discussion before their conclusions is technical and is on VAR methods of estimation, impulse responses and decomposition of these impulse responses. Impulse responses generally measure the effects of a one percent change in or shock to say aid on other variables like y, d, x and m. Their three main findings can be stated as follows.

1. Aid flows are highly volatile and unpredictable. Therefore there is a need for aid smoothing in the aid-dependent countries.

2. Although the sample of countries is relatively homogenous, there is evidence that they have reacted diversely to changes in aid flows.

3. In the highly aid-dependent countries most aid is both absorbed and spent. However, they appear to spend more than they absorb, which may lead to short-run macroeconomic imbalances.

It is not known from this interesting work what proportion of spending consists of increase in investment and increase in consumption. If these components are estimated it might have been possible to say how aid affects investment and therefore growth rate in an indirect way.

3. Further Empirical Results

Our survey of earlier works revealed that many empirical works on the effects of aid on growth have both specification and estimation weaknesses. Therefore, in this section we present results based on what we believe to be a more satisfactory specification for estimation with country specific time series data. Panel data estimation with these data is outside the scope of this paper.

We first present a few results for Fiji based on our approach. We then briefly present some results for the Solomon Islands and PNG. These three countries have relatively large populations among the PICs.

The specification of our production function is the standard Cobb-Douglas production function with constant returns and Hicks neutral technical progress (in per worker units) is:

$$y_t = A_0 e^{gt} k_t^a \qquad (8)$$

where y is output per worker, A_0 is the initial stock of knowledge, assumed to grow at the rate of g per period and k is capital per worker. Since the variables have unit roots[8], our estimate of this basic output equation for Fiji with the GETS formulation and the two stage non-linear instrumental variables method (2SNLLS-IV) is as follows.[9]

[8] We have used the ADF and Generalized ADF tests and found that all the variables in our regressions have unit roots. To conserve space these results are not reported.

[9] Lagged values of the variables are used as instruments. The Sargan Chi-square test was insignificant at the 5% level indicating that our choice of instruments is appropriate.

$$\Delta \ln y_t = -1.31(\ln y_{t-1} - 2.365 + 0.005T + 0.225 \ln k_{t-1})$$
$$\quad (7.85) \qquad (42.75) \quad (13.68) \quad (8.93)$$
$$0.375 \Delta \ln k_t \text{-} 0.024 COUP + 0.042 DUM95 \qquad (9)$$
$$(3.93) \qquad (2.25) \qquad (3.82)$$

$\bar{R}^2 = 0.752$; Sargan's $\chi^2 = 2.257[.813]$ $\chi^2_{sc} = 0.821[0.37]$;
$\chi^2_{ff} = 0.033[0.86]$; $\chi^2_{n} = 0.725[0.696]$; $\chi^2_{h} = 0.594[0.441]$

T is time trend, *COUP* is a dummy for the political coups and *DUM95* is a dummy to capture investment and export incentives in 1995. T-ratios are in the parentheses below the coefficients. The χ^2 test statistics, with *p*-values in the square brackets, are for serial correlation, functional form misspecification, non-normality in the distribution of residuals and heteroscedasticity. The insignificant Sargan test indicates that our choice of instruments is valid.

The above equation is well determined and the Ericsson-MacKinnon (2002) cointegration test statistic indicates cointegration. The estimated share of profits at 0.22 is plausible but less than its stylized value of 0.3. The coefficient of trend at 0.005 indicates that TFP in Fiji is low confirming the growth accounting finding. This is our baseline equation for comparisons.

We report now estimates of an *ad hoc* specification, without capital and labour, to capture the effects of aid.

$$\Delta \ln y_t = -0.770(\ln y_{t-1} \text{-} 3.356 + 0.003T + 0.06526 \ln aid_{t-1})$$
$$(4.86) \qquad (16.44) \quad (2.27) \quad (2.99)$$
$$0.108 \Delta \ln aid_t + 0.021 DUM95 \qquad (10)$$
$$(4.19) \qquad (1.99)$$

$\bar{R}^2 = 0.306$; Sargan's $\chi^2 = 6.8895[.441]$ $\chi^2_{sc} = 0.365[0.546]$
$\chi^2_{ff} = 0.000[0.99]$; $\chi^2_{n} = 1.133[0.568]$; $\chi^2_{h} = 0.085[0.771]$

As our baseline equation, this equation is also well determined. However, the Ericsson-MacKinnon test implies that there is no cointegration. Subject to this caveat, the above results show that aid has a significant permanent level effect and a short run growth effect. A 10% increase in aid temporarily increases growth rate by 1% and the level of output permanently by 0.6%. These results seem more plausible than the findings of Jayaraman and Choong (2006). However, compared to our baseline equation, the overall explanatory power of this equation is poor because its adjusted R^2 of 0.306 is less than half of 0.752 in the baseline equation.[10]

Since it is hard to imagine a production function without capital and labour, we shall estimate a production function augmented with the aid variable. There are two ways of introducing aid into the production function. Firstly, it may be assumed that aid impinges on the infrastructure of the economy as in the endogenous growth models; see Feeny (2005) for an explanation. Secondly, it is difficult to extend the Solow (1956) exogenous growth model for aid to have permanent level effects like human capital as in Mankiw, Romer and Weil (1992). This approach is possible only if it can be justified that aid has an impact on the productivity of labour and/or capital and that may be only a possibility.

We shall use a new approach where in the Solow model, aid is assumed to have a permanent, albeit perhaps a very small growth effect. Our approach is purely empirical in spirit to capture the permanent growth effects of any growth improving variable(s) that have been rationalized by the endogenous growth models.

In the Solow (1956) model the steady state growth rate is given by g in equation (8) which in turn is assumed to depend only on time. In other words the unknown determinants of TFP in the production function are assumed to be highly trended. Therefore, the Solow residual may also be called as our measure of ignorance of the determinants of growth. We now assume that TFP depends on some variables, in addition to time, that have been identified to have permanent growth effects e.g., aid,

[10] Addition of the square of aid or the Burnside-Dollar (2000) type of aid-policy interactive term did not improve the results.

openness of the economy and human capital etc. Therefore, if aid has a permanent growth effect, the earlier Cobb-Douglas production function in equation (7) can be modified by expressing $g = (g_1 + g_2 aid)t$ and the production function may be written as:

$$y_t = A_0 e^{(g_1 + g_2 aid)t} k_t^a \qquad (11)$$

Note that if aid has no permanent growth effect g_2 will be insignificant and *TFP* depends only on the time trend. Other alternative forms are also possible, e.g., $gg_1 + g_2 aid^{-1})t$ and $(g_1 t + g_2 aid)$ etc. In the latter formulation the evolution of the stock of knowledge is assumed to be $A_t = A_0(e^{g_1 t} e^{g_2 aid_t})$. This formulation was used by Bloom, Canning and Sevilla (2004) to capture the effects of health on growth. A disadvantage with this formulation is that it is difficult to say that aid or health has a permanent growth effect because by growth we mean a certain rate of increase in output per period. The advantage of the inverse form (given above) is that the growth effects of aid and similar variables will eventually taper off. Such a specification is useful to offer support with the exogenous models to Jones' (1995) criticisms that there is no evidence from time series data that growth has increased proportionately with the observed persistent increases in growth factors like R&D and investment expenditures.

The estimate of this equation with GETS formulation and the NLLS-IV method for Fiji is as follows.

$$\begin{aligned}
\Delta \ln y_t = -&1.381(\ln y_{t-1} \text{-} 3.273 + (0.007 + 0.000 \ln aid_{t\text{-}1})T + 0.223 \ln k_{t-1}) \\
&(8.09) \qquad\quad (44.44) \;\; (1.02) \quad (0.17) \qquad\qquad\quad (9.78) \\
&0.400 \Delta \ln k_t \text{-} 0.022 COUP + 0.045 DUM95 \qquad\qquad\qquad\qquad (12) \\
&(3.28) \qquad\quad (3.33) \qquad\quad (3.43)
\end{aligned}$$

$\bar{R}^2 = 0.739$; Sargan's $c^2 = 5.307[0.505]$; $c^2_{sc} = 0.270[0.604]$;
$c^2_{ff} = 0.26[0.871]$; $c^2_{n} = 0.621[0.733]$; $c^2_{h} = 0.768[0.381]$

This equation is well determined and its summary statistics are comparable to the baseline equation. The Ericsson-MacKinnon test implies cointegration.[11] Note that the growth effect of aid is almost zero and insignificant, which is not an unexpected result. We have also estimated a non-linear specification for the effects of aid where the reciprocal of the aid was used, but the coefficient of aid was again insignificant. Finally, we estimated the baseline equation by modifying so that aid has only a temporary growth effect. Neither the current nor the lagged values of the change in the log of aid were significant. Therefore, we may say that total aid does not seem to have any significant effects on the level or growth of output in Fiji. However, it is likely that some components of aid, e.g., project aid, as in Feeny (2005) for the PNG, may have a significant effect. We hope to investigate such effects of aid in a later work. The main conclusion from this is that the effects of aid (or any other growth and/or output enhancing variable) are likely to be biased if such equations are estimated with misspecified equations and without including capital and labour in the production function.

Given below are some results on the effects of aid in the Solomon Islands. These results further confirm our findings for Fiji. The comparable equations viz., baseline equation, an *ad hoc* growth-aid equation and an equation with the augmented production function have been estimated. The baseline equation is as follows.

$$
\begin{aligned}
\Delta \ln y_t = -0.464(&\ln y_{t-1} - 3.030 + 0.018T + 0.290 \ln k_{t-1}) \\
&(7.71) \qquad (5.32) \quad (2.57) \quad (1.88)^{*} \\
&0.640\Delta \ln k_t \text{-} 0.140\text{DUM98} \qquad\qquad (13) \\
&(7.87) \qquad (3.68)
\end{aligned}
$$

$\bar{R}^2 = 0.875$; Sargan's $c^2 = 5.307[0.505]$; $c^2_{sc} = 4.82[0.03]$;

$c^2_{ff} = 0.266[0.61]$; $c^2_{n} = 0.174[0.92]$; $c^2_{h} = 0.930[0.34]$

[11] There is generally a misperception that the estimate of the adjustment coefficient should be less than unity i.e., $| l | < 1$. While when l less than unity, convergence is would be smooth, when it is more than unity convergence would have cycles. When there is an ECM adjustment mechanism, there would be always convergence.

An asterisk indicates significance at 10% level. GETS formulation of the arbitrary aid equation did not produce any meaningful results. However, the Johansen maximum likelihood method gave the following cointegrating and short run dynamic ARDL equations, respectively.[12]

$$\ln y = 1.481 \ln aid - 0.112 \ln aid^2 \qquad (14)$$

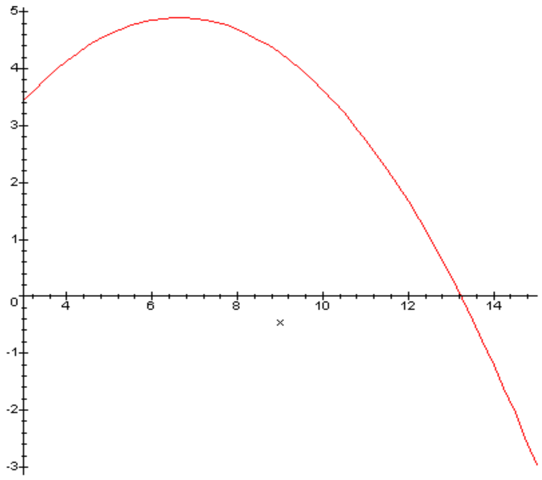
$$\begin{aligned}
\Delta \ln y_t = {} & \text{-}9.1883 + 0.008\text{T} - 0.575 ECM_{t-1} \\
& (5.30) \qquad (2.94) \qquad (5.32) \\
& 0.095 \Delta \ln y_{t-1} \text{-}1.316 \Delta \ln aid_{t-1} + 0.099 \Delta \ln aid^2{}_{t-1} \qquad (15) \\
& (0.55) \qquad (3.01) \qquad (2.90)
\end{aligned}$$

$\bar{R}^2 = 0.519$; $c^2_{sc} = 0.136[0.712]$; $c^2_{ff} = 0.297[0.59]$; $c^2_{n} = 6.516[0.04]$; $c^2_{h} = 0.085[0.77]$

The above equation gives a plausible result that aid has a positive and a non-linear declining effect on output. The plot of output (log output per worker on the vertical axis) and aid (log aid per worker on the horizontal axis) is given in Figure-1 and implies that aid reaches its maximum effect when log aid is 6.62. The mean value of log aid (per worker) is 6.26, implying that in the Solomon Islands aid is at its near maximum positive effect.

[12] A 2nd degree ARDL is used and the computed Eigen value test statistic (with 5% critical values in brackets) for the null of no cointegration is 25.52 (24.35) and for the null that there is at most one cointegration vector is 12.37 (18.33). That the cointegration vector is for output is also tested. The lagged ECM, normalized on output, is insignificant in the aid equation. The estimated coefficient has the wrong sign of 1.259 with a p-value of 0.15. It is pointless to test that this equation is for the square of aid.

Figure -1



When we have estimated the aid equation with per worker capital with the Johansen method, the coefficient of capital was negative. Therefore, we have estimated this equation with the GETS specification and obtained the following.

$$\begin{aligned}
\Delta \ln y_t = & -0.509(\ln y_{t-1} - 3.255 + (0.025 - 0.001 \ln aid_{t-1})T + 0.236 \ln k_{t-1}) \\
& \quad (7.71) \qquad\qquad (6.35) \quad (3.48) \quad (0.55) \qquad\qquad\qquad (1.72)^{*} \\
& 0.598 \Delta \ln k_t \text{ -}0.167 DUM98\text{-}0.119 DUM81 + 0.008 \Delta \ln aid_{t\text{-}1} \\
& \quad (3.90) \qquad (6.97) \qquad\qquad (3.32) \qquad\qquad (0.29)
\end{aligned} \tag{16}$$

$\bar{R}^2 = 0.862$;Sargan's $c^2 = 2.853[.583]$; $c^2_{sc} = 3.651[0.06]$;
$c^2_{ff} = 0.098[0.76]$; $c^2_n = 0.377[0.83]$; $c^2_h = 0.719[0.40]$

Although the summary statistics of this equation are satisfactory, the coefficient of aid is negative and insignificant. It was necessary to include an additional dummy variable

DUM81 and an insignificant lagged change in aid to make the coefficient of capital significant.[13] Estimates with a non-linear aid variable did not produce any sensible result.

We have a limited amount of data on aid for the PNG and the estimates of the baseline production function did not produce plausible results for the period 1978 to 1999. Therefore, we constrained the coefficient of capital to 0.3 and estimated an augmented aid equation to get the following:

$$
\begin{aligned}
\Delta \ln y_t = & -\underset{(2.19)}{0.356}(\ln y_{t-1} - \underset{(180.38)}{8.896} + (\underset{(6.71)}{0.087} - \underset{(5.62)}{0.032}\ln aid_{t-1})T + \underset{\text{(constrained)}}{0.30}\ln k_{t-1}) \\
& \underset{(2.34)}{0.304}\Delta \ln k_t - \underset{(1.60)}{0.212}\Delta \ln aid_{t-1} - \underset{(6.02)}{0.071}CRISIS \qquad (17)
\end{aligned}
$$

$\bar{R}^2 = 0.395$;Sargan's $\chi^2 = 3.191[.671]$; $\chi^2_{sc} = 1.134[0.287]$;
$\chi^2_{ff} = 6.253[0.012]$; $\chi^2_n = 1.142[0.565]$; $\chi^2_h = 0.688[0.41]$

where *CRISIS* is a dummy variable, as in Feeny (2005), taking values of unity in 1989, 1994 and 1997. Although the summary statistics of this equation are not comparable to our estimates for Fiji and the Solomon Islands, the effects of aid (as a ratio to GDP) on growth are negative in the short and long runs. *Ad hoc* specifications with aid variable alone did not yield any meaningful results.

These results, although selective, indicate that when country specific time series estimates are based on misspecified equations, they are unreliable. Our results for Fiji, Solomon Islands and PNG should be seen as examples of the consequences of such misspecifications. This calls for, as in Feeny's (2005), to disaggregate aid into, at the least, into project and non-project components. Perhaps the former may have some

[13] The DUM81 variable is added because when we have tested with the Gregory and Hansen (1996) method for cointegration with structural breaks, in all the four types of models the break point is found to be 1981. However, it should be noted that the Gregory and Hansen method is appropriate for the Engle-Granger two-step method and not for GETS. Furthermore, the Ericsson-MacKinnon test indicates that there is no cointegration in the above equation. Addition of a non-linear aid term gave similar weak results.

effects on the growth rate. Given that, much attention is given to the effects of aid on growth with a view to derive generalized guidelines for aid allocation and the current dominant view that aid is more effective in countries with good economic policies and institutions is difficult to accept. In our view it is useful to investigate how aid can be made more effective in a country or region than developing some questionable aid effectiveness rule as if it is a universal law.

5. Conclusions and Limitations

This paper has briefly reviewed the literature on the aid-growth relationship with respect to the Pacific Island countries. This review showed that all the empirical works on the PICs have closely followed the specification and methodology of Burnside and Dollar (2000). It is pointed out that there are serious misspecification errors due to the need to estimate the steady state growth equations and the short period values of the variables used. Such data can only be used to estimate the production functions but not steady state growth equations. Consequently there are significant differences between the conclusions of some papers that aid is effective in improving growth rates and others that the growth effects of aid are insignificant in the PICs. The latter view is supported by our results based on a modified production function which has been extended to capture the effects of aid on the steady state growth rate of output in Fiji, PNG and the Solomon Islands. Our empirical finds support some controversial conclusions by Hughes (2003) that aid has been often misused in the PICs.

The aforesaid conclusions are subject to several caveats. Firstly, we have examined evidence from only three larger countries. Secondly, we did not allow for the conditionality variables to play any role. Thirdly, we have ignored all other important growth enhancing variables like learning by doing, education and health etc. Finally, given that the country specific samples are small it should have been better to estimate the relationships with the appropriate panel econometric methods. For these reasons our attempt should be seen mainly methodological on the specification of the aid-growth relationship. It is hope that other scholars will follow some of our guidelines and fill various gaps in the existing literature.

Data Appendix

y is output per worker obtained as a ratio of GDP (1990 prices) to the labour force. Data on GDP is obtained from the United Nations database (2006) and Asian Development Bank database (2006). Labour force data is obtained from the World Development Indicator (2003) and interpolated (from 2000-2005) using that proportion of working age (15-64) to total population.

k is capital per worker computed as the ratio of real stock of capital to labour force. Capital stock is estimated using the perpetual inventory method with 4% rate of depreciation.

Aid is the ratio of total aid to GDP. Data obtained from the World Development Indicators (2005) and from 2000-2005, the aid ratio is estimated using data from Asian Development Bank's website.

COUP is a dummy for the political coups in Fiji. It takes a value of unity in 1987 and 2000 but zero otherwise.

DUM81 resembles the break point in data as suggested by Gregory and Hansen's (1996) tests for structural breaks. It takes a value of unity since 1981 to 2005 and zero otherwise.

DUM95 captures investment and export incentives in Fiji in 1995. It takes a value of unity in 1994-1996 and zero in the periods.

DUM98 captures the effects of devaluation of the Fiji dollar in 1998. It takes a value of unity in 1988-1989 and zero in the periods.

CRISIS is a dummy variable which takes values of unity in 1989, 1994 and 1997 but zero otherwise.

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