JOURNAL OF ECONOMIC DEVELOPMENT
Volume 17, Number 2, December 1992

Overinvestment, Economic Growth and the Debt-Service Ratio: Evidence from the 1970's

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This paper measures overinvestment, the level of excess capital formation. First, OLS is used to predict I/Y, the share of investment in GDP given the level of GDP per capita, the shares of mining and agricultural in GDP, and the growth rate of GDP. Overinvestment is defined as actual I/Y minus predicted I/Y. Thus, overinvestment is the level of I/Y that does not contribute to economic growth. When estimating the debt-service ratio using OLS, predicted I/Y has no effect but overinvestment has a positive and statisically significant effect. This indicates that overinvestment adds to the debt-service ratio but does not add to economic growth.

I. Introduction

This paper analyzes the effect of overinvestment on the debt-service problem in the Third World. To this aim, overinvestment must first be defined and measured. Overinvestment (OVR) is defined as the share of investment in GDP that exceeds the "predicted" share of investment needed to generate the rate of economic growth achieved by that country. This measure will be positive or negative, but has a mean of zero.

By virtue of the method used to construct the measure OVR, the growth rate of the country's economy is unaffected by OVR. However, it will be shown that the coefficient on OVR is positive and statistically significant in the OLS estimation of debt-service ratio. This implies that the level of "overinvestment" did not contribute to the growth rate of the economy, but instead, saddled the country with higher debt-service ratios.

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Thus, whatever contribution the higher level of investment may have made to economic growth is offset by the higher debt-service burden created by that investment. This is represented by path B in Figure 1.

Figure 1

Possible Outcomes from a Rise in Foreign Borrowing

A: Foreign Capital→Large increase in GNP→Debt-Service Ratio falls

B: Foreign Capital→Small increase in GNP→Debt-Service Ratio Rises→GNP decreases

To the borrowing nation, borrowed capital has both a benefit and a cost. The benefit is the additional output that can be created from the increase in the capital stock. The cost, however, is the reduction of the future income stream that can be reinvested domestically or an increase in future debt-servicing.

If the increased future stream of output generated by the borrowed capital well exceeds the repayment stream of those funds, the investment benefits the country and decreases its debt-service ratio as in path A. However, if the additional investment resulting from the borrowed capital is not sufficiently profitable either because of a realization crisis or a low marginal efficiency of capital then the investment will result in only slightly higher GNP, but an increase in the debt-service ratio as in path B. If this occurs, the country may be gaining short-term growth at the expense of its long-term growth. The investment described by path B can be defined as the level of overinvestment. This is the level of investment which may be profitable from a short-run standpoint, but my result in a future stream of repayment that may cause the debt-servicing burden to increase because the increased rate of growth is either too small or not sustainable over the long run.

The empirical analysis in this paper proceeds by first quantifying the level of overinvestment by use of two-stage least squares. Then, having quantified overinvestment it is verified that the measure OVR is not statistically significant in the determination of the growth rate of real GDP, but is statistically significant in the determination of the debt-service ratio. The regression analysis is performed on a set of 65 developing countries (listed in the Appendix) for which all the necessary data were available. All data is obtained from the *World Bank*, World Tables, 3rd edition except data on the debt service ratio is from the *World Bank*, Debt Tables and GDP per capita is from Summers and Heston (1984).

II. Measuring Overinvestment

Paramount to this paper is the construction of a measure of overinvestment. The definition of overinvestment most useful for this means is the level of investment beyond which the cost of obtaining the capital equals or exceeds the benefit derived from the expansion of output. Thus, it is the intent of this paper to break investment into two components, one which positively adds to the rate of growth, and the other which does not.

The share of investment in GDP can be modelled using the accelerator model of investment as expressed in (1):

$$(1) \qquad I = k_1(Y^{exp} - Y_{-1}) - k_2 r + e$$

where

I = Investment
Y^{exp} = the level of output expected in the current period
Y_{-1} = the level of output achieved in the previous period
r = the rental cost of capital
e = the error term

The rental cost of capital, r, is determined by the supply and demand for capital. Investment and non-business borrowing is the demand for capital. Data for all non-business borrowing is not readily available for a large sample of Third World countries, so the level of non-business borrowing will not be including the analysis.

The supply of loanable funds is a function of the level of economic activity. The proportion of total output which is saved varies by economic activity and by level of GNP/CAP. For example, mining is a very capital-intensive industry and produces a larger share of income accruing to owners of capital then does most other industrial activity.[1] Also, most agricultural activity in the Third World is still subsistence agriculture which produces little or any savings. Thus, r can be expressed as:

$$(2) \qquad r = -(\delta_1 Y + \delta_2 MIN \times Y + \delta_3 AGR \times Y)$$

where

[1] This is verified by comparing the capital-output ratios presented in the *World Bank*, World Tables Economic Data Sheet 3 for the various sectors of manufacturing.

Y = total GDP
MIN = the share of mining and petroleum in GDP
AGR = the share of agriculture in GDP

Equation (2) says that r is negatively related to the supply of capital which is dependent upon not only the level of total output, but also the shares of mining and agriculture in that total output. The expectation is that $\delta_3 < \delta_1 < \delta_2$. Factoring out the Y, total output yields an expression for the cost of capital as a function of the share of mining and agriculture in output.

(3) $$r = -(\delta_1 + \delta_2 MIN + \delta_3 AGR)Y$$

Substituting (3) into (1) and dividing by total output, Y, and assuming $Y^{exp} = Y$ gives an expression for IY, the share of investment in GDP as follows:

(4) $$IY = \pi_0 + \pi_1 YDOT + \pi_2 MIN + \pi_3 AGR + \mu$$

where

π_0 = the constant term
YDOT = the growth rate of real GDP, or $(Y-Y_{-1})/Y$
μ = the stochastic error term

The expected sign on YDOT is positive both because the higher rate of growth of demand creates a larger demand for capital in order to produce even higher levels of output and because the investment causes a higher rate of economic growth. This simultaneity is dealt with later.

The sign on MIN is expected to be positive because of the higher share of income that will accrue to owners of capital in the mining sector. This will raise the share of savings in total GDP.

The sign on AGR is expected to be negative. The share of output in the subsistence agricultural sector produces a much lower marginal propensity to save than industrial activity. The log of real gdp/cap (ln y) was originally included in (4) because the share of savings is expected to be a positive function of average real income. However, in the original estimation of (4), the coefficient on ln y was negative with a t-ratio near zero. The strong correlation between AGR and gdp/cap creates a serious problem of collinearity that is dealt with by deleting ln y, the less significant variable of the two from the regression.

The model for the rate of growth of real GDP used in this paper is taken from Feder (1983). Feder's model is:

$$(5) \qquad YDOT = \alpha_0 + \alpha_1 IY + \alpha_2 LFDOT + \alpha_3 XXDOT + \alpha_4 XDOT + \mu$$

where

LFDOT = the growth rate of the labor force
XDOT = the growth of exports
XXDOT = the growth rate of exports multiplied by the share of exports in GDP

Feder's model is modified in this paper to include two dummy variables. One is for the countries in the Sahel region of Africa which were severely affected by drought during the 1970-1980 time period chosen for the empirical analysis. The other is for the oil exporting countries. Thus, the model for YDOT becomes:

$$(6) \qquad YDOT = d_0 + d_1 IY + d_2 LFDOT + d_3 SAH + d_4 XXDOT + d_5 XDOT + d_6 OIL$$

The sign on d_1 is expected to be positive. However, if the level of overinvestment is great, the magnitude of d_1 will decrease and its significance is decreased as well. The signs on d_2, d_4, and d_5 are also expected to be positive as discussed in Feder. The sign on d_3 is expected to be negative to account for the fall in consumption attributed to the drought and the sign on d_6 is expected to be positive because the period under analysis is characterized by a sharp increase in oil prices which becomes a bonanza for the oil exporting countries.

There exists some simultaneity between YDOT and the independent variables. The simultaneity between IY and YDOT is dealt with in the next section is the only simultaneity of concern for the purposes of this paper. The simultaneity between YDOT and LFDOT and YDOT and XPDOT has been discussed in several previous works such as Hagen and Hawrylyshyn, and Feder (1983) to name a few.

III. Simultaneity of YDOT and IY

If simultaneity exists the estimates of the coefficients obtained by OLS estimation are biased. This creates the need to perform two-stage least squares. However, it has been discussed at length that simultaneity does

not pose a serious problem for the growth regressions of the type presented in this paper. The effect of YDOT on IY is thought to be much less than the effect of IY on YDOT, so it is not necessary to worry about the feedback effect of YDOT on IY. This paper is not concerned with the true coefficients in (6). Rather, equation (6) is used to show the importance of the independent variables in determining YDOT, thereby justifying the use of these variables as instrumental variables in the two-stage least squares determination of IY.

The problem of simultaneity between IY and YDOT is much more serious for the estimate of IY. The feedback effect of IY on YDOT is strong and thus it is necessary to perform a two-stage least squares for the OLS estimates of IY. The results for both the OLS and 2SLS estimates of IY based on (4) using all exogenous variables contained in (4) and (6) as the instrument list are;

For OLS:

$$\text{(7)} \qquad IY = 20.82 - 0.15AGR + 0.28MIN + 0.89YDOT$$
$$(-3.21) \quad (3.64) \quad (3.80)$$
$$R^2 = 0.50 \qquad \text{s.e.e.} = 4.52$$

For 2SLS:

$$\text{(8)} \qquad IY = 21.67 - 0.15AGR + 0.27MIN + 0.76YDOT$$
$$(-3.24) \quad (3.47) \quad (2.30)$$
$$R^2 = 0.49 \qquad \text{s.e.e.} = 4.53$$

where all variables are average shares from 1970-1980 and are expressed as percents of GDP and YDOT is the growth rate of real GDP from 1970-1980. T-ratios are in parenthesis under the coefficients and s.e.e. is the standard error of estimation.

The variable IHAT is constructed by calculating the predicted level of IY using the estimates obtained from the two-stage least squares estimate of equation (4). The economic interpretation of IHAT is that it is the value of IY expected given the countries distribution of output between agriculture and mining needed to obtain the level of economic growth, YDOT.

The variable OVR, the measure of overinvestment used in the empirical analysis to follow, is the residual of the 2SLS estimate of equation (4). The economic interpretation of OVR is that it is positive for countries which had higher than the expected level of investment needed to achieve their given rate of economic growth. Countries with $OVR < 0.0$ were countries that achieved their level of economic growth with less than ex-

pected levels of investment. Conceptually, OVR represents the quantity of investment that produced either little or no contribution to economic growth.

If the measure of OVR has been constructed properly it is expected that the OLS estimate of (6) should reveal that the contribution of OVR to YDOT is not statistically significant, but that of IHAT is. The results are:

(9) $$\begin{aligned} YDOT = {} & 0.25 + 0.079IY + 0.71LFDOT - 2.17SAH \\ & (2.27)) \quad (3.42) \quad (-4.47) \\ & + 0.29XXDOT + 0.12XDOT + 1.64OIL \\ & (2.27) \quad (1.88) \quad (3.58) \\ & R^2 = 0.58 \quad \text{s.e.e.} = 1.72 \end{aligned}$$

(10) $$\begin{aligned} YDOT = {} & -3.37 + 0.26IHAT - 0.014OVR + 0.59LFDOT \\ & (5.30) \quad (-0.35) \quad (3.04) \\ & -1.81SAH + 0.25XXDOT + 0.12XDOT + 0.27OIL \\ & (-4.41) \quad (2.72) \quad (2.08) \quad (0.48) \\ & R^2 = 0.65 \quad \text{s.e.e.} = 1.59 \end{aligned}$$

The results are as expected. The coefficient on OVR is not statistically different from zero. The coefficient on IHAT in (10) is significantly greater than the coefficient on IY in (9) and its t-value is nearly twice as large. This result indicates that the level of OVR did not contribute to growth in any significant way, thus netting out the amount of OVR increased the reported significance of IHAT, or normal investment.

IV. Overinvestment and Debt

The results presented above show the validity of this measure of overinvestment. In this part of the paper, it will be shown that the level of overinvestment has a great effect on the debt-service ratio. The general effect of investment on the debt-service ratio might be expected to be ambiguous. On one hand, investment represents the demand for capital, some of which must be met by foreign savings. The higher the level of foreign savings, ceteris paribus, the greater the debt-service. On the other hand, as discussed in the introduction, if the capital borrowed from abroad is invested effectively, it will create a large enough increase in output that the ratio of debt-service payments to GDP would fall. The way in which overinvestment has been defined in this paper, it is unambiguous that overinvestment will increase the debt-service ratio because the level of overinvestment does not necessarily contribute to economic growth but

does necessarily add to the demand for capital.

A country can purchase capital goods by purchases financed by domestic savings, by export earnings, or by foreign borrowing. Thus, the level of foreign borrowing is positively related to the level of investment, negatively related to domestic savings and export earnings. This is represented by equation (11):

$$(11) \qquad YDEBT = \alpha_0 + \alpha_1 SY + \alpha_2 IY + \alpha_3 XDOT + \mu$$

where SY is the share of savings in GDP. YDEBT is the ratio of debt-service payments to GDP.[2]

It is not correct to have both IY and SY as independent variables because of the very high degree of collinearity between the two.[3] Therefore, a proxy for SY is used. The proxy is based upon the argument presented in the derivation of the model for IY. Savings is a function of the level of real GDP per capita and the distribution of total GDP among the agricultural sector (low savings sector) and the mining sector (high savings sector).

$$(12) \qquad SY = \beta_0 + \beta_1 Ly + \beta_2 AGR + \beta_3 MIN + \mu$$

where Ly is the log of y, real GDP per capital.

$$(13) \qquad YDEBT = \delta_0 + \delta_1 IY + \delta_2 Ly + \delta_3 AGR + \delta_4 MIN + \delta_5 XDOT + \mu$$

The expected sign on δ_1 is positive. The higher the level of investment, the higher the demand for capital. δ_2 is expected to be negative given that the share of savings in GDP rises as y rises. The sign on δ_3 is expected to be negative also, because agricultural production requires less capital than industrial production. It is expected that δ_4 is positive because mining requires large inputs of capital. δ_5 is expected to be negative because the higher the rate of increase of export purchasing power, the smaller the need for borrowed capital to finance investment and the higher the rate of growth of real output. It has been argued that the oil exporters were extended more credit because of the expected growth of their economies. Therefore, it is expected that δ_6 be positive. The results of the OLS estimate of (13) are:

2 This ratio is used rather than the ratio of debt-service to exports because that ratio is highly correlated with the degree of import substitution. See, for example, Saltz (1992).

3 $IY \equiv SY + FY$ where FY is the share of capital flows in GDP. Thus, IY and SY are highly collinear.

(14) $$YDEBT = 23.63 + 0.16IY - 2.57\,Ly - 0.19AGR - 0.13XDOT$$
$$(2.01)\quad (-3.06)\quad (-3.79)\quad (-2.08)$$
$$-0.050MIN$$
$$(-0.75)$$
$$R^2 = 0.37 \quad s.e.e. = 2.57$$

The value of YDEBT is for 1980, the end of the period in equation. This is used because the debt-service ratio is a function of present and past debt, therefore, is a function of present and past investment. The value used for y is GDP per capita for 1975, the midpoint of the time period studied.

The coefficient on IY is positive and statistically significant at the five percent level, indicating that investment lead to an increase in the debt-service ratio, despite the fact that investment contributes positively to the growth rate of real GDP. However, reestimating (13) using IHAT and OVR in place of IY reveals the most interesting result found in this analysis. The results of the OLS estimation of (13) are:

(15) $$YDEBT = 21.67 - 0.24IHAT + 0.23OVR - 1.24Ly - 0.17AGR$$
$$(-1.99)\quad (2.65)\quad (-1.50)\quad (-3.78)$$
$$-0.039XDOT + 0.10MIN$$
$$(-0.67)\quad (1.53)$$
$$R^2 = 0.45 \quad s.e.e. = 2.41$$

The coefficient on IHAT in (15) is negative and statistically significant at the six percent level indicating that "normal" levels of investment increase the rate of economic growth and thus reduce the debt-service ratio. On the other hand, the coefficient on OVR is positive and statistically significant at the one percent level indicating that it is the level of "overinvestment" that increases the debt-service ratio. This is because overinvestment does not increase growth, but still represents a demand for capital, increasing the need for borrowing from abroad.

Table 1

COMPARING COUNTRIES WITH OVRINV<0 & OVRINV>0

Averages	y	YDOT	INV	YDEBT	DEBHAT
OVRINV>0	1186	4.3	25.8	4.3	3.5
OVRINV<0	1225	4.6	19.5	3.0	3.8
All countries	1206	4.4	22.7	3.7	3.6

Table 1 gives a comparison of countries which had a value for OVR>0 with countries that had a value of OVR<0. It has been postulated in this paper that the countries that have OVR>0 have not achieved any greater economic growth but have higher debt-service ratios on average.

V. Summary and Conclusions

The intention of this paper was to show that those countries which engaged in overinvestment created an excessive demand for capital that led to an increase in their debt-service ratios with little gain in economic growth. This entailed first empirically defining overinvestment. This was done by estimating by use of two-stage least squares the "normal" level of investment needed to produce the rate of growth of real GDP achieved given the country's distribution of output among mining and agriculture. Two-stage least squares is necessary because of the simultaneity that exists between the rate of growth of output and the share of investment in output. However, the 2SLS estimates differ only slightly from the OLS estimates.

It was then shown that the measure OVR, which is calcualted by taking the actual level of IY minus the predicted level of IY obtained from the two-stage least squares, has no effect on the rate of economic growth.

The OLS estimation of the debt-service ratio showed, as expected, that the debt-service ratio is a function of the level of investment, given investment represents the demand for capital. However, when investment was broken up into IHAT, the "normal" level of investment expected to achieve the actual rate of growth of real GDP and OVR, it is shown that "normal" investment does not add to the debt-service ratio, but OVR does.

The conclusion which can be drawn from these results is that those countries which devoted a high share of their resources to the production of capital goods simply increased their demand for capital to the point where the use of that capital did not produce sufficiently high increases in GDP to offset the future cost of service the debt created by that investment.

The significance (t-value of 2.65) of the coefficient on OVR in the OLS estimate of YDEBT, as well as the comparison presented in Table 1 should convince the reader that overinvestment was a major contributor to the International Debt Crisis.

Appendix

Table A.1

SELECTED DATA AND LIST OF COUNTRIES IN THE ANALYSIS

Country	IY	DEBTY	OVR
Algeria	42.9	9.0	9.8
Argentina	25.2	3.0	3.7
Bangladesh	12.3	0.7	−4.3
Benin	21.9	0.6	4.1
Bolivia	17.7	4.7	−6.9
Brazil	21.8	3.5	−3.9
Burma	16.5	2.4	−2.3
Cameroon	21.4	3.6	−1.2
C.A.R.	12.2	1.1	−5.6
Chad	13.0	3.1	1.3
Chile	19.5	5.2	−4.0
Colombia	23.9	1.7	1.6
Congo	31.4	8.3	1.5
Costa Rica	25.2	4.3	3.1
Dominican Republic	23.3	2.4	−0.9
Ecuador	25.5	3.7	−4.6
Egypt	27.4	6.9	0.1
El Salvador	17.7	1.2	−2.0
Ethiopia	10.0	1.1	−5.8
Ghana	5.7	0.5	−7.2
Greece	27.9	2.1	5.5
Guatemala	17.6	0.8	−4.2
Honduras	22.2	3.9	1.5
Hong Kong	26.7	0.3	−2.8
India	21.6	0.6	3.0
Indonesia	20.2	2.7	−8.9
Ivory Coast	26.3	8.3	3.5
Jamaica	20.5	7.9	−1.4
Kenya	24.8	2.6	3.4
Korea	29.4	4.8	3.5
Liberia	26.1	4.1	0.6
Madagascar	17.2	1.8	−0.9
Malawi	25.5	4.5	6.5
Malaysia	26.1	1.4	0.4
Mali	15.5	0.8	−3.9

Country	IY	DEBTY	OVR
Mauritania	31.8	5.9	8.9
Mauritius	26.0	3.3	2.6
Mexico	25.7	4.9	-0.7
Morocco	23.8	6.7	-0.7
Nicaragua	18.4	3.8	0.2
Niger	27.7	2.2	6.8
Nigeria	26.2	0.5	-2.3
Pakistan	16.6	2.4	-4.5
Panama	29.2	14.5	5.9
Paraguay	25.8	2.1	-0.6
Peru	17.0	8.1	-7.6
Philippines	28.7	1.6	5.3
Portugal	23.9	4.1	1.2
Rwanda	18.6	0.2	-0.2
Senegal	17.3	6.9	-2.1
Sierra Leone	13.6	4.3	-7.3
Somalia	17.4	0.5	1.6
Sri Lanka	22.7	2.0	1.4
Sudan	16.4	1.8	-4.2
Tanzania	21.7	1.1	3.9
Thailand	26.1	1.3	2.7
Togo	31.3	14.4	9.2
Trinidad	28.0	1.5	-5.2
Tunisia	28.2	4.9	0.4
Turkey	24.7	1.2	2.4
Upper Volta	20.0	1.4	-0.6
Uruguay	15.9	1.9	-7.8
Venezuela	30.8	4.9	-0.1
Zaire	27.9	5.8	6.7
Zambia	27.0	9.4	2.6

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