EFFECTS OF EXTERNAL DEBT BURDEN ON LDC'S INVESTMENTS: EMPIRICAL EVIDENCE FROM NIGERIA

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ABSTRACT

This article attempts to answer the question of whether the external debt stock and associated servicing always discourage domestic investments in less-developed countries as claimed by some authors. Use was made of a comparative modeling approach involving multiple log-linear regression, distributed lag, and autoregressive models. Comparative estimation methods were also employed, including the OLS, Cochrane-Orcutt, Maximum Likelihood, and instrumental variable techniques against time-series annual Nigerian data from 1970 through 2001. The results, among others, indicate that both external debt stock and debt service are not always disincentives to domestic investments. The debt service (debt burden) variable particularly holds some positive effects for Nigeria's domestic investments especially when such payments attract further capital inflow and the externally-borrowed funds are put to best economic uses. In this light, developing countries may have to change their orientation - which is biased towards debt forgiveness - and see some good in debt-servicing as a proper management strategy.

1.0 INTRODUCTION

External indebtedness has become a natural economic phenomenon among the less-developed countries (LDCs) of the globe. It has been seen as a disaster waiting to happen, as well as a real burden plaguing these countries. The huge accumulations of debt over the years (load or overhang) are believed to provide no breathing space to the debtor-countries to exercise themselves in carefully-planned economic activities. Poverty is said to be seriously associated with large debt stock; thus, LDCs with heavy loads of debt are currently branded heavily indebted poor countries (HIPC). The overhang theory is also accompanied by psychological, social, moral, and political hazards and unsolicited intervention and assertion associated with debtor-creditor relationship. The debtor is the pronounced slave of the creditor, and so is the nature of the relationship between the LDCs and their creditors.

Moving hand-in-glove with the debt overhang phenomenon is the debt burden argument. External debt burden is usually seen in the light of the debt service payments that are made by debtor-countries to their creditors. These

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payments relate to the liquidation of principal and interest associated with the debt contract. When debt service becomes significantly large, a number of effects are usually anticipated. For one thing, debt service is believed to reduce investments and productive activities as needed resources are otherwise channeled to loan repayments. Theory also holds that it drains foreign exchange and crowds out private investors. The point is that "governments face serious financial constraints internally to meet local currency requirements for debt service and most often resort to borrowing from the banking system and crowd out private investors" (Mwaba, 2004: 3). Debt service payments are seen also to promote poverty since they limit resources which would have been invested in basic social services essential to the poor. Furthermore, debt service creates uncertainties which discourage investors from making new commitments in view of the fact that taxes may be raised by the government in order to meet debt obligations. Debt service is the cost of external borrowing and represents a contractual charge on a country's income, savings and foreign exchange reserves. Increased borrowing (overhang) causes increased debt service, which must be paid in foreign exchange. Where export earnings are low or declining, difficulties associated with debt repayments in foreign exchange exacerbates a very serious burden. Considering these, it does not appear an overstatement when the debt service payments are seen as a real burden for the LDCs.

Some questions that should be asked at this point are: Are the conditions of debt overhang and debt burden always harmful to the economy? Is the tendency of large or increased debt stock always anti-developmental, if it is in the first place? Is debt service always a negative vector in the investment growth and development of the economy? Economic and finance theories are not lacking in proffering answers to these questions. For instance, the "non-evil" doctrine affirms that external funds are needed to augment internally generated resources if a country will grow and develop to the utmost. Mwaba (2001) agrees that the accumulations of foreign debt or borrowing by governments can be highly beneficial as it provides resources necessary to promote economic growth and development.

In the same vein, economic and financial theory equally accommodates the fact that debt service has inherent positive potentials. From the psychological point of view, regular service of debt encourages creditors' willingness for future lending. Confidence is created in the process and the creditor is more willing to make more funds available to the debtor. Using these funds properly produces the desirable effects of generating higher returns (from activities into which the borrowed funds are channeled) than the demands of debt service. This is the efficient resource

allocation argument. In the long-run, the aggregate effect would be positive. Morisset (1991) argued that debt reduction, through debt service, possesses two complementary positive effects on the economy: liquidity and incentive effects. The former involves reduction in the net transfers and the latter comes from the decline in the stock of debt. These are not indicative of the ever-harmful theory associated with both external debt stock and external debt service.

It is easier to see the rationale between a positive and significant relationship between the external debt stock (or increases thereof) and domestic investments than it is to see such a relationship between external debt service and investments. This same assertion was confirmed in a recent study investigating the relationship between GDP, debt stock and debt service (Ezirim and Muoghalu, 2004). On the other hand, the positive and significant short- and long-run effects of debt service on income and investments were found in Ezirim, Muoghalu, and Elike's study (2004). Surprisingly, the debt stock was revealed to significantly affect investments in the long-run, but not in the short-run. The reason for this has been ascribed to the socio-economic and structural realities of the Nigerian economy. Evidence from several LDCs, as found by different authors, seem to disagree on the nature of the relationship existing between investments and the two external debt variables [see the section on Literature Review). Invariably, more studies need to be conducted in an attempt to resolve the existing disagreements. The present study seeks to find an answer to the question of whether or not external debt service (the debt burden variable) acts as disincentive to domestic investments. It also aims at furthering the general understanding of the effects of debt stock (the debt overhang variable) on investments.

2.0 LITERATURE REVIEW

As earlier pointed out, international economics and finance literature is rife with many studies on or relating to external indebtedness and macroeconomic magnitudes. Many of these issues have been reviewed (Ezirim, Muoghalu, and Briggs, 2000; Ezirim, Muoghalu, and Elike, 2004; Ezirim, Muoghalu and Emenyeonu, 2005; and Muoghalu and Ezirim 2006). We shall highlight some of the studies that bear directly or indirectly on our chosen topic. Karagol (2002) based his investigation on the Turkish experience and found that debt service facilitated an increased level and flow of debt stock. He equally found that debt stock also facilitated debt service. It was also discovered that when Turkey was servicing its debt, investment and growth was impaired. Servicing therefore was seen to exacerbate the debt problem and thus a disincentive to growth. Metwally and Tamaschke (1994) found that debt servicing reduces the growth potentials of economies of Algeria, Egypt, and Morocco during the

period 1975-1992. This study revealed how debt servicing worsened the debt problems of the countries studied. Like Karagol (2002), Olgun et al. (1998) found a two-way relationship between debt stock and debt service. The results also indicated that debt service did not affect the rate of economic growth of Turkey. Levy and Chowdhury (1993) found that a high level of indebtedness discourages domestic investment, which in turn reduces the level of GNP. Accordingly, an increase in the public and publicly guaranteed external debt may indirectly depress the level of GNP by discouraging capital formation and encouraging capital flight due to tax increase expectations.

Bullow and Rogoff (1990) and Savvides (1992) found that the external debt of LDCs is not a primary cause of economic slow-down. Thus, external debt and its attendant debt service are not evils to be exorcised at all cost. However, Savvides (1992) added that incentives to invest are weakened in view of the compulsion of debt servicing and as a result the debtor country only shares partially in an increase in the output and exports. As earlier stated, Morisset (1991) found debt reduction by debt service as possessing two important effects on the economy. These effects are in respect of liquidity and incentive to the economy and its activities including investments based on the Argentine experience during 1962-1986 period. Geiger (1990), Sawada (1994), and Rockerbie (1994) found that there is a negative but significant relationship between debt burden and economic growth. Mwaba (2001) showed that declining service ratios have stimulated growth in Uganda in the 1990s. Elbadawi, Ndulu, and Ndungu (1997) underscored debt stock to spur growth and investment, while debt accumulation represented by lagged variables deters investment and growth. The Economic Commission for Africa ECA (UNECA, 1998) saw external debt burden as a facilitator of investment slump among the African countries. From the Commission's study, debt overhang was seen to negatively affect investment. Debt burden, on its own, crowds out domestic expenditure and makes it difficult for investment stimulation among the countries' studies.

From these and other studies reviewed, it is clear that many of them see debt service as a disincentive to domestic investment. Only a few perceive this point differently. Whereas some see debt stock as an incentive to investment and growth, others disagree with this finding. This suggests that the relationships between the debt variables and the macro-economic indicators - notably investment - are far from being conclusive. This study wants to contribute its own quota in resolving the question of whether debt burden and overhang are always deterrents to domestic investments.

3.0 METHODOLOGY

The method of study employed in this study involves econometric modeling,

estimations and analysis of the results. The modeling proceeded from the ordinary Log-linear regression models expressing the relationships between domestic investments, debt stock, and debt service. The article equally specified some distributed lag models of the partial adjustment and autoregressive adaptive expectation sorts. Estimation of the models specified was carried out using a number of techniques such as (a) ordinary least squares with associated diagnostic tests, test of serial correlation of residuals, and variable addition tests; (b) alternative tests for non-nested regression models with included Akaike Information and Schwarz Bayesian Information Criteria; (c) Cochrane-Orcutt method with convergence after selected number of iterations; (d) maximum likelihood estimation techniques; and (e) instrumental variable estimations. By using five major estimation methods, the article sought to attempt a comparative analysis of the various techniques in an attempt to verify the reliability of the estimates generated. Analyses are done in two major parts. The first one is the analysis of the global statistics to determine the overall utility of the selected models and estimation methods. The other is the relative analysis of the predictors in an attempt to see how the generated estimates explain the chosen phenomena within the context of the nominated country. All the estimations and computations are done using Microfit 4.0 software.

4.0 THE MODELS

Following the specifications and results of some previous studies as well as the prescriptions of theory, we can hypothesize that the domestic investments of a country is a positive function of the total debt stock outstanding (or increases over time) and a negative function of total debt service payments, ceteris paribus. This relationship can be captured in a classical log-linear regression expression of the form:

$$LnTDI_t = \alpha_0 + \alpha_1 LnDSO_t + \alpha_2 LnDSP_t + U_{1t};\ \alpha_1 > 0;\ \alpha_2 < 0 \quad \ldots\ldots (1)$$

Where TDIt is the total domestic investment over time, DSOt is the debt stock outstanding at time t, DSPt is the debt service payments at time t, Uit is the stochastic error term, and i are the parameters. Relating all the variables to the total output or GDP of the country yields us such variables as the domestic investment ratio (DIR), total debt ratio (TDR), and the debt service ratio (DSR). If we substitute these variables in equation 1 above it becomes:

$$LnDIR_t = \beta_0 + \beta_1 LnTDR + \beta_2 LnDSR + U_{2t};\ \beta_1 > 0;\ \beta_2 < 0 \quad \ldots\ldots (2)$$

Where U2t is the error term and i are parameters. Another way of transforming the variables in expression 1 above will be to use computed rates of change or growth rate for each of them. Some commentaries have equally argued that the debt burden variable (i.e. the DSPt or

DSRt variables in expressions 1 and 2, respectively) is better expressed by relating the total debt service payments with total export proceeds since exports constitute the major source for repaying external debts. This argument, though plausible, is not adopted here since we prefer a situation where all the variables are deflated with a common denominator. Thus, expression 2 is adopted for the purposes of our estimations.

Introducing the distributed lag phenomenon, we hypothesize that, apart from the foregoing external debt variables (TDR and DSR), previous investment levels positively affect current investment levels, ceteris paribus. This implies that the investments made in any given year do not exhaust all its effects in the given year. Instead, its effects extend to the current and future periods and, in turn, affect current and future investments. This is captured by the lag of the investment variable (DIRt-1). This distributed lag mechanism implies that the DIRt does not adjust to optimum levels in any given one period of time. Nerlove (1958) termed the phenomenon the stock or partial adjustment principle. Given the regime of possible implicated distributed lag effects, we can then re-write expression 2 to include:

$$LnDIR_t = \lambda_0 + \lambda_1 LnTDR + \lambda_2 LnDSR + \lambda_3 LnDIR_{t-1} + U_{3t} \quad (3)$$

Where λ_1 $\lambda_3 > 0$; $\lambda_2 < 0$; U_{3t} is the error term and other variables are as earlier defined.

Following the adaptive expectation theory, the principal explanatory variables (namely TDR and DSR) may have autoregressive effects. This is captured by the lag of the independent variables in equations 1 and 2. If we incorporate the lagged effects, equation 3 expands to:

$$DIR_t = \psi_0 + \psi_1 LnTDR + \psi_2 LnTDR_{t-1} + \psi_3 LnDSR + \psi_4 LnDSP_{t-1} + \psi_5 LnDIR_{t-1} + U_{4t}$$

Where $\psi_1 + \psi_2, \psi_5 > 0$; $\psi_3, \psi_4 < 0$ and .....(4)

U_{4t} is the error terms.

Equation 4 states that the domestic investments of a country is a positive function of the previous and present levels of the debt stock, a negative function of the previous and present levels of debt service payments, and a positive function of the previous level of domestic investments. Its assumption is that the previous levels of debt stock, debt service, and investments affect the current level of investment, ceteris paribus.

5.0 DATA, ESTIMATION PROCEDURE AND GLOBAL ANALYSIS

Data for our estimation was generated from the Central Bank of Nigeria Statistical Bulletin and the Bank's Annual Reports and Statements of Accounts. The raw data were transformed into ratios as required in expressions 2, 3, and 4. Where the procedure required, the relevant data went through first-order differencing. Generally, we utilized time-series annual data from 1970 through 2001.

We estimated all the relevant specified models starting with equation 2. The results are presented in Table 1. As depicted by the Table, all the beta coefficients of equation 2 were significant at 1% level. The R-squared, R-Bar-squared, and F-statistic were 0.934, 0.93, and 206.4* (significant at 1%), respectively. The LLL, AIC, and SBC statistics were all appropriate as shown on the Table. However, the presence of autocorrelation problem cannot be denied given the DW statistic of 0.81. Such a condition where the observed R-squared is greater than the DW lends credence to possible spurious regression (Granger and Newbold, 1974; Gujarati, 1995, 1999). That we cannot deny the presence of serial correlation problem is further confirmed by the results of the LM- and F-versions of the serial correlation tests of residual serial correlation which were 12.2* and 17.3* respectively. These values were significant at 1% indicating that we cannot accept a hypothesis of the absence of serial correlation among the residuals. Even when the model passed the tests for functional form and heteroscedasticity, we still thought the serial correlation problem was acute enough to make us look for a better model to explain the relationship between investments and external debt service in Nigeria.

Considering the hypothesis of possible distributed lag effects of previous investments in the country, we estimated equation 3. As shown in Table 1, only two out of the three independent variables were significant at 1% levels. The global statistics showed significant improvement from our estimates of equation 2. The R-squared, R-Bar-Squared, and F-ratios were 0.980, 0.978, and 447.2* (significant at 1%). The LLL, AIC, SBC statistics were significantly lower (a more desirable feature) at -84.5, -88.5, and -91.4. The DW- and Durbin's h-statistics were 1.96 and .132 [.895], respectively. That the Durbin's h-statistic recorded a probability of .895 indicates that autocorrelation problem was not significant at conventional levels. This was confirmed by the diagnostic Lagrange multiplier test of serial correlation of residuals. The observed LM- and F-versions were .052 and .043 respectively and these were not seen to be significant even at 10%. Thus, we have no reason to worry about serial correlation. Furthermore, the model passed the Ramsey's RESET test of functional form using the square of the fitted values; the normality test based on test of skewness and kurtosis of residuals; and the heteroscedasticity test based on the regression of squared residuals on squared fitted values. All the observed statistics were not significant at conventional levels. These accords equation 3 a much better explanatory as well as forecasting power than equation 2, and is thus preferred for further analysis in this paper.

Against the back-drop of a hypothesis of possible autoregressive effect of the

independent variables (total debt ratio, TDR and debt service ratio, DSR), we estimated equation 4. This was done through the variable addition test (OLS case) with zero restrictions on the coefficients of additional variables. The results of the independent variables were not different from those of equation 3, in terms of the number of significant variables and their sign implications. The joint test of zero restrictions on the coefficients of additional variables indicate a Lagrange Multiplier statistic of CHSQ (2) = .539 [.764]; Likelihood ratio statistic of CHSQ (2) = .54 [.762]; and F-statistic of F (2, 25) = .221 [.803]. The probability values (in parenthesis) indicate that these were not significant at conventional levels. The test of serial correlation of residuals showed an LM statistic of .052 [.820] and F-statistic of .043 [.837], which confirmed the absence of any serious serial correlation problem among residuals.

We equally compared the global utility of the estimated models to see which should be most appropriate for our further analysis. This was done using alternative tests for non-nested regression models. Accordingly, equation 3 was compared with equation 2, and thereafter with equation 4. The results are set forth in Tables 2 and 3 respectively. Table 2 summarized the test results comparing equations 2 and 3. It can be seen from the Table that the results of the encompassing test statistic (N-Test, NT-Test, W-Test, J-Test, and JA-Test) reveal an F (1, 27) of 63.3 [.000] when equation 2 was set against equation 3. When, on the other hand, equation 3 was set against equation 2, it revealed F (3, 27) was 3.24 [.038]. The values in parenthesis show that the former case was significant only at a 5% level. The Akaike's Information and Schwarz's Bayesian Criteria of equation 2 versus equation 3 were -15.94 and -17.38 respectively. These all favored equation 3 - a testimony to its better forecasting ability.

Table 3 depicts the results of similar comparison between equations 3 and 4. Setting equation 3 against equation 4, the encompassing F (2, 25) value was .221 [.803]. When equation 4 was set against equation 3 the encompassing F (4, 25) ratio of 28.85 [.000] was revealed. Whereas the second case was significant at 1% level, the first case was not significant even at 10%. The AIC and SBC of equation 3 versus equation 4 were 24.48 and 23.04, respectively. These favor equation 3. Thus, among the three estimated models, equation 3 stands out as the most reliable in analyzing the relationship between domestic investments and the exogenous external debt variables. Our subsequent analysis of the effects of predictors rests mainly on it.

5.1 Analysis of Relative Effects of Predictors

In order to further cross-check the reliability of the OLS method employed in this paper, we applied other estimation techniques. These were the Cochrane-

Orcutt AR (1), Maximum Likelihood AR (4), and Instrumental Variable estimation methods. The Cochrane-Orcutt method AR (1) converged after two iterations. Maximum likelihood estimation AR (4) converged after four iterations. All the three methods yielded similar estimates, as did the earlier OLS method for equation 3. In particular, the instrumental variable technique produced exactly the same results as the OLS method (see Table 4). These suggest that the generated estimates of the model (equation 3) are reliable for the purposes of analysis.

It is easily seen from Tables 1 and 4 that, in all cases under the different estimation methods, the total debt ratio (TDR) was positively related to total domestic investments as expected. However, the beta coefficients ranging from .003 to .004 were not significant at conventional levels. Treating these coefficients as elasticities, one unit positive change in external debt stock brings about 0.4% positive change, at most, in the total domestic investments. This shows that the debt stock did not significantly affect domestic investments during the period covered by the study. Even after one year of such receipt of external debt (as represented by the lagged TDRt-1 variable), the TDR still did not affect investments significantly (see Table 1). Thus, in the short-term, the effect of the debt stock on domestic investments was not significant. These results are consistent with the findings in Ezirim, Muoghalu and Elike (2004). Although positively related, the total external debt stock (TEDs) did not affect the GNP and aggregate investments of Nigeria. The explanation to this ugly, "uneconomic" tendency has been blamed on the endemic problems of funding inadequacy due to poor borrowing capacity, corruption and financial misappropriations. The results also agree with Elbadawi, Ndulu, and Ndungu (1997), which underscore the fact that it is debt accumulation, and not its flow or servicing, that deters investments.

From Tables 1 and 4, we see that in all the results of the four estimations of equation 3, the debt service ratio was significant at conventional levels. The revealed beta coefficients ranged from .247 to .281, and these were significant at 5% and 1% levels, respectively. By interpretation, one unit change in debt service ratio (DSRt) is accompanied by a 24.7% change (at least) in investments in the same direction. This result contradicts many previous studies such as those of Metwally and Tamaschke (1994), Levy and Chowdhury (1993), Savvides (1992), and UNECA (1998). However, the result agrees with the results of such studies as Elbadawi, Ndulu, and Ndungu (1997), especially when it is taken for granted that there is a direct relationship between debt accumulation (overhang) and debt service payments (debt burden). These results equally lend empirical support to the findings in Ezirim, Muoghalu, and Elike (2004), where the observed relationships were both positive and significant. The

inference from these is that debt service payments by LDCs, such as Nigeria, do not always act as disincentive to investments. There could be a positive angle to the practice of meeting debt obligations as they fall due. Explanations to this position can be invoked from the socio-economic, psychological, and the efficient resource allocation arguments presented in the introductory part of this paper.

The results further revealed that in all cases, the lagged domestic investment ratio were positively signed and significant at 1% level. Its beta coefficient was .824 on the average. Impliedly, one unit change in previous investments brings about 0.82 unit (82%) change in current investments. Thus, current domestic investments are affected by previous domestic investments. This being the case, we cannot accept a null hypothesis of no distributed lag effect as expressed by the models. This equally confirms the presence of the stock adjustment principle at work in the expressed relationships. If we invoke the prescriptions of Nerlove (1969) as demonstrated in Ezirim (1999) and Ezirim, Muoghalu, and Elike (2004), the adjustment parameter (() becomes (= 1 - This yields an adjustment index of 0.176. The attained level of desired investments in any given year becomes 17.6% in the face of the external debt condition of Nigeria. This compares favorably with the 18.15% level obtained in Ezirim, Muoghalu, and Elike (2004). Evidently, it appears that a very low proportion of the externally-borrowed funds are invested in the country's productive activities. Even if they were investments in the first place, such investments were not channeled to the domestic sector. That the country is crying for the reparation/repatriation of funds fraudulently invested in overseas economies may be an explanation to the destination of the huge amount of borrowed funds.

6.0 CONCLUDING REMARKS AND POLICY RECOMMENDATIONS

From our analysis, we can summarize a number of useful inferences and conclusions. First, huge accumulations of debt (external debt stock) do not spur or boost investments in a typical LDC such as Nigeria. Increases or flow over time may do that, perhaps, but surely not huge outstanding of debt stock. Second, External debt service payments, although they represent outflows from a country, do not always act as disincentives to investments. The socio-economic and/or psychological element associated with debtor-creditor relationship and the efficient resource allocation argument help to make debt service produce some positive incentive effect to domestic investments. Thirdly, as is consistent with the stock adjustment principle, the effects of previous investments were not exhausted in the given year of the investments but spread out over subsequent years to boost current and future investments. Fourth, following

from the point above, only about 17.6% of desired levels of domestic investments are attained in Nigeria (on the average) given the effects of external indebtedness of the country. This level is quite low and is seen as anti-developmental; seeing that the proportion of externally-borrowed funds that eventually gets invested in the country was comparatively low.

An important recommendation that follows from the results of the analysis in this paper is that Nigeria, as well as other LDCs, should not be inclined to see debt service as an evil to be exorcised by all means. Debt servicing can be positive activity, especially when the country develops the culture of channeling borrowed funds to profitable and designated activities. If this is done, the returns on such activities would naturally be higher than the demands of debt service. Again, the development of a good export base would make debt service a burden-free exercise. Thus, borrowed funds can be channeled to export-generating activities of the country. By faithfully servicing the country's debt, the tendency to reduce the debt overhang problem is apparent and the country would in the near future walk out of the problems that are related to external debt.

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Table 1: OLS Estimation Results of Equations 2, 3 and 4.

Panel A: Estimates of Regressors for Estimated Models F			
Predictors	***Equation 2***	***Equation 3***	***Equation 4***
Constant	5.51 (3.33)*	1.17 (1.08)	.919 (.762)
TDR	.015 (5.84)*	.003 (1.57)	.0024 (.805)
DSR	.872 (8.35)*	.281 (2.94)*	.376 (2.15)**
DIR_{t-1}	-	.806 (7.96)*	.846 (6.84)*
TDR_{t-1}	-	-	.003 (.126)
DSR_{t-1}	-	-	-.137 (-.65)
Panel B: Global Statistics			
R-squared	.934	.980	-
R-bar-squared	.930	.978	-
S.E. of Regression	7.01	3.96	-
F-statistic	206.4*	447.2*	-
Eq. LLL	-106.2	-84.5	-
AIC	-109.2	-88.5	-
SBC	-111.4	-91.4	-
DW-statistic	.809	1.96	-
Durbin's h-statistic	-	.132[.895]	-
Panel C: Diagnostic Tests of the Estimated Models ++			
Serial Correlation LM-version F-version	 12.2* 17.3*	 .052 .043	 .052 .043
Functional Form LM-version F-version	 .693 .620	 1.34 1.17	 -
Normality (LM)	14.3*	3.88	-
Heteroscedasticity LM-Version F-Version	 .094 .089	 1.16 1.13	 -

++ ---> Global statistics for equation 4 were not generated since estimates were gotten through variable addition tests.

* represents significant level of 1% or less; ** represents significant level of 5% or less.

Table 2: Alternative Tests for Non-Nested Regression Models: Equation 2 Vs. Equation 3

Dependent variable is X_3 31 observations used from 1971 to 2001 Regressors for model M_2: A0 X4 X5 Regressors for model M_3: X_3 (-1)		
Test Statistic	**M_2 against M_3**	**M_3 against M_2**
N-Test	-9.9600[.000]	-3.6044[.000]
NT-Test	-9.4495[.000]	-2.6213[.001]
W-Test	-4.4980[.000]	3.1282[.002]
J-Test	7.9557[.000]	3.1282[.002]
JA-Test	7.9557[.000]	3.0323[.002]
Encompassing	F(1, 27) 63.2937[.000]	F(3, 27) 3.2414[.038]

Model M_2: DW .77615; R-bar-squared .92790; Log-likelihood -103.2110.
Model M_3: DW 1.8994; R-bar-squared .97263; Log-likelihood -89.2668.
Model $M_2 + M_3$: DW 1.9610; R-bar-squared .97764; Log-likelihood -84.4989.
Akaike's Information Criterion of M_2 versus M_3 = -15.9443 favors M_3.
Schwarz's Bayesian Criterion of M_2 versus M_3 = -17.3782 favors M_3.

Table 3: Alternative Tests for Non-Nested Regression Models: Equation 3 Vs. Equation 4

Dependent variable is X_3 31 observations used from 1971 to 2001 Regressors for model M_3: A0 X4 X5 X3(-1) Regressors for model M_4: X4(-1) X5(-1)		
Test Statistic	**M_1 against M_4**	**M_4 against M_3**
N-Test	.44934[.653]	-12.9864[.000]
NT-Test	.44137[.659]	-10.8701[.000]
W-Test	.45196[.651]	-4.7380[.000]
J-Test	-.41702[.677]	11.2857[.000]
JA-Test	-.42589[.670]	4.8734[.000]
Encompassing	F(2, 25) .22122[.803]	F(4, 25) 28.8499[.000]

Model M_3: DW 1.9610; R-bar-squared .97808; Log-likelihood -84.4989.
Model M_4: DW .71962; R-bar-squared .88737; Log-likelihood -110.9741.
Model $M_3 + M_4$: DW 2.0832; R-bar-squared .97674; Log-likelihood -84.2270.
Akaike's Information Criterion of M_3 versus M_4 = -15.9443 favors M_3.
Schwarz's Bayesian Criterion of M_3 versus M_4 = -17.3782 favors M_3.

Table 4: Comparative Estimation Results of Equation 3 from Different Techniques

Panel A: Estimates of Regressors for Model 3			
Predictors	**Cochrane-Orcutt, AR (1)**	**Maximum Likelihood AR (4)**	**Instrumental Variable**
Constant	1.45 (1.38)	1.51 (1.54)	.862 (.864)
TDR_t	.003 (1.49)	.004 (1.50)	.003 (1.55)
DSR_t	.247 (2.72)**	.255 (2.98)*	.248 (2.49)**
DIR_{t-1}	.833 (8.51)*	.815 (7.99)*	.842 (7.85)*
Panel B: Comparative Global Statistics			
R-squared	.982	.982	.980
R-bar-squared	.979	.975	.978
S.E. of Regression	3.84	4.24	3.96
F-statistic	346.6*	146.6*	447.2*
Eq. LLL	-80.2	-72.6	-
AIC	-85.2	-80.6	-
SBC	-88.78	-86.3	-
DW-statistic	2.06	2.12	1.96

*Represents significant level of 1% or less.

**Represents significant level at 5% or less.