An Empirical Investigation into the Causes of Economic Growth in the Third World Using Full Information Maximum Likelihood Estimators

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Introduction

The literature has quite extensively dealt with investigations into the determinants of economic growth in cross-national studies. The models mostly used in prior studies are derived from standard neoclassical economic theory, where the growth rate of real GDP is modelled as a function of the growth rate of the capital stock, the growth rate of the labor force, and also the growth rate of exports.[1] These models are based on two major assumptions : (1) the growth rate of the inputs constrain the rate of growth of output and (2) countries face financing "gaps" which constrain their financing of investment and imported goods for economic growth. As a result, the standard empirical analyses in the literature into the determinants of economic growth traditionally begin by finding the OLS estimate where the rate of growth of real GDP is the dependent variable and the share of investment in the GDP (used as a proxy for the growth rate of the capital stock), the growth rate of the labor force, and the growth rate of exports are the independent variables.[2] Other independent variables have been added depending on the model tested.

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1. See Esfahani [1991], Feder [1983], Heller and Porter [1978], Humphries [1976], Michaely [1977], Otani and Villanueva [1990], Ram [1990], Robinson [1971], and Stern [1991], for examples.

2. Ram [1990] for instance uses the growth rate of imports instead of exports. Feder [1983] uses both the growth rate of exports and the growth rate of exports multiplied by the share of exports in GDP.

Most cross-national investigations contain no accounting for potential simultaneity bias among the dependent and independent variables. Further, the investigation of the direction of causality has usually been studied only using time-series studies.[1] The problem with time-series analysis of the determinants of economic growth is that we cannot draw general conclusions from the results of a particular time-series analysis unless the results from those time-series analyses are replicated among a large sample of countries. This is generally not the case.

Ignoring simultaneity in cross-national studies is so commonplace that accounting for simultaneity has often been summarily dismissed.[2] Thus, the major contribution of this paper to the literature is the use of full information maximum likelihood (FIML) estimators to account for the possibility of bias in the OLS estimates created by the existence of simultaneity. This paper also introduces 3 additional explanatory variables which significantly help to explain the variation in growth rates of real GDP.

The empirical results contained in this paper illustrate that some of the conclusions one might draw using OLS analysis may be incorrect. Apparently, some of the statistically significant correlations that are present when using OLS estimates of the model are a result, not of causality, but more of effect or simultaneous determination. Several of the statistical correlations computed OLS are not duplicated using the FIML technique of parameter estimation.

The Data and Period Analyzed

This paper's empirical analysis encompasses two decades, one from 1960-70 and the other from 1970-81. The latter period ends with 1981 because after that date, the World Bank ceases to disaggregate mining, an important independent variable, from industrial production data. Further, the effect of the second oil shock is so severe that the tremendous fall in real GDP after 1981 obscures correlations. Two separate time periods are analyzed to test whether the choice of time period effects the results. The FIML estimates are importantly different from the OLS estimates in both time periods. The analysis includes all developing countries for which the necessary data are available are included in the analysis. For the period 1960-70 there are 66 countries and for the 1970-81 time period, 67 countries. Afghanistan, included in the earlier period is not included in the later period beacuse the necessary data stops after 1978.

The Standard Model

The standard neo-classical growth model can be expressed as :

$$YDOT = a_0 + a_1 \, INV + a_2 \, LDOT + a_3 \, XDOT + \mu \tag{1}$$

where μ is the stochastic error term, a_0 is the constant term and :

1. There have been some studies done, such as Salvatore [1983] and Esfahani [1991], for example have attempted to account for simultaneity in cross-national studies.
2. See discussion in Feder (1983) for example.

YDOT = The growth rate of real GDP for the period from 1960-1970 and for 1970-81.

INV = the average share of investment in GDP during the period from 1960-70 and 1970-81 expressed as a percent.

LDOT = the growth rate of the labor force from 1960-70 and from 1970-80.[1]

XDOT = the growth rate of real exports from 1960-70 and from 1970-81.

For the periods from 1960-70 and from 1970-81 respectively, the OLS estimates of equation 1 are :

$$YDOT = -0.59 + \underset{(3.62)}{0.16INV} + \underset{(3.29)}{1.06LDOT} + \underset{(2.13)}{0.081XDOT} \tag{2a}$$

$R^2 = 0.44$ s. e. e. = 1.64 F-stat = 16.53

$$YDOT = -1.48 + \underset{(2.65)}{0.088INV} + \underset{(3.33)}{0.88LDOT} + \underset{(4.29)}{0.22XDOT} \tag{2b}$$

$R^2 = 0.41$ s.e.e = 1.98 F-stat = 14.89

where t-ratios are in parenthesis below the coefficient and s.e.e. is the standard error of estimation. Equations (2a) and (2b) show that the coefficients all have the expected signs and are statistically significant at one percent level except for the coefficient on XDOT in (2a), the period from 1960-70, which is significant at only the four percent level. In both cases, between 40 and 45% of the variation in YDOT is explained by this model.

The OLS estimates presented above may lead the investigator to errantly conclude that higher levels of investment in GDP, a faster growth rate of the labor force, and a higher rate of export growth (export promotion) will "cause" a higher growth rate of real GDP. Many studies drawn these conclusions. Again, the purpose of this paper is to explore whether or not these conclusions would differ if we account for simultaneity.

The OLS analysis indicates that a faster growth rate of the labor force is correlated with a faster growth of real GDP. A more interesting relationship is that between LDOT and YPCD, which denotes the growth rate of real GDP per capita. As it will be shown later most of the variation in LDOT is explained by the growth rate of the population, PDOT. If a higher LDOT is merely the result of a higher population growth , then *income per capita* may not rise because of a rise in LDOT, only the growth of total income may rise more. Thus, it is important to focus the analysis on the growth rate of real GDP per capita, YPCD. Therefore, the dependent

1 The period from 1970-80 is used because of data availability.

variable used to measure growth is YPCD rather than YDOT as in most previous studies.[1]

Extending the Model

The first step in the empirical analysis is to add three variables which help to explain the variation in growth rates among countries which are not simultaneously determined by the growth rate of GDP. Thus, the model presented in equation (1) is modified not only by changing the dependent variable from YDOT to YPCD, but also by adding the variables SAH, MIN, and OIL which are explained below.

The variable SAH is a dummy variable for the countries of the African sahel region, where frequent droughts have wreaked havoc upon the agricultural output of these countries. The variable SAH has the value 1 for the countries in the region that experienced great difficulties during the period under investigation, 0 for all other countries.[2]

The variable MIN is the average share of mining in GDP during the period in question. The importance of including this variable is that many of the international prices for minerals plummeted during these two decades, causing a loss of export earnings and a decline in the value of output generated from mining. The economies of Zambia, Zaire, and Bolivia, for example were very dependent upon the earnings generated from their mining activities throughout the 1950's and 60's. These economies experiences significantly slower economic growth during the decades in question than in the prior decade.

The third variable added is OIL, a dummy variable with the value of MIN for the oil exporting countries, zero for all others.[3] This method gives a better fit than assigning the same value (one) to all oil exporters, no matter how much oil they exported. Since petroleum production is counted under mining in the *World Tables*, MIN is used as an approximation of the relative exports of oil in GDP. This variable is included because the oil exporters were expanding more rapidly because of the increasing demand for oil and the rising price for oil, especially after 1973. As expected, this variable is not statistically significant for the 1960-70 period, but is extremely significant for the 1970-81 period.

Incorporating the new variables, the model becomes :

$$\begin{aligned} YPCD = b_1 + b_2INV + b_3XDOT + b_4LDOT \\ + b_5SAH + b_6MIN + b_7OIL \end{aligned} \tag{3}$$

1. Dollar [1992] uses income per capita growth in his work. See his article, for example, for a discussion on the use of YPCD instead of YDOT.
2. Two criterion were used in assigning the value of SAH. The first is the country must be located in the Sahel region. The second is the country must have experienced a significant fall in real agricultural output during the time period.
3. The classification as an oil exporter is based on the *World Development Report 1985*.

where the expected signs are b_2, b_3, b_4 and $b_7 > 0$, and b_5 and $b_6 < 0$ as discussed. However, for the period from 1960-70, b_7 may not be expected to be statistically significant. Also, b_4 may not be statistically significant in determining per capita growth as previously discussed. The OLS estimates of equation (3) are (4a) for 1960-70 and (4b) for 1970-81. The results are :

$$\begin{aligned} \text{YPCD} = & -0.78 + \underset{(+\,3.78)}{0.16\text{INV}} - \underset{(-\,7.89)}{3.13\text{SAH}} - \underset{(-\,2.62)}{0.067\text{MIN}} - \underset{(-\,1.10)}{0.038\text{OIL}} \\ & + \underset{(+3.66)}{0.11\text{XDOT}} + \underset{(+\,0.77)}{0.22\text{LDOT}} \end{aligned} \tag{4a}$$

$R^2 = 0.65$ S. E. E = 1.26 F-STAT = 18.48

$$\begin{aligned} \text{YPCD} = & -0.25 + \underset{(+\,2.81)}{0.094\text{INV}} - \underset{(-\,3.58)}{2.71\text{SAH}} - \underset{(-\,5.45)}{0.21\text{MIN}} + \underset{(+\,6.60)}{0.24\text{OIL}} \\ & + \underset{(+\,4.58)}{0.19\text{XDOT}} - \underset{(-\,0.35)}{0.098\text{LDOT}} \end{aligned} \tag{4b}$$

$R^2 = 0.64$ S. E. E. = 1.62 F – STAT = 17.95

As anticipated, LDOT is not statistically significant in the determination of *per capita* GDP growth in either period. Also, the variable OIL is not statistically significant in the earlier period. All other variables are statistically significant at the one percent level. The R^2 for both periods is between 64 and 66 percent, or roughly tow-thirds of the total variance is explained by this model. In the period 1970-81 the variance in YPCD is much greater because of the extreme difficulties some countries faced in adjusting to quadrupling international oil prices and the resulting worldwide recession.[1]

Correcting for Simultaneity

Again, the main, purpose of the empirical analysis is to account for the possibility of simultaneity among the independent and dependent variables. As the analysis presented in this paper will show, it is incorrect to dismiss simultaneity and that the conclusions drawn from standard OLS analysis are to be questioned.

The variables SAH, OIL, and MIN are clearly exogenous. All of these variables relate to G-d given natural resource endowments and climatic conditions. However, the statistical significance of the variables INV and XDOT does not establish a "causality." The correlation may be the result of a reverse causality or some third factor that simultaneously determines both the dependent and independent variable.

To account for simultaneity in the model given in equation (3), a system of equations are simultaneously estimated which account for the various interactions

1. The mean and variances of YPCD are for 1960-70, $u = 2.33$ and $\sigma^2 = 4.15$, while for 1970-81, they are $u = 1.68$ and $\sigma^2 = 6.70$.

between YDOT and the other possibly indigenous variables INV, LDOT and XDOT.[1] Thus, a system of equations explaining INV, XDOT and LDOT must be derived. Equation (3) is to be thought of as just one of the equations necessary for this system.

The system requires an explanatory equation for the share of investment in GDP, INV. The reduced form of the equation used in this paper is :

$$INV = c_0 + c_1LYPC + c_2LYPC^2 + c_3LPOP + c_4LPOP^2 + c_5AGR + c_6MIN + c_7YDOT + \mu \quad (5)$$

where L denotes log of, c_0 is the constant term and

YPC = real GDP per capita for 1965 or 1975.

POP = population (in thousands) for 1965 or 1975.

AGR = the average share of agriculture in GDP for the time period expressed as a percent of GDP.

The functional forms follows from Chenery and Taylor [1968]. We have added AGR and MIN to account for the difference in the capital requirements of these two sectors. Mining is a highly capital-intensive industry, while agriculture tends to be of low capital-intensity in general.[2] The coefficient c_5 is expected to be negative because the agricultural sector demands less capital and is typically the subsistence sector or low profit sector for Third World countries. Thus, economic activity in the agricultural sector does not, in general, lead to as much aggregate savings as industrial activity. The coefficient c_6 is expected to be positive because mining is extremely capital-intensive, thus the higher the share of mining in GDP, the higher the level of capital required by the country. The last term, YDOT, is the standard accelerator term.[3] It is usually modeled that investment represents a closing of the gap between existing capital stock and desired capital stock. The faster the economy is growing, the more rapidly the desired capital stock rises. Thus, it is expected that the sign on c_7 is positive. However, it is not clear whether this coefficient should be expected to be statistically significant in Third-World countries. These countries are characterized as capital scarce and that gap between desired capital stock and actual capital stock is so large that investment is probably not constrained by demand for capital, but by the supply.

There is little a *priori* expectation of the determining factor of XDOT other than government policy and factor endowment. If all sectors exported and grew equally and the level of capital inflows remained the same, it could be written :

1. At this point in the analysis, LDOT will still be treated as possibly endogenous even though it is not statistically significant in the OLS analysis of YPCD.
2. There are some significant differences between the capital- intensity of agriculture among countries. However, it is reasonable to assume that within a country, the agricultural sector is less capital-intensive than its mining sector.
3. For example, see Jorgensen [1971] for a discussion of the accelerator.

$$XDOT = YDOT - PDOT \tag{6}$$

For example, if output increased 5% and population grew 2%, then exportable output grew 3%, ceteris paribus.

Modifying equation (7) for possible sectoral shifts that occur during development and accounting for differing trade elasticities among agricultural and non-agricultural goods, equation (7) can be written as follows :

$$XDOT = d_0 + d_1LYPC + d_2LYPC^2 + d_3LPOP + d_4LPOP^2 + d_5AGR + d_6YDOT + d_7PDOT + d_8OIL + \mu \tag{7}$$

where the four Chenery-Taylor variables used in (6), LYPC $LYPC^2$, LPOP, and $LPOP^2$ are included to account for the possible sectoral shifts.

Using fixed prices to calculate real export growth leads to the strange result that the oil exporters may have actually experienced a decline or a slower growth of exports because the demand for oil fell as a result of the sharp rise in oil prices after 1973. Therefore, it is expected that for the 1970-81 period, the coefficient d_8 is negative. The sharp increase in oil prices may have caused a slight fall in the volume of oil exported causing XDOT for the oil exporters to be smaller than normal. However, the oil exporters actually experienced a sharp increase in export revenues.

LDOT can be modelled similarly to INV and XDOT. To account for the structural changes in the economy the variables LYPC, $LYPC^2$, LPOP and $LPOP^2$ are again included. We conjecture that the major determinant of LDOT is population growth, PDOT. Also, YDOT might be expected to influence the rate of migration into the labor force. If the real income to be earned outside the household is expanding rapidly, there is more inducement for people to enter the labour force. Therefore, it is expected that LDOT is a positive function of YDOT. We expect that as the gap between the earnings of the subsistence sector and the modern sector rise, there will be a higher rate of migration out of the subsistence sector. Therefore, we might expect LDOT to be positively related to the level of income per capita, LYPC. Finally, LDOT is modelled as :

$$LDOT = e_0 + e_1LYPC + e_2PDOT + e_3YDOT + \mu \tag{8}$$

$$YPCD = YDOT + PDOT \tag{9}$$

With the addition of the identity in (9), equations (3), (5), (7) and (8) represent a system of equations which model economic growth. To account for the feedback effects and simultaneity, this system must be solved using an appropriate method, of which standard OLS is not one. The method used in this analysis is the method of full information maximum likelihood. All (possibly) endogenous variables, YDOT, INV, LDOT and XDOT are determined simultaneously under this method.

Equations (3), (5), (7) and (8) are estimated using an iterative three-stage least squares process which continuously updates the estimates of the parameters until the changes in the matrix of determination converges to zero.[1] The computer software used is Micro Tsp version 7.0.

PDOT is treated as exogenous in this system of equations. There are several arguments which can be used to justify this assumption. For one, the annual variation in population growth for an individual country is much smaller than the annual variations in GDP growth. If PDOT is used instead of LDOT in (3), the coefficient on PDOT is not statistically significant. This indicates that population growth is not correlated with *per capita* income growth, so the issue of simultaneity can be dismissed.

The discussion of the results is broken up into two parts. The first part is for the earlier time period, the second part for the later time period.

Results : 1960-70

Both the OLS and FIML estimates of the four equations in the system are presented in Table 1. The results show that there are some important differences by the OLS and FIML estimates of equation (3) for YPCD. First, the statistical significance of XDOT in the OLS of (3) is not consistent with the non-significance of XDOT when (3) is estimated using FIML. This result indicates that the positive and statistically significant correlation between YPCD and XDOT found using OLS does not indicate that XDOT "caused" YPCD.

Table 1

OLS and FIML Estimates of the Model for the Period 1960-70

OLS ESTIMATES

$$\underset{}{YPCD = -0.71} + \underset{(+4.28)}{0.15INV} - \underset{(-7.03)}{3.11SAH} - \underset{(-3.16)}{0.071MIN} + \underset{(+3.75)}{0.12XDOT} + \underset{(+1.00)}{0.21LDOT}$$

$R^2 = 0.65$ S. E. E. = 1.26 N =66

$$INV = 14.3 + \underset{(+1.00)}{12.90LYPC} - \underset{(-1.09)}{1.04LYP^2} - \underset{(-1.88)}{7.73LPOP} + \underset{(+1.87)}{0.41LPOP^2} + \underset{(+2.76)}{0.19MIN}$$

$$-\underset{(-2.97)}{0.15AGR} + \underset{(+2.84)}{0.71YDOT}$$

$R^2 = 0.55$ S. E. E. = 3.92 N = 66

1. See Thiel [1953] and Basmann [1957] for a detailed explanation of the method of full-information maximum likelihood estimators.

$$\underset{}{XDOT} = -15.4 + \underset{(+1.25)}{20.5LYPC} - \underset{(-1.29)}{1.59LYPC^2} - \underset{(-1.80)}{9.49LPOP} + \underset{(+1.64)}{0.46LPOP^2} + \underset{(+4.02)}{1.53YDOT} - \underset{(-1.10)}{1.18PDOT}$$

$R^2 = 0.32$ S. E. E. = 5.05 N = 66

$$LDOT = -0.91 + \underset{(+1.80)}{0.054YDOT} + \underset{(+9.79)}{0.93PDOT} + \underset{(+0.62)}{0.059LYPC}$$

$R^2 = 0.68$ S. E. E. = 0.45 N = 66

FIML ESTIMATES

$$YPCD = -0.68 + \underset{(+3.22)}{0.17INV} - \underset{(-7.28)}{3.15SAH} - \underset{(-3.00)}{0.073MIN} + \underset{(+1.56)}{0.12XDOT} + \underset{(+0.23)}{0.054LDOT}$$

$R^2 = 0.64$ S. E. E. = 1.27 N = 66

$$INV = 34.2 + \underset{(+0.95)}{12.64LYPC} - \underset{(-1.02)}{1.01LYOC^2} - \underset{(-2.41)}{10.2LPOP} + \underset{(+2.37)}{0.54LPOP^2} + \underset{(+1.67)}{0.098MIN} - \underset{(-4.64)}{0.21AGR} - \underset{(-0.85)}{0.36YDOT}$$

$R^2 = 0.39$ S. E. E. = 4.54 N = 66

$$XDOT = -46.3 + \underset{(+1.71)}{29.6LYPC} - \underset{(-1.65)}{2.15LYPC^2} - \underset{(-1.75)}{9.69LPOP} + \underset{(+1.61)}{0.48LPOP^2} + \underset{(+0.09)}{0.06YDOT} - \underset{(-0.30)}{0.34PDOT}$$

$R^2 = 0.14$ S. E. E. = 5.67 N = 66

$$LDOT = -0.93 + \underset{(+1.11)}{0.055YDOT} + \underset{(+9.67)}{0.96PDOT} + \underset{(+0.47)}{0.050LYPC}$$

$R^2 = 0.68$ S. E. E. = 0.45 N = 66

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t-ratios are in parentheses below coefficient.
S.E.E. = standard error of estimation.
N = number of observations.
Convergence of the system was achieved after 6 iterations of 3SLS.

Similarly the coefficient of YPCD and its significance in (7) differs between the OLS and the FIML estimates. Combined with the result discussed in the previous paragraph we can infer from the FIML estimates that there is no "causal" relationship between the two variables, only that they both appear to be determined simultaneously. Those countries which were able to achieve higher rates of economic growth per capita were also able to achieve faster export growth. This result does not support the hypothesis that export promotion, indicated by higher XDOT's "caused" greater economic growth in this period.

The statistical significance of INV at the one percent level is indicated in both estimates of equation (3). This indicates that higher levels of investment did apparently "cause" more rapid growth of real GDP per capita. From another perspective, the statistical significance of INV, but lack of statistical significance of XDOT using FIML indicates that the more important determinant of economic growth for Third World countries during this period was the *internal* financing of investment. There did not appear to be a significant problem with earning foreign exchange, indicated by the insignificance of XDOT.[1] What these result that those countries which successfully financed higher levels of investment achieved more rapid growth of output, including exported output.

The coefficient on LDOT was not statistically significant in either method of estimation. Thus, the statistical correlation between YDOT and LDOT is related to the fact that PDOT is a significant determinant of both. Faster population growth causes a higher growth rate of the labor force and a larger growth in demand, ceteris *paribus*. All other coefficients in equation (3) are identically the same for both methods of estimation.

A comparison of the OLS and FIML estimates of (5) reveal an important difference as well. The FIML estimate shows that there is no evidence of an accelerator principle during this period for the developing countries. The coefficient on YDOT in equation (5) has the wrong sign but is not statistically significant even at the ten percent level. The OLS estimate of equation (5) does show a positive and statistically significant correlation between INV and YDOT. This, evidently, does not indicate that a higher rate of GDP growth caused a higher share of investment in GDP because this statistical relationship is not replicated in the FIML estimate where simultaneity has been dealt with. Thus, it can be concluded from the combined FIML estimates of equations (3) and (5) that increased levels of investment caused more rapid growth of real GDP, but more rapid growth of real GDP did not cause a higher level of investment.

Also, the OLS and FIML estimates of equation (7) for XDOT reveal an important difference. According to the OLS estimate, YDOT is statistically correlated with XDOT, but is not statistically significant when estimated using FIML. Combined with the estimates (3), we can conclude that no causal relationship between XDOT and YDOT exists in either direction for this time period.

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1. This statement should be taken lightly. The coefficient on XDOT in the FIML estimate of YPCD is significant at the twelve percent level. If some outliers are excluded, the variance in the system may be reduced sufficiently to reveal a coefficient that is statistically significant at the ten percent level.

In neither estimate of LDOT is the coefficient on YDOT statistically significant even at the ten percent level in this time period. Thus, there is no evidence to support the hypothesis that more rapid growth of real GDP causes a higher rate of entry into the labor force.

Results : 1970-81

As was the case with the period from 1960-70, comparing the OLS and FIML estimates of the four equations in our model, there are some important differences. Table 2 contains both the OLS and FIML estimates of the four equations. Comparing the OLS and FIML estimates of (3) reveals an interesting difference. In this case, INV is not statistically significant when simultaneity is accounted for using FIML. Since the coefficient on YDOT is not statistically significant in the FIML estimate of INV, we can conclude that YDOT and INV are simultaneously determined, i.e. no causality exists between the two in this period. Apparently, those factors which help to facilitate the financing of investment also facilitated economic growth.

However, in this period the coefficient on XDOT remains positive and statistically significant even after accounting for the simultaneity using the FIML method of estimation of equation (3). Coupled with the non-significance of INV and LDOT in this system after correcting for simultaneity, the ability to export becomes the most important determinant of economic growth in this period except for the exogenous variables MIN and OIL. For this period, the hypothesis that export promotion "caused" more rapid economic growth is supported by the empirical analysis.

Table 2

OLS and FIML Estimates of the Model for the Period 1970-81

OLS ESTIMATES

$$\underset{}{YPCD} = -0.74 + \underset{(+2.72)}{0.12INV} - \underset{(-1.34)}{0.78SAH} - \underset{(-3.58)}{0.15MIN} + \underset{(+4.83)}{0.23XDOT} - \underset{(-0.74)}{0.23LDOT} + \underset{(+4.88)}{0.22OIL}$$

$R^2 = 0.60$ S. E. E. = 1.72 N =67

$$INV = 66.3 - \underset{(-0.42)}{7.15LYPC} + \underset{(+0.39)}{0.48LYPC^2} - \underset{(-0.62)}{3.27LPOP} + \underset{(+0.53)}{0.14LPOP^2} + \underset{(+2.88)}{0.25MIN} - \underset{(-2.25)}{0.20AGR} + \underset{(+3.97)}{1.00YDOT}$$

$R^2 = 0.54$ S. E. E. = 4.82 N = 67

Table 2 *contd.*

$$XDOT = -1.04 + \underset{(+0.40)}{6.04LYPC} - \underset{(-0.34)}{0.38LYPC^2} - \underset{(-1.00)}{4.31LPOP} + \underset{(+1.09)}{0.24LPOP^2} + \underset{(+5.84)}{1.21YDOT} - \underset{(-2.37)}{1.77PDOT} - \underset{(-3.72)}{0.29OIL}$$

$R^2 = 0.50$ S. E. E. = 3.93 N = 67

$$LDOT = -2.68 + \underset{(+2.62)}{0.057YDOT} + \underset{(+10.3)}{0.75PDOT} + \underset{(+5.22)}{0.43LY}$$

$R^2 = 0.68$ S. E. E. = 0.44 N = 67

FIML ESTIMATES

$$YPCD = -0.42 + \underset{(+0.50)}{0.064INV} - \underset{(-1.12)}{0.51SAH} - \underset{(-1.22)}{0.089MIN} + \underset{(+2.69)}{0.34XDOT} + \underset{(-0.42)}{0.22LDOT} + \underset{(+4.83)}{0.20OIL}$$

$R^2 = 0.55$ S. E. E. = 1.82 N = 67

$$INV = 58.4 - \underset{(-0.33)}{5.41LYPC} + \underset{(+0.30)}{0.36LYOC^2} - \underset{(-0.51)}{2.60LPOP} + \underset{(+0.45)}{0.12LPOP^2} + \underset{(+2.62)}{0.22MIN} - \underset{(-2.47)}{0.22AGR} + \underset{(+1.06)}{0.56YDOT}$$

R2 = 0.51 S. E. E. = 4.94 N = 67

$$XDOT = -31.9 + \underset{(+0.93)}{11.7LYPC} - \underset{(-0.92)}{0.86LYPC2} - \underset{(-0.30)}{0.75PLOP} + \underset{(+0.24)}{0.03LPOP2} + \underset{(+4.17)}{1.63YDOT} - \underset{(-3.27)}{2.26PDOT} - \underset{(-3.52)}{0.27OIL}$$

$R^2 = 0.45$ S. E. E. = 4.13 N = 67

$$LDOT = -2.42 + \underset{(+2.57)}{0.11YDOT} + \underset{(+9.65)}{0.73PDOT} + \underset{(+4.04)}{0.36LY}$$

$R^2 = 0.65$ S. E. E. = 0.45 N = 67

See notes at Table 1. Convergence achieved after 10 iterations.

Also of interest is the FIML estimate of XDOT for this later time period. The coefficient on YDOT is positive and statistically significant as well beyond the one percent level. Since the coefficient on XDOT was statistically significant in the FIML estimate of equation (3) and the coefficient on YDOT is statistically significant in the FIML estimate of (7), there exists a feedback between export growth and GDP growth.

As in the previous period, the coefficient on LDOT in (3) is neither the OLS or FIML estimate of YPCD is statistically significant. However, in this time period the coefficient of YDOT in the FIML estimate of LDOT is statistically significant. This reveals that the direction of causality is from growth of real GDP to a more rapid growth of the labor force as postulated earlier. Thus, for this time period the hypothesis that more rapid growth of per capita income causes a more rapid entry into the labor force is supported at the one percent level.

Conclusions

This paper reports some important differences in the determinants of economic growth for the Third World as between OLS and FIML analysis. The method of FIML revealed that XDOT was not a statistically significant determinant of YPCD in the earlier period whereas OLS analysis revealed a statistically significant correlation between XDOT and YPCD. OLS indicates that XDOT is statistically significant in both time periods. Fot the earlier period, this correlation is apparently a result of some other factors explaining both XDOT and YPCD simultaneously. In the later period, the correlation is explained by a bi-directional causality between XDOT and YPCD. Thus, more rapid growth of output caused a more rapid growth of exports and more rapid growth of exports caused more rapid growth of output.

Perhaps, it is not surprising that in the earlier period only the financing of investment constrained economic growth while in the latter period export growth is the significant determinant of economic growth and not investment. The latter period, 1970-81, is characterized by a worsening in the terms of trade for most developing nations and a major recession which results in a decline in the demand for exports from the developing nations. Thus, the ability to earn foreign exchange to purchase imports is much more problem some during this latter period. In the earlier period, the low levels of per capita income may have constrained the availability of capital. This may have produced impediments to both the growth of output and to the growth of exports.

Another interesting difference revealed by comparing the FIML and OLS estimates is that in the latter period INV is not a significant determinant of economic growth. This may seem counter-intuitive but can be explained by the presence of the other variables in the system. Apparently, the ability to earn foreign exchange constrained both the country's ability to finance its investment and to expand its level of output.

This paper has also shown that labor force growth, LDOT, is not a significant determinant of the growth rate of *per capita* income. The correlation between the growth of income and the growth rate of the labor force that earlier studies have found appears to relate to the observance that the growth rate of population is a major determinant of both the growth rate of GDP (but not per capita GDP) and of the growth rate of the labor force. In the latter period, we did find that a higher growth of real GDP per capita induced a higher growth of the labor force.

The policy implications of these results are unclear. If a higher share of investment did not cause more rapid economic growth in the latter period, is it correct to assume that investment is not an important determinant of growth ? This is not likely true as a rule. The uniqueness of the period from 1970-81 may have accounted for this observation. First, many countries may have been constrained in financing their investment by the unavailability of foreign capital. Thus, the oil shock may explain both lower levels of investment and a slower growth rate of GDP simultaneously. Second, it is also possible that countries which did achieve higher levels of investment were able to increase their output but could not find demand for that output because of the worldwide recession. Third, investment finance through external sources may have resulted in unexpectedly high costs of repayment because of the massive rise in interest rates. Thus, traditional cost-benefit analysis of investment with reasonable assumptions on future interest rates may have led to poorly chosen investment projects and the ensuing debt-crisis.

Further, the conclusion that in the earlier period, higher rates of export growth did not cause more rapid economic growth may be in error. First, the variable XDOT may not be a good indicator of the growth rate of export revenue. As was the case with the oil exporters, their export revenues grew, but XDOT was often negative for these countries. Thus, using fixed prices to compute XDOT may not give an accurate measure of "export promotion". Second, leaving aside the measurement problem mentioned above, high rates of export growth may be indicative of recent export promotion, but as a whole the country may still be highly protective. Countries which may have been pursuing export promotion for many years may not continue to have above average rates of export growth but instead, have well above average "openness."[1] Thus, XDOT may not be a good indicator of export promotion.

The main purpose of this paper, however, was not to propose economic policies for developing countries but to develop a methodology by which an empirical analysis of the determinants of economic growth could be undertaken. As noted earlier, much of the literature in this area has dismissed any major consideration of simultaneity in cross-national studies. The analysis in this paper reveals that simultaneity must not be dismissed and that the conclusions drawn from standard OLS analysis are to be interpreted carefully.

1. Openness can be defined as the share of exports in GDP plus the share of imports in GDP.

APPENDIX

Table A. 1

Summary Statistics For 1960-70 and 1970-81 Periods

Summary Statistics 1960-70			Summary Statistics 1970-81		
Variable	Mean	STD DEV	Variable	Mean	STD DEV
AGR	32.6	16.9	AGR	27.6	14.7
INV	17.4	5.5	INV	22.5	6.7
LDOT	2.0	0.8	LDOT	2.4	0.8
LPOP	8.8	1.3	LPOP	9.1	1.3
LYPC	6.6	0.6	LYPC	6.9	0.8
MIN	4.2	7.8	MIN	5.9	8.1
PDOT	2.5	0.6	PDOT	2.5	0.8
XDOT	6.4	5.8	XDOT	3.8	5.2
YDOT	4.8	2.1	YDOT	4.2	2.5
YPCD	2.3	2.0	YPCD	1.7	2.6

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