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This paper considers savings, investment and economic growth for India using annual time series data for the period 1950/51 to 2003/04. The analysis uses Perron's innovational outlier model to conduct unit root tests which endogenously determines a structural break. The empirical results show that the null hypothesis of unit root cannot be rejected for gross domestic product. Moreover, the results show that the most significant structural breaks over the last five decades correspond to the wars, regime change and the nationalisation of the banks. The study also utilises the Autoregressive Distributed Lag (ARDL) approach to test for cointegration. Whilst the results support the existing evidence for the Carroll-Weil hypothesis; the study also finds that saving unambiguously determines investment in both the short and long runs. No evidence is found to support the commonly accepted growth models in India, that investment is the engine of economic growth.

Keywords

structural break, ARDL model, savings, investment, economic growth

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Savings, Investment and Growth in India: An Application of the ARDL Bounds Testing Approach

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Abstract

This paper considers savings, investment and economic growth for India using annual time series data for the period 1950/51 to 2003/04. The analysis uses Perron's innovational outlier model to conduct unit root tests which endogenously determines a structural break. The empirical results show that the null hypothesis of unit root cannot be rejected for gross domestic product. Moreover, the results show that the most significant structural breaks over the last five decades correspond to the wars, regime change and the nationalisation of the banks. The study also utilises the Autoregressive Distributed Lag (ARDL) approach to test for cointegration. Whilst the results support the existing evidence for the Carroll-Weil hypothesis; the study also finds that saving unambiguously determines investment in both the short and long runs. No evidence is found to support the commonly accepted growth models in India, that investment is the engine of economic growth.

Keywords: structural break, ARDL model, savings, investment, economic growth.

JEL Classifications: F43, E21, E22, C22, C52

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I Introduction

The role of savings and investment in promoting economic growth has received considerable attention in India since independence and in many countries around the world. The central idea of Lewis's (1955) traditional theory was that increasing savings would accelerate growth, while the early Domar-Harrod models specified investment as the key to promoting economic growth. On the other hand, the neoclassical Solow (1970) model argues that the increase in the savings rate boosts steady-state output by more than its direct impact on investment because the induced rise in income raises savings, leading to a further rise in investment. Bacha (1990) and Jappelli and Pagano (1994) also claimed that savings contribute to higher investment and higher GDP growth in the short-run. However, the Carroll-Weil hypothesis (Carroll-Weil 1994) states that it is economic growth that contributes to savings, not savings to growth. On the other side, the new growth theories since the mid 1980s, typified by Romer (1986, 1990), Lucas (1988) and Barro (1990) reconfirm the view that the accumulation of physical capital are the drivers of long-run economic growth.

Development and growth theories are replete with examples of how savings and investment play a critical role in promoting economic growth. However, most Indian studies look at the relationship between savings, investment and growth by commonly testing for bivariate cointegration and Granger causality separately between investment and growth, or between savings and growth. This paper differs from other studies in the literature by conducting unit root test which endogenously determines a structural break in the time series and by studying the relationship among the three variables (savings, investment and growth) using the Autoregressive Distributed Lag (ARDL) approach to cointegration.

The paper is divided into four sections; in section two, the unit root tests are conducted within the framework of the recent techniques in determining an endogenous structural break in time series data; while the rationale, concept and the results of using the ARDL Modelling approach in this study are presented in Section three. The final section summarises the important findings and brings out some policy implications.

Annual data for the period of 1950/51 to 2003/04 was used in the study. Data for gross domestic savings (GDS) and gross domestic investment (GDI) were taken from the National Accounts Statistics of India (2005). Goss Domestic Product (GDP) figures are available from the Reserve Bank of India (2005). All variables were divided by the population (available from the Reserve Bank of India) and converted to Naperian logs to put the variables in per population context.

II Unit Root Tests with Structural Break

Structural change occurs in many time series due to economic crises, policy changes, changes in institutional arrangements and regime shifts. In recent years, the issue of structural change has become of considerable importance in the analysis of macroeconomic time series. One of the problems associated with structural change is testing of the null hypothesis of structural stability against the alternative of a one-time structural break. If such structural changes are present in the data generating process, but not allowed for in the specification of an econometric model, results may be biased towards the erroneous non-rejection of the non-stationarity hypothesis (Perron 1989; Perron 1997; Leybourne and Newbold 2003). Perron and Vogelsang (1992) and Perron (1997) have proposed a class of test statistics which allows for two different forms of structural break: the Additive Outlier (AO) model, which allows for the structural change to take place instantaneously; and the Innovational Outlier (IO) model. This paper uses the Innovational Outlier (IO) model where changes are assumed to take place gradually.

The IO model allows for a gradual change in the intercept (IO1) and gradual changes in both the intercept and the slope of the trend function (IO2) such that:

$$\text{IO1}: x_t = \mu + \theta DU_t + \beta t + \delta D(T_b)_t + \alpha x_{t-1} + \sum_{i=1}^{K} c_i \Delta x_{t-i} + e_t \qquad (1)$$

$$\text{IO2}: x_t = \mu + \theta DU_t + \beta t + \gamma DT_t + \delta D(Tb)_t + \alpha x_{t-1} + \sum_{i=1}^{K} c_i \Delta x_{t-i} + e_t \qquad (2)$$

where T_b denotes the time of break (1 < T_b< *T)* which is unknown, $DU_t = 1$ if t > T_b and zero otherwise, $DT_t = T_t$ if t > T_b and zero elsewhere, D(T_b) = 1 if t = T_b+1 and zero otherwise, x_t is any general ARMA process and e_t is the residual term assumed white noise. The null hypothesis of a unit root is rejected if the absolute value of the t-statistic for testing α=1 is greater than the corresponding critical value. Perron (1997) suggests that the time of structural break (T_b) can be determined by two methods. The first approach is that equations (1) or (2) are sequentially estimated assuming different T_b with T_b chosen to minimize the t-ratio for α=1. In the second approach, T_b is chosen from among all other possible break point values to minimize the t-ratio on the estimated slope coefficient (γ).

The truncation lag parameter (k) is determined using the data-dependent method proposed by Perron (1997). The choice of k in this method depends upon whether the t-ratio on the coefficient associated with the last lag in the estimated autoregression is significant. The optimum k (or k*) is selected such that the coefficient on the last lag in an autoregression of order k* is significant and that the last coefficient in an autoregression of order greater than k* is insignificant, up to a maximum order k (Perron, 1997).

This study uses the above approach (IO model) to test for stationarity/non-stationarity for the three variables (GDS, GDI and GDP). In order to decide what particular model is most relevant, firstly the least restrictive model is estimated (IO2 model). If the tγ is significant at the five per cent level or better, the results are reported. If tγ is not statistically significant, the results of IO1 are reported. We find that the tγ is significant for all the three variables and thus the results of IO2 are only reported.

As can be seen from the reported results in Table 1, the unit root null hypothesis is rejected in favour of the alternative if the t-statistic for α is significant and greater than the critical values tabulated by Perron (1997). Results of the IO results indicate that GDI and GDS are stationary in log level while GDP is non-stationary under structural change at a five per cent significance level. It is well known that the stationary test under structural change have a low power and this could be a reason for the different order of integration of the three variables. However, the cointegration method used here, the ARDL method allows testing for a long-run relationship between variables of mixed order of integration (as explained below).

The timing of the structural break (T_b) for each series using the IO model is also shown in Table 1. The IO model indicates the single most significant break. The computed break dates of 1980 and 1984 for GDS and GDP correspond with the nationalization of six more banks[1] in 1980 along with the rapid expansion of bank branches in the early eighties. The computed break date of 1965 for GDI coincides with the wars with China (1962) and Pakistan (1964) and the change in leadership in India. This provides complementary evidence to models employing exogenously imposed structural breaks in the Indian economy.

Insert Table 1 here

III ARDL Cointegration Approach

Several methods are available for conducting cointegration tests. Commonly used methods include the residual based Engle-Granger (1987) test, Johansen (1988), Johansen-Juselius (1990) and Gregory and Hansen (1996). The proposed autoregressive distributed lag (ARDL) approach, developed by Pesaran and Shin (1995 and 1998), Pesaran et al. (1996) and Pesaran et al. (2001) has become popular in recent years**.** The main advantage of the ARDL model given the power and testing of the long-run relationship is that it can be applied irrespective of the order of integration (and in small samples) while other cointegration techniques require all variables be of equal degree of integration (and large sample). Thus, the ARDL approach avoids the use of Augemented Dicky Fuller unit root tests and autocorrelation function tests for testing the order of integration.

In fact, Hendry et al (1984) argue that the ARDL process of econometric modeling is an attempt to match the unknown data generating process with a validly specified econometric model, and thus economic theory restrictions on the analysis are essential. This will be done by specifying each of the three variables in turn as the dependent variable. According to the Henry-type approach, the test for the adequacy of the ARDL model is defined in terms of its statistical properties. Importantly, the diagnostic tests of the model in this paper do not exhibit any evidence of serial correlation or heteroscedasticity and the model passes the test of functional form and normality[#].

The ARDL framework is as follows:

$$\Delta \ln GDP = \alpha_0 + \sum_{j=1}^{n} b_j \Delta \ln GDP_{t-j} + \sum_{j=0}^{n} c_j \Delta \ln GDS_{t-j} + \sum_{j=0}^{n} d_j \Delta GDI_{t-j} + \delta_1 \ln GDP_{t-1} + \delta_2 \ln GDS_{t-1} + \delta_3 \ln GDI_{t-1} + \varepsilon_{1t} \quad (3)$$

The parameters δ_i where i = 1, 2, 3 are the corresponding long-run multipliers, while the parameters b_j, c_j, d_j are the short-run dynamic coefficients of the underlying ARDL model.

In the ARDL model outlined, we first test the null of no cointegration (i.e. H_0: $\delta_1 = \delta_2 = \delta_3 = 0$) against the alternative using the F-test with critical values tabulated by Pesaran et al (2001). The asymptotic distributions of the F-statistics are non-standard under the null hypothesis of no cointegration relationship between the examined variables, irrespective of whether the variables are purely $I(0)$ or $I(1)$, or mutually cointegrated. Two sets of asymptotic critical values are provided by Pesaran et al. (2001). The first set assumes that all variables are $I(0)$ while the second set assumes that all variables are $I(1)$. The null hypothesis of no cointegration will be rejected if the calculated F-statistic is greater than the upper bound critical value. If the computed F-statistics is less than the

[#] I would like to thank an anonymous referee for their useful contribution here.

lower bound critical value, then we cannot reject the null of no cointegration. Finally, the result is inconclusive if the computed F-statistic falls within the lower and upper bound critical values.

Under the inconclusive cases, following Kremers *et al*. (1992) and Bannerjee *et al*. (1998) the error correction term will be a useful way of establishing cointegration.

Since we have only fifty-three annual observations, the maximum lag length of two was chosen in the ARDL model. A significant F-statistics for testing the joint level significance of the lagged level indicates the existence of a long-run relationship. Our results (reported in Table 2) suggest that there is no long-run relationship among GDS, GDI and GDP only when GDP is the dependent variable; that is the null hypothesis of no cointegration is not rejected for GDP. The F-statistic for GDP (1.51) is lower than the lower bound critical value (3.88), concluding that neither gross domestic savings nor gross domestic investment have had an affect in the long-run on India's economic growth (for over 50 years)[2]. This result not only supports the stationary tests done in section II, where we found that GDP is not of the same integrating order as GDS and GDI but is also consistent with the observations in Figure 1 where GDP diverges from savings and investment. The finding does not support policies designed to increase savings and investment in order to promote economic growth in India.

Insert Figure 1 here

The above result is consistent with Aghion *et al* (2006) who claim that in countries close to the frontier, local firms are familiar with the frontier technology, and therefore, do not attract foreign investment to undertake an innovation project, so 'local savings does not matter for growth'. However, it is questionable whether this is applicable to India as Aghion *et al* (2006) also claim that in relatively poor countries catching up with frontiers requires the involvement of foreign investors together with effort on the part of a local bank which can monitor local projects to which technology must be adapted. In such a country, 'local savings matters for innovation, and therefore growth'.

This finding is also consistent with Sahoo, Nataraj and Kamaiah (2001), who conclude that 'savings as the engine of growth is refuted in the Indian context'; and Sandilands and Chandra (2003) who conclude that 'Indian capital accumulation does not cause growth in the long-run'. However, Sahoo, Nataraj and Kamaiah (2001) look at the relationship between gross savings and growth only, without taking into account the role played by investment; while Sandilands and Chandra (2003) look at the relationship between investment and growth only, without taking into account the role played by savings.

On the other hand, the finding refutes the claims made by others including Saggar (2003) that total investment rate does Granger cause real GDP growth rate in India; and Mathur (2005) who establishes that most of the South Asian countries are catching up with the best practice frontier and therefore increasing savings and investment are important.

Table 2 also shows that the null hypothesis of no cointegration is rejected for GDS as the F-statistic of 7.72 exceeds the upper bound critical value of 4.61. However, in the case of GDI, we have inconclusive outcome because the calculated F-statistic (3.85) is less than the upper bound critical value (4.61) but is on the borderline of the lower bound critical value (3.88). In this case, following Kremers *et al.* (1992) and Bannerjee *et al.* (1998) the error correction term will be a useful way of establishing cointegration.

Insert Table 2 here

Following the establishment of the existence of cointegration, we estimate the long-run coefficients of the ARDL model. One of the important issues in applying the ARDL model is choosing the order of the distributed lag function. Pesaran and Smith (1998) argue that the Schwartz-Bayesian Criteria (SBC) should be used in preference to other model specification criteria because it often has more parsimonious specifications; the relatively small sample data in this study reinforces this point. The empirical results in Tables 3 and 4 show the long-run coefficients of variables under consideration. Firstly, the empirical results reveal that a one per cent increase in GDP will lead to 0.48 per cent increase in GDS, significant at a one per cent level. The finding supports the Carroll-Weil hypothesis that savings do not cause growth, but growth does cause savings and is consistent with Sahoo, Nataraj and Kamaiah (2001), who claim that ‘GDP has powerful long-and short-run effects on savings’. Secondly, with GDI being the dependent variable, the results reported in Table 4 indicate the existence of a long-run impact of only GDS on GDI, at the one per cent significance level. This finding is consistent with Seshaiah and Sriyval (2005) who show that it is savings influencing investment whereas investment is not influencing savings. A one per cent increase in GDS leads to a large 1.3 per cent increase in GDI in the long-run, supporting the traditional Solow view that savings determine investment in the long-run.

After estimating the long-run coefficients, we obtain the error correction representation of the ARDL model. The ECM represents the speed of adjustment to restore equilibrium in the dynamic model following a disturbance. The ECM coefficient shows how slowly/quickly variable return to equilibrium and it should be negative and significant, which is the case here. Bannerjee *et al* (1998) holds that a highly significant error correction term is further proof of the existence of a stable long-term relationship. The estimated coefficient of the ECM (-1) is equal to -0.60 suggesting a relatively quick speed of adjustment back to the long-run equilibrium. The result specifically states that deviation from the long-term GDS path is corrected by 60 per cent over the following year, significant at the five cent level. Similar results are achieved for GDI with the estimated coefficient of the ECM (-1) equal to -0.54, suggesting that deviation from the long-term GDI path is corrected by 54 per cent over the following year. This is significant at the one cent level and therefore concludes that a long-term relationship exists among the three variables when GDI is the dependent variable.

Tables 3 and 4 also report the short-run coefficient estimates obtained from the ECM version of the ARDL model. It is important to note that Granger Causality was not done here due to the low lag length that resulted in the SBC selection criteria[3]. Consistent with the long-run findings, Table 3 indicates that GDP affects GDS in the short-run with an elasticity of 0.29 at the one per cent significance level. The result is consistent with the other studies keeping in mind that these studies only look at Granger causality for savings and growth without taking the effect of investment[4]. Unlike in the long-run, the empirical results in Table 4 indicate that GDI affects GDS in the short-run with the significant elasticity of 0.44 at the one per cent level. However, as per the long-run findings, we find that GDS affects GDI in the short-run with a lower elasticity of 0.70 at the one per cent significance level. This is consistent with the short-run theory of Bacha (1990) and Jappelli and Pagano (1994) in a way that savings contribute to higher investment but the link from investment to higher GDP growth is missing.

Insert Table 3 here

Insert Table 4 here

IV Conclusion

This paper makes two contributions; the unit root tests are conducted within the framework of determining an endogenous structural break and by studying the relationship of savings, investment and growth using the autoregressive distributed lag (ARDL) approach to cointegration. The paper uses annual time series data to endogenously determine the most significant and important structural break for GDS, GDI and GDP for India from 1950/51 to 2003/04. The empirical results based on the Perron's innovational outlier model show that GDP is non-stationary while GDS and GDI are both stationary at log levels. Moreover, we found that the most significant structural breaks occurring over the last five decades and which were detected endogenously coincided with the two wars (1962 and 1964), regime change (1964) and nationalization of banks (1980).

Next, the ARDL cointegration approach was employed to determine the long-run relationship of GDS, GDI and GDP. The F-statistics indicate that the null of no cointegration cannot be rejected only when GDP is the dependent variable. We also estimate the long-run and short-run elasticities of the relationship between GDS, GDI and GDP growth which brings out three conclusions. Firstly, the econometric evidence supports the Carroll-Weil hypothesis that savings do not cause growth, but growth causes savings. Secondly**,** the results clearly support the view that savings drive investment in both the short-run and long-run. Lastly, there is no evidence that investment is the driver of economic growth in India since independence.

The empirical results obtained in this paper can be viewed as though savings and investment are derivative rather than the initiating factors of economic growth**.** The lack of empirical validation of commonly accepted growth theories is problematic for policy formulation in India. Even though savings have no effect on growth, it should still be encouraged for its desirable level effects. The paper does not suggest that Indian policy makers should deemphasise investment, but rather that equal attention should be paid to the view which regards savings and investment as a consequence of higher growth, not the primary cause. Although the interpretation of these findings is powerful, much more work is required in this area. One way to establish a savings-GDP relationship in India and indeed an area for future research would be to estimate the relationship using data from the Indian states.

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[1] Initial nationalization of the 14 commercial banks took place in 1969.

[2] The ecm(-1) was also insignificant, thus supporting the F-test of no relationship when GDP is the dependent variable.

[3] Granger Causality was not done here due to low optimal lag length that resulted in the ARDL model. Econometrically, Granger Causality can be established even if one does not have co-integrating relationship (Granger 1988, Khan Masood et.al 2005).Granger causality in the absence of cointegration is interpreted as short-run causal relationship. Over and above this VAR analysis (Sims 1980) and impulse response function can always used to establish the relationships among the variables (with no cointegration) over time

[4] Mühleisen (1997) study, while indicating that there is significant causality from growth to savings, consistently reject causality from savings to growth for all forms of savings. Mahambare and Balasubramanyam (2000) conclude 'the Granger causality test suggests that causality runs from growth to savings' for India. Saggar (2003) finds that causality runs from output to savings and not in the opposite direction.

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Table 1: Innovational Outlier Model for determining the break date in both intercept and slope (IO2)

Variable	Tb	k	$T_{\hat{\alpha}}$	Results
LGDP	1984	0	-4.281	Unit Root
LGDS	1980	1	-6.878	Stationary
LGDI	1965	1	-8.113	Stationary

Note: Critical values for the IO2 models at the 1%, 5% and 10% are -6.32, -5.59 and -5.29 respectively.
The maximum lag of 4 was chosen

Table 2: F-statistics for testing the existence of a long-run relationship among variables

Equation	The calculated F-statistics
$F(GDP/GDS,GDI)$	1.51
$F(GDS/GDI,GDP)$	7.72***
$F(GDI/GDS,GDP)$	3.85**

Note: The relevant critical value bounds of 3.88 and 4.61 are obtained from Pesaran and Shin (2001).
*** significant at 1% level, ** significant at 5% level * significant at 10% level

Figure 1

Savings, Investment and Growth in India

R's crore at constant prices

Gross Domestic Savings, Gross Domestic Investment and Gross Domestic Product for India: 1950/51-2003/04

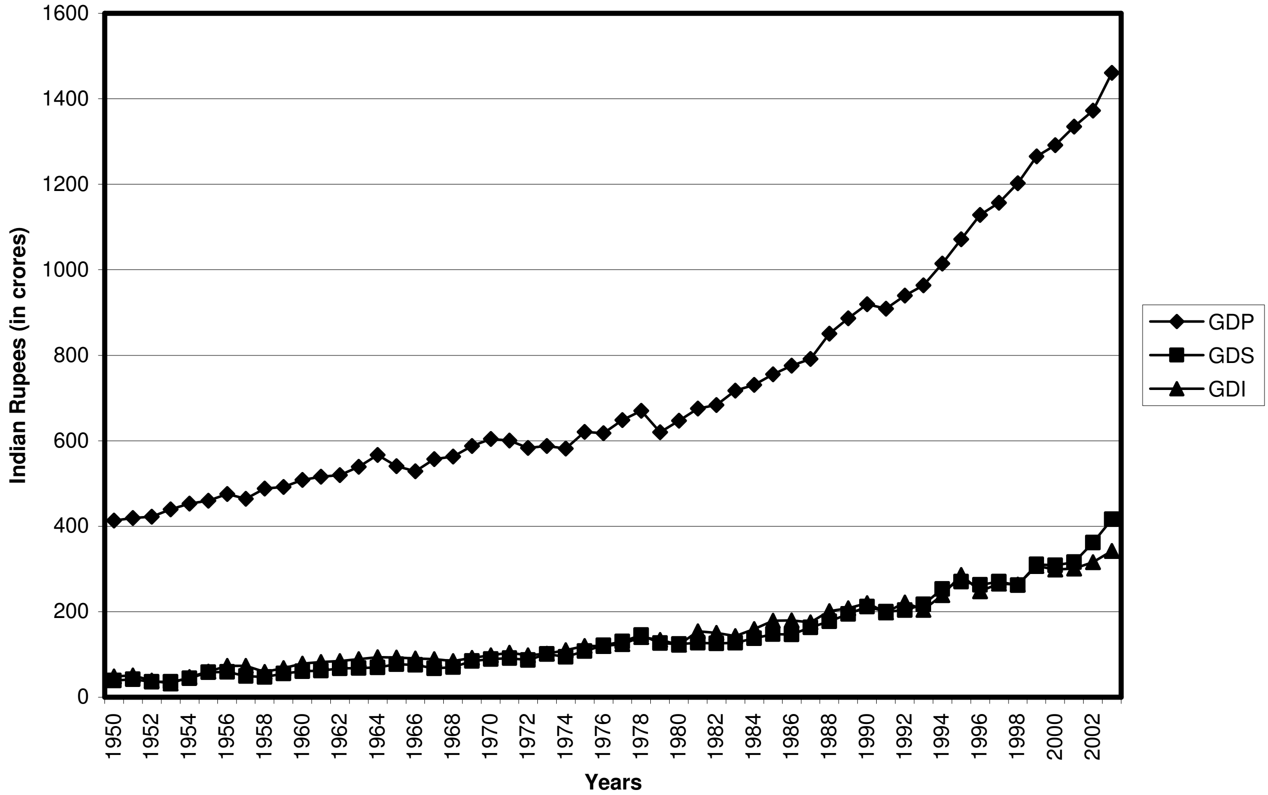

Table 3: Estimated long-run coefficients and short–run error correction model (ECM)

Dependent variable: LGDS

The long-run coefficients results ARDL (1,1,0)			ECM–ARDL: dependent variable: ΔLGDS		
Regressor	Coefficient	T-Ratio	Regressor	Coefficient	T-Ratio
LGDI	0.1066	0.6802	$\Delta LGDI_t$	0.4449	5.3036***
LGDP	0.4814	2.6543***	$\Delta LGDP_t$	0.2891	2.7311***
Constant	0.2658	0.2435	Constant	0.1597	0.2425
D1980	-0.1514	-2.735***	D1980	-0.0909	-2.6031***
Trend	0.0320	4.7267***	ECM_{t-1}	-0.6006	-4.8715**

Note: *** significant at 1% level, ** significant at 5% level * significant at 10% level

R^2 = 0.6461; F(5 ,46) = 16.4309***

Table 4: Estimated long-run coefficients and short–run error correction model (ECM)

Dependent variable: LGDI

The long-run coefficients results ARDL (1,0,0)			ECM–ARDL: dependent variable: ΔLGDI		
Regressor	Coefficient	T-Ratio	Regressor	Coefficient	T-Ratio
LGDS	1.3004	3.8649***	$\Delta LGDS_t$	0.7019	5.2160***
LGDP	-0.5884	-1.4728	$\Delta LGDP_t$	-0.3176	-1.5271
Constant	2.6878	1.2517	Constant	1.4507	1.1984
D1965	-0.1207	-1.1891	D1965	-0.0651	-0.1354
Trend	-0.0018	-0.1338	ECM_{t-1}	-0.5397	-5.3928***

Note: *** significant at 1% level, ** significant at 5% level * significant at 10% level

R^2 = 0.5415; F (5, 46) = 10.8622 ***