THE STATISTICAL RELATIONSHIP BETWEEN IMPORTS OF INVESTMENT GOODS AND GROSS DOMESTIC PRODUCT IN DEVELOPING COUNTRIES

This paper examines the statistical relationship between imports of investment goods and gross domestic product for twelve developing countries. We find that the association is a highly significant one in a statistical sense. We reach this conclusion by re-interpreting the results presented in a recent paper by David Wall.[1]

Wall fitted the following regressions (Y is adjusted gross domestic product, X is imports of investment goods, X^1 is imports of raw materials and industrial inputs, X^2 is imports of machinery, and t indicates the time period[2]):

$$(1) \quad Y_t = \alpha_0 + \alpha_1 X_t$$

$$(2) \quad Y_t = \beta_0 + \beta_1 X_{t-1}$$

$$(3) \quad Y_t = \Theta_0 + \Theta_1 X^1_t + \Theta_2 X^2_{t-1}$$

$$(4) \quad \log Y_t = \lambda_0 + \lambda_1 \log X_t$$

The regressions are fitted for 12 countries; as there are only eight observations for each country[3] and as lagged values are used in some regressions, the degrees of freedom available vary from four to six.

Table 1 gives the t-values obtained in the various regressions and one star and two stars denote values that are positive and significant at the ten and five per cent levels respectively using a one tail test. For the purpose on hand a one tail test is appropriate as the hypothesis being tested is that imports of investment goods and gross domestic product are positively correlated. In order to make a satisfactory test of the hypothesis it is necessary to con-

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1. D. Wall, "Import Capacity, Imports and Economic Growth", *Economica*, May, 1968, pp. 157-68.

2. More precisely, Y is gross domestic product adjusted to remove annual fluctuations in agricultural output by the substitution of the trend value of agricultural output for the actual value, X^1 is SITC groups 2–6, X^2 is SITC group 7 less 732, and $X = X^1 + X^2$.

3. The data consist of annual observations for the period 1955-62.

TABLE I

t-values of Coefficients

Equation Number	1	2	3		4
Degrees of Freedom	6	5	4		6
Coefficient	α_1	β_1	Θ_1	Θ_2	λ_1
1. Argentina	2.29**	1.11	−0.47	1.58*	2.04**
2. Brazil	1.80*	1.98*	0.09	0.85	1.93*
3. Columbia	−0.95	−1.14	−2.20	0.69	−0.84
4. Ecuador	3.21**	2.82**	1.59*	1.69*	3.04**
5. Honduras	5.83**	5.41**	4.80**	1.06	5.81**
6. Mexico	0.80	0.56	−0.28	0.21	0.88
7. Panama	12.13**	7.29**	5.81**	0.89	15.12**
8. Burma	0.69	0.23	0.42	−1.76	0.89
9. Ceylon	2.04**	2.38**	1.53**	0.51	2.16**
10. Korea	4.60**	4.23**	1.28	3.83**	3.47**
11. Philippines	1.84*	2.04**	0.75	1.22	1.86*
12. Nigeria	4.83**	4.07**	3.34**	2.23**	4.86**

sider the whole set of results and consider whether the observed set of results could be obtained by chance.[4]

There are two approaches one may use to decide whether the observed regression results support the contention that there is a positive statistical association between G.N.P. and imports. First, if one grants the necessary statistical assumptions in order for the t-tests to be applicable, then the binomial distribution can be applied to test whether or not the observed number of significant regression coefficients is likely due to chance. If the regression coefficients are in truth zero or negative then the probability of observing a single coefficient which is significantly positive at the ten per cent level is less than or equal to one in ten. If the regression coefficients between countries are independently distributed then the probability of observing k significant coefficients out of n when the level of significance used is γ is less than or equal to $\sum_{k}^{n} \binom{n}{k}(1-\gamma)^{n-k}(\gamma)^{k}$. Thus for equation (1) in Table I

4. Wall does not do this. Wall observes (*ibid*., p. 164) that "in only four cases (Panama, Honduras, Korea and Nigeria) were good fits with significant coefficients obtained". He reaches this conclusion by picking the highest t-value for a country and seeing if it is significant at the one per cent level. (Wall does not specify the significance level that he is using but reference to tables of the t-distribution indicates that his statement is consistent with the adoption of a one per cent significance level for either a one or two tail test but is inconsistent with the adoption of a five percent significance level for either a one or two tail test as then more than four countries would have significant t-values.)

there are nine coefficients that are positive and significant at the ten per cent level. The probability of observing this number or more when the true value of these coefficients is zero or negative is less than .00005.[5] The results of the tests utilizing this approach for $\gamma = .05$ and .1 are presented in Table II. The highest probability obtained is less than .007. This provides strong support for the hypothesis that G.N.P. and imports are positively associated.

TABLE II

Probabilities by Obtaining Observed Results by Chance

Equation number	1	2	3	4
n	12	12	24	12
Number of coefficients significant at 5 per cent level (k)	7	7	5	7
Probability of observing k or more out of n, $\gamma = .05$	< .00005	< .00005	< .00700	< .00005
Number of coefficients significant at 10 per cent level (k)	9	8	9	9
Probability of observing k or more out of n; $\gamma = .10$	< .00005	< .00005	< .00038	< .00038
Number of positive coefficients (k)	11	11	20	11
Probability of observing k or more out of n; $\gamma = .5$	.00310	.00310	< .00200	.00310

5. It is necessary to give probabilities as less than a certain level because of lack of sufficient detail in the standard binomial tables.

The second approach which can be used to analyze the significance of the reported regressions is distribution free. If there is either a negative or zero relationship between the dependent and independent variables in the regressions then the probability of observing one half or more of them positive is less than or equal to one half. We can utilize a binomial distribution with $\gamma = .5$ to test whether or not k or more positive coefficients out of a total of n is likely on the basis of chance. Thus for equation (1) there are 11 positive coefficients out of 12. If in truth there is no correlation between the two variables the probability of observing this many (or more) positive coefficients is .0031. The results of this test are also given in Table II. The probabilities here are higher than for the previous test for it makes weak statistical assumptions and is in fact distribution free. The highest probability is .0031. Again strong support of a significant positive correlation is provided.

Whichever approach to examining the whole set of regression results is adopted, the probability of obtaining the observed results by chance is very low.[6] We thus conclude that the evidence strongly supports the view that, for the developing countries covered in this study, there is a significant positive association between imports of investment goods and growth.

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6. Note that the tests being applied here assume that the same functional form is appropriate in all twelve countries. If this assumption were relaxed, so that the best fitting regression were taken in each case, we have k equal 8, 9, and 12, for γ equals .05, .10, and .5 respectively. The probabilities for the first two are both less than .00005 and for the last, .00020.