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Saving, Investment and Growth in India: Evidence from Cointegration and Causality Tests

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Summary

This study examines the long-run equilibrium relationship between real domestic saving, investment and growth and tests the null hypothesis of non-causality between these variables in India during 1951-2015. The cointegration tests confirmed the existence of a long-run equilibrium relationship between domestic savings, investment and growth for India. The estimated long-run elasticities suggested a stronger elasticity of saving in explaining the investment in India than growth. The ARDL short-run estimates were consistent with long-run estimates. The causality test suggested the absence of causal relationship between growth and investment, and between growth and saving. However, a unidirectional causality from saving to investment was confirmed suggesting that domestic savings play a very important role in supporting national investments.

JEL: E21, E22, F43, C32

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1. BACKGROUND

For an emerging economy like India, saving and investment are two vital macroeconomic policy variables. These variables, *inter alia*, can be used not only for reaching the targeted level of growth but also for maintaining a sustainable level of growth with price stability and sufficient liquidity in India. In the economic literature, it has been argued that domestic savings is one of the significant sources of funding public and private investment for a given economy. To add to this, the World Bank in its various reports (cited in Bahmani-Oskooee and Chakrabarti, 2005, p.284) has consistently maintained that private investment is the 'engine for growth and poverty reduction'. Therefore, any policy that affects domestic savings can also affect investment and thus growth. Thus, the examination of long-run equilibrium relationship or long-run cointegration between growth, savings and investment is of paramount importance especially for an emerging economy like India which is striving toward higher and sustainable growth.

For India, such a long-run relationship with respect to gross domestic product has a special importance, considering that since independence, the country has attributed

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a greater role of domestic savings and investment in promoting a sustainable level of economic growth. For example, the World Bank referred to the experience of India and other economies for having achieved remarkable growth and considerable poverty reduction through nurturing private investment (ibid., 2005).

The traditional economic assumption was that to accelerate growth, one has to increase domestic savings (Lewis, 1955). For example, Kaldor (1956) and Samuelson and Modigliani (1966) studied how different savings behaviour encouraged or induced growth in economies. The neoclassical model of Solow (1970) also proposed that the increase in the savings increases output by more than its direct impact on investment. However, the Harrod-Domar models suggested that investment is important and vital in advancing economic growth. Empirical studies have interesting but inconclusive debate on this issue in various economies. For example, the conventional observation is that domestic savings contribute to higher investment and hence higher growth in the short-run (Bacha, 1990; De Gregorio, 1992; Jappelli and Pagano, 1994). However, contradicting this, several empirical studies such as those of Carroll-Weil (1994), Sinha and Sinha (1998), Salz (1999), Anoruo and Ahmad (2001) argued that it is the gross domestic product (GDP) growth that causes savings and savings do not cause growth. Alomar (2013) also found that economic growth rate Granger caused growth rate of savings in four study countries, the opposite result was observed in one country (Oman) and a bi-directional causality was found in Bahrain. Sothan (2014), Misztal (2011) and Ijeoma et al. (2011) found that neither domestic saving Granger causes economic growth nor economic growth Granger causes domestic saving, and they concluded that domestic saving and economic growth are independent of each other in study countries. Thus, empirical findings seem to be inconclusive. To add to this, Edwards (1995) established that per capita growth is one of the important determinants of both private and public savings. Again contrary to this, the new growth theorists such as Romer (1986, 1990), Lucas (1988) and Barro (1990) reconfirmed the view that the buildup of physical capital (investment) is the main driver of long-run economic growth.

The evidence from India on growth, savings and investment relationship is limited and different authors have concluded differently owing to their traditional flaws in methodology. For instance, most of studies in India examined this relationship in a bivariate cointegration and causality framework such as investigating cointegration separately between saving and investment, or between investment and growth, or between growth and saving. Similarly, Granger causality was investigated separately between investment and growth, or between savings and growth, or between investment and saving. For example, Sahoo et al. (2001) investigated the long-run relationship between savings and growth and concluded that savings do not operate as the engine of growth in India. Next, Sandilands and Chandra (2003) investigated the relationship between investment and growth and found that investment does not cause growth in the long-run. The former study did not take into account the explicit role played by investment while the latter study did not take into consideration the explicit role played by savings in India. On the same line, Saggar (2003) concluded that total investment rate does Granger cause real GDP growth rate in India but no explicit role of saving was investigated in the system.

Similarly, there are studies that investigate the nexus between saving and investment without taking into consideration the role of growth. Notable among them is Singh (2008) who used both single-equation and system estimators and established a cointegrating relationship between savings and investment in India. However, recently, using the autoregressive distributed lag (ARDL) cointegration method, Verma (2007) attempted to determine the long-run relationship of savings, investment and GDP and argued that saving does not cause growth, but growth causes saving. The study also noted that savings undoubtedly determine investment in both the short and long run. Further, the study noted that there is no evidence to support the commonly accepted growth proposition for India, that investment is the engine of economic growth.

The important econometric drawback in Verma (2007) study is the usage of critical values as tabulated by Pesaran et al. (2001). Narayan (2005) has demonstrated that the two sets of critical values reported in Pesaran and Shin (1995) as well as in Pesaran et al. (2001) provide critical value bounds for all classifications of the regressors into purely I(1), purely I(0) or mutually cointegrated. However, these critical values are generated for large sample sizes of 500 and 1000 observations and 20,000 and 40,000 replications respectively. Narayan (2004) and Narayan (2005) argue that existing critical values, because they are based on large sample sizes, cannot be used for small sample sizes. For instance, he compares the critical values generated with 31 observations and the critical values reported in Pesaran et al. (2001) and finds that the upper bound critical value at the 95% significance level for 31 observations with 4 regressors is 4.13 while the corresponding critical value for 1000 observations is 3.49, which is 18.3% lower than the critical value for 31 observations. Given the relatively small sample size (53 observations) in Verma (2007) study, the usage of critical values of Pesaran et al. (2001) instead of Narayan (2005) (where the critical values for the bounds F-test are computed for small sample sizes ranging from 30-80 observations) may be misleading.

Similarly, a relatively recent study by Jangili (2011) examined the relationship between the logarithms of saving, nominal investment and nominal GDP for India using Johansen-Juselius method of cointegration. The study has noted that that there is a long-run equilibrium relationship between the selected variables. Also, the Granger causality test showed that higher saving and investment lead to higher economic growth. Though Johansen-Juselius (1990) cointegration test is widely used method to investigate long-run equilibrium relationship among variables, this method requires that the variables in the system are to be integrated of order one I (1). Further, this method is considered weak as this method does not provide robust results for small samples or structural breaks (Ilyas et al., 2010; Hasan and Butt, 2008). The ARDL approach to cointegration avoids the above said limitations. Moreover, Pesaran and Shin (1999) argued that ARDL approach to cointegration provides robust results and consistent estimates of the long-run coefficients in case of small samples.

In the light of above discussion, the present paper re-investigates the relationship between growth, domestic savings and investment for India using wide range of estimators.

2. ECONOMETRIC MODELING AND DATA

To investigate the long-run equilibrium between the selected time series, the present study uses the ARDL bounds test and the Gregory and Hansen (1996) residual test for cointegration with regime shifts. Next, the long-run elasticities are estimated using a range of estimators such as the ARDL model, the fully modified ordinary least squares (FMOLS) estimator of Phillips and Hansen (1990) and the dynamic ordinary least squares (DOLS) estimator of Stock and Watson (1993). These estimators are prominent for producing parsimonious results in small sample sizes. In econometric literature, it is generally held that the use of more than one estimator is essential if there is concern about the robustness of the results obtained. Further, the short-run elasticities are also estimated.

Cointegration Models

ARDL Bounds Test for Cointegration: To determine the long-run equilibrium relationship between the selected macroeconomic variables, the following three ARDL models are specified.

$$\Delta \log G_t = \alpha_0 + \sum_{i=1}^{n} \beta_{1i} \Delta \log G_{t-i} + \sum_{i=1}^{n} \beta_{2i} \Delta \log S_{t-i} + \sum_{i=1}^{n} \beta_{3i} \Delta \log I_{t-i} + \gamma_1 \log G_{t-1} + \gamma_2 \log S_{t-1} + \gamma_3 \log I_{t-1} + \varepsilon_{1t} \quad (1)$$

$$\Delta \log S_t = \alpha_0 + \sum_{i=1}^{n} \beta_{1i} \Delta \log S_{t-i} + \sum_{i=1}^{n} \beta_{2i} \Delta \log G_{t-i} + \sum_{i=1}^{n} \beta_{3i} \Delta \log I_{t-i} + \gamma_1 \log S_{t-1} + \gamma_2 \log G_{t-1} + \gamma_3 \log I_{t-1} + \varepsilon_{2t} \quad (2)$$

$$\Delta \log I_t = \alpha_0 + \sum_{i=1}^{n} \beta_{1i} \Delta \log I_{t-i} + \sum_{i=1}^{n} \beta_{2i} \Delta \log G_{t-i} + \sum_{i=1}^{n} \beta_{3i} \Delta \log S_{t-i} + \gamma_1 \log I_{t-1} + \gamma_2 \log G_{t-1} + \gamma_3 \log S_{t-1} + \varepsilon_{3t} \quad (3)$$

In the above models (1), (2) and (3), Δ is the first-difference operator and 'G', 'S' and 'I' are growth, saving and investment respectively. In the equation (1), where 'G' is the dependent variable with 'S' and 'I' as the long-run regressors, the null hypothesis of no cointegration defined by $H_0 : \gamma_1 = \gamma_2 = \gamma_3 = 0$ is tested against the alternative of $H_1 : \gamma_1 \neq 0, \gamma_2 \neq 0, \gamma_3 \neq 0$, denoted by FG(G|S I) by means of F-test. In the equation (2), where 'S' is the dependent variable with 'G' and 'I' as the long-run regressors, the null hypothesis of no cointegration defined by $H_0 : \gamma_1 = \gamma_2 = \gamma_3 = 0$ is tested against the alternative of $H_1 : \gamma_1 \neq 0, \gamma_2 \neq 0, \gamma_3 \neq 0$, denoted by FS(S|G I) by means of F-test. Similarly, in (3), where 'I' is the dependent variable with 'G' and 'S' as the long-run regressors, the similar null hypothesis (denoted by FI(I|G S) is applicable. The terms ε_{1t} , ε_{2t} and ε_{3t} are mutually uncorrelated white noise error terms.

Once the long-run ARDL model suggests a long-rum relationship between the growth, savings and investment, the conditional long-run equilibrium relationship is estimated by the following reduced form of ARDL equation. For instance, if 'I' is the dependent variable the specification takes the following form:

$$I_t = \alpha_0 + \sum_{i=1}^{n} \beta_1 I_{t-i} + \sum_{i=1}^{n} \beta_2 G_{t-i} + \sum_{i=0}^{n} \beta_3 S_{t-i} + \varepsilon_{4t} \quad (4)$$

Following model (4), the short-run elasticities are estimated as equation (5):

$$\Delta I_t = \alpha_0 + \sum_{i=1}^{n} \lambda_1 \Delta I_{t-i} + \sum_{i=0}^{n} \lambda_2 \Delta G_{t-i} + \sum_{i=0}^{n} \lambda_3 \Delta S_{t-i} + EC_{t-1} + \varepsilon_{5t} \quad (5)$$

where, Δ is the difference operator, EC representing the error-correction (EC) term derived from the long-run equilibrium cointegrating relation using the ARDL model (4) specified above.

Using equation (5), the Granger-causality test is performed once there is evidence of cointegrating relationship between the selected variables. It has been noted by Engle-Granger (1987) that if the causality test is conducted at first-difference through vector autoregression (VAR) modeling, than it will be misleading in the presence of cointegration. Thus, by including the lag EC terms, not only is the direction of causality determined but also a distinction is made between the short-run and long-run causality. For the equations, where there is no evidence of cointegration, the causality tests are performed only in difference form with the EC term omitted. Using F-test in the ARDL specifications variable deletion test is conducted for the joint significance of the coefficients of the individual lag independent variables to determine the short-run causality. The negative sign and the statistical significance of the lag EC terms included in the ARDL model determine the long-run causality.

Residual based test for cointegration with regime shifts

The standard model of cointegration with no structural changes can be written as:

$I_t = \alpha_1 + \beta_1 G_t + \beta_2 S_t + e_t$ t = 1, 2,….., n (6)

In many cases, if model (6) is to capture a long-run relationship, the parameters α_1, β_1 and β_2 should be considered as time-invariant. However, in many other cases, it may be desirable to think of cointegration as holding over some (fairly long) period of time, and then shifting to a new long-run relationship. In practice, the timing of this shift is largely unknown. The structural change would be reflected in changes in the intercept α_1 and changes to the slope coefficients β_1 and β_2. To model structural change, we have to define the dummy variable:

$$D_{t\tau} = \begin{cases} 0 \; if \; t \leq [n\tau] \\ 1 if \; t > [n\tau] \end{cases}$$

where the unknown parameter $\tau \in (0,1)$ denotes the timing of the change point.

From the above, Gregory and Hansen (1996) propose three models of structural change. First, there is a level shift in the cointegrating relationship, which can be modeled as a change in the intercept (α_1), while the slope coefficient (β_1) is held constant.

$$I_t = \alpha_1 + \alpha_2 D_{t\tau} + \beta_1 G_t + \beta_2 S_t + e_t$$

t = 1, 2,….., n (7)

where α_1 represents the intercept before the shift, and α_2 represents the change in the intercept at the time of the shift. We denote above level shift model (7) by (C).

Second, a time trend 't' is introduced into the level shift model and is written as:

$$I_t = \alpha_1 + \alpha_2 D_{t\tau} + \alpha_3 t + \beta_1 G_t + \beta_2 S_t + e_t$$

t = 1, 2,….., n (8)

The above model (8) is denoted by (C/T).

Third model allows the possibility of slope vector to shift and is written as:

$$I_t = \alpha_1 + \alpha_2 D_{t\tau} + \beta_1 G_t + \beta_2 S_t + \beta_3 G_t D_{t\tau} + \beta_4 S_t D_{t\tau} + e_t$$

t = 1, 2,….., n (9)

Here, α_1 and α_2 are as in the level shift model (7) and β_2 denote the cointegrating slope coefficients before the regime shift and β_3 and β_4 denote the change in the slope coefficients. We denote the above regime shift model (9) by (C/S).

To test for cointegration between G_t, S_t and I_t with structural change, that is, the stationarity of e_t in equations (7), (8) and (9), Gregory and Hansen (1996) propose commonly used ADF statistic. Here, the interest is in the smallest values for ADF(τ) across all possible breakpoints required to reject the null hypothesis of no cointegration.

The necessary data on real GDP, saving (gross domestic savings) and investment (gross domestic capital formation) were collected from the various issues of the Handbook of Statistics on Indian Economy, Reserve Bank of India (RBI). The period of the study is from 1951 to 2015 and the variables are measured at 2004-05 constant prices and are transformed into natural logarithms.

3. EMPIRICAL RESULTS AND ANALYSIS

3.1 Unit Root Results

The bounds test for cointegration does not require pre-testing of the stationarity of the variables in question. However, the selected variables are required to be stationary, in order to run the Gregory and Hansen (1996) residual-based test for cointegration. The order of integration of the selected variables is also important because other long-run estimators such as FMOLS of Philips–Hansen (1990) and the DOLS of Stock and Watson (1993) are employed. To test the stationarity of growth, savings and investment and the order of integration, the

Augmented Dickey Fuller (ADF) and Phillips Perron (PP) unit root tests are used.

The associated coefficient of a given time series is stationary if the estimated coefficient is negative and significant compared with the critical values (Table 1). As per the ADF and PP tests of unit root, the selected variables (saving, investment and growth) appear to be non-stationary in their levels with intercept as well as with intercept and trend suggested by their respective calculated test statistics which are found to be insignificant.

Similarly, applying the same unit root tests to first differences of the selected variables, the critical values are less (in absolute terms) than the calculated t-values for all the three selected macroeconomic variables. This confirms that growth, saving and investment become stationary after differencing once and are integrated of order one, I(1).

Table 1. ADF and PP Unit Root Tests of Stationarity

Variables	ADF (Intercept)	ADF (Intercept & Trend)	PP (Intercept)	PP (Intercept & Trend)
		Level Series		
G	3.256	0.036	5.281	0.750
S	0.208	-2.519	1.685	-2.463
I	0.670	-1.727	1.716	-1.502
		First-Difference Series		
G	-7.434*	-8.744*	-7.464*	-9.214*
S	-7.067*	-9.786*	-9.869*	-18.161*
I	-8.783*	-8.974*	-9.089*	-10.988*

Notes: a. Automatic selection of lags based on minimum Schwarz-Bayesian information criterion (SBC): 0-10.
b.* denotes rejection of null hypothesis that time series has a unit root at 1% level of significance.
Source: Authors' estimation based on data collected from 'Handbook of Statistics on Indian Economy', RBI.

3.2 Cointegration Results

As mentioned before, the presence of long-run equilibrium relationship between India's growth, savings and investment included in model (1), (2) and (3) is confirmed if the F-test of joint significance of lagged levels of the variables included in the model rejects the null of no cointegration. From Table 2, it is confirmed that when India's investment is taken as regressand, the estimated F-value FI(I|G S) = 4.916 is found to be higher than the upper bound critical value of 4.070 at 95% confidence interval during the period of analysis.

However, if India's growth is taken as the dependent variable during the same period, the estimated F-value FG(G|S I) = 3.034 is found to be lower than the upper bound critical value at 90% confidence interval. However, the calculated F-value FG(G|S I) = 3.034 is higher than the lower bound critical value at 90% confidence interval (Table 2). Since, the calculated F-statistic falls between the upper and lower bounds, the cointegration test becomes inconclusive.

In such a case, one can reject or accept the null hypothesis on the basis of order of integration of the selected variables. From Table 1, it was evident that all the time series variables are integrated of order one, I(1). Therefore, the decision can be made based on the critical values of upper bound which does not accept the alternate hypothesis of long-run equilibrium relationship that is existence of cointegration.

Table 2. Cointegration Test Results

Panel A: Bound Test for Cointegration: Calculated ARDL F statistic						
Period	FG(G|I S)		FS(S|G I)		FI(I|G S)	
1951-2015 (T=65)	3.034		2.468		4.916**	
Critical value bounds of the F statistic: intercept and no trend						
	90% level		95% level		99% level	
Sample Size (T=65)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
	2.740	3.455	3.285	4.070	4.538	5.475

Panel B: Gregory and Hansen (1996) test for Cointegration		
Model (1951-2015) Dependent Variable: Investment	ADF*	Tb
(C)	-5.732*	1960
(C/T)	-6.023*	1960
(C/S)	-7.306*	1971
Model (significance level)	Critical Values (ADF*)	
(C) [99%]		-5.44
(C/T) [99%]		-5.80
(C/S) [99%]		-5.97

Notes : a. Critical values bounds of the F-statistics are extracted from Narayan (2005, p. 1987).
b. ADF* critical values are extracted from Table 1 in Gregory and Hansen (1996, p.109).
c. * and ** denote rejection of null hypothesis of no cointegration at 1% and 5% level of significance, respectively.
d. Lag length was based on SBC.
e. Tb refers to time break point.

Source: Same as Table 1.

Similarly, from Table 2 it is confirmed that when savings of India is taken as the dependent variable during the same period of analysis, the estimated F-value FS(S|G I) = 2.468 is lower than the upper bound critical value at the 90% confidence interval. Further, the calculated F-value FS(S|G I) = 2.468 is lower than the lower bound critical value at the 90% confidence interval.

Similarly, from Table 2, it is again evident that the residual based test for cointegration models with regime shift used in the present analysis also validates the results obtained from the ARDL bounds test during the same study period (Table 2). This leads to the conclusion that there is evidence for long-run equilibrium relationship between India's investment, growth and saving when investment is expressed as the dependent variable both with and without regime changes.

Therefore, it can be confirmed from the bounds test of cointegration and residual based test of cointegration that the null hypothesis of no long-run equilibrium relationship between the selected macroeconomic variables cannot be accepted for India when investment is expressed as the dependent variable and growth and saving are expressed as the explanatory variables.

3.3 Long-run and short-run elasticities

Since the domestic investment, growth and saving are found to have long-run equilibrium relationship; the long-run and short-run elasticities are estimated using ARDL models (4) and (5) respectively. The long-run elasticities are also estimated using the FMOLS and the DOLS which are reported in Table 3.

Table 3. Estimates of Long-run Coefficients and Diagnostics

Panel A: ARDL Estimates			
Period	Constant	G	S
1951-2015 (T=65)	-1.365	0.468	0.654
	(-0.845)	(2.140)**	(4.208)*
Long-Run Diagnostic Tests 1. Serial Correlation LM Test: 2.011 (0.155) 2. Ramsey RESET Test: 0.634 (0.104) 3. Normality: 3.213 (0.201) 4. Heteroscedasticity Test: 0.320 (0.451)			
Panel B: DOLS			
1951-2015 (T=65)	-2.185	0.465	0.690
	(-2.779)	(3.261)**	(3.536)*
Long-Run Diagnostic Tests 1. Serial Correlation LM Test: 1.326 (0.236) 2. Ramsey RESET Test: 0.132 (0.640) 3. Normality: 1.177 (0.555) 4. Heteroscedasticity Test: 2.534 [0.111)			
Panel C: Fully Modified Phillips-Hansen Estimates (FMOLS)			

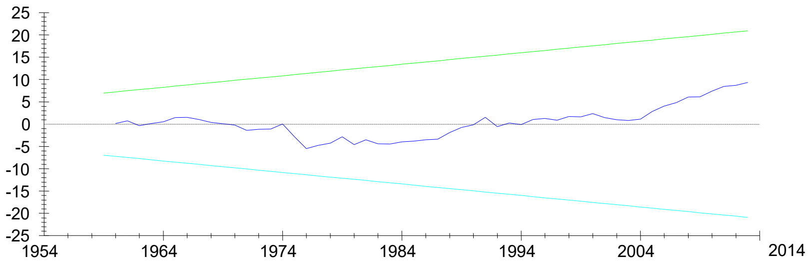
Notes : a. * and ** denote statistical significance at 1% and 5% levels, respectively.
b. The figures in parentheses are t-statistic values, c. Lag length was based on SBC.
d. For all the panels, investment (I) is the dependent variable.
Source: Same as Table 1

From Table 3, it can be observed that all the three panels (A, B and C) provide similar evidence on the long-run correlation of investment, growth and saving for India, demonstrating the robustness of the results obtained from the three estimators used in the study. Consistently, the three estimators suggest that the effect or influence of national saving is higher (stronger) on investment compared to growth in India. It can be observed from Table 3, that the calculated average long-run elasticity of saving from all the three estimators is about 0.686% whereas the estimated average long-run elasticity of growth from all the three estimators is about 0.440%, the latter being weak compared with the former.

According to Xiao (1999); Xiao and Phillips (2002) one of the other popular method to examine the long-run relationship between the selected variables is to examine the fluctuations of the residual process of a cointegrating regression equation. Accordingly, the cumulative sum (CUSUM) and CUSUM of squares (CUSUMQ) of recursive residuals test of Brown et al. (1975) can be applied to the residuals of a cointegrating regression model to directly test the null of long-run relationship or cointegration. If the given I_t, G_t and S_t series are cointegrated, then the residuals of a cointegrating regression equation should be stable with long-run movements within the critical bounds. Further, the CUSUM test is also useful for detecting systematic changes and stability of calculated the long-run coefficients.

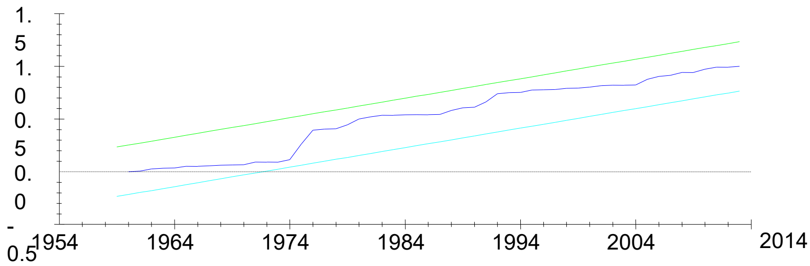
Therefore, in view of the above observations, the CUSUM and CUSUMSQ tests proposed by Brown et al. (1975) are applied to the cointegrating equation. The CUSUM and CUSUMSQ tests display a pair of straight lines drawn at 5% level of significance. If either of the lines crosses, the null hypothesis of stability (cointegration/ long-run relationship among I(1) variables) against instability (no cointegration among I(1) variables) of regression residuals must be rejected at the 5% level of significance.

The plot of the CUSUM and CUSUMQ of recursive residuals is depicted in Figure 1 and 2 suggesting that the residuals do not drift beyond 5% upper and lower critical bounds. Therefore, CUSUM and CUSUMQ tests reinforce the cointegration results and suggest the long-run stability of equilibrium residuals and, thus, the long-run equilibrium cointegrating relationship between investment, growth and saving for India.



The straight lines represent critical bounds at 5% significance level

Figure 1. *Plot of Cumulative Sum of Recursive Residuals*



The straight lines represent critical bounds at 5% significance level

Figure 2. *Plot of Cumulative Sum of Squares of Recursive Residuals*

As noted before using model (5) within the framework of ARDL, the error correction model was also estimated. The results of short-run and error correction estimates of ARDL model are reported in Table 4. It becomes evident that the error correction term is found to be negative and significant. This reveals that there is a fairly effective feedback mechanism by domestic saving and growth in India. As evidence suggests, the error correction term (-0.328) is robust during 1951-2015 for India, suggesting that a deviation from the long-run equilibrium level of investment in one year is corrected by about 32% in the next year. As long as the estimated short-run elasticities are concerned, the changes in India's savings have relatively a stronger degree of influence (about 0.59%) compared to changes in growth (which is about 0.15%) on investment, which is again consistent with the long-run estimates as observed before in Table 4.

Table 4. Short-Run and Error Correction Estimates of ARDL

Period	Constant	ΔG	ΔS	EC_{t-1}
1951-2015 (T=65)	-0.447	0.151	0.588	-0.328
	(-0.770)	(2.923)***	(4.947)*	(-3.108)**

Notes : a. *, ** and *** denote significance respectively at 1%, 5% and 10% levels.
b. The figures in parentheses are the t-statistic values.
c. Lag length was based on SBC, d. Investment (ΔI) is the dependent variable.
Source: Same as Table 1

3.4 The Dynamics of Short-run Causality

As noted earlier, to estimate short-run dynamics of causality between the selected time series, F-test has been employed on the joint significance of the lagged variables. Accordingly, model (5) has been estimated to determine the nature and direction of short-run casualty between investment, savings and growth in India. However, as noted earlier, where long-run cointegration was rejected by the ARDL bounds tests, the error-correction term was not included in the ARDL specification and a variable deletion test was conducted for the joint significance of the coefficients of the individual lag explanatory variables included in the ARDL specifications. Further, for the short-run causality analysis, diagnostic tests for serial correlation, heteroscedasticity and functional form were conducted so as to obtain unbiased and consistent/efficient estimates which are however for brevity not reported.

The results of Granger causality test is reported in Table 5. It was confirmed by the ARDL bounds test that there exists no long-run cointegrating relationship for growth on saving and investment as they are neutral to growth in the long-run. In the short run also the causality seems to be neutral from saving and investment on growth (see row 3 in Table 5) as the calculated F-statistic are not significant. This suggests that the changes in growth in India are neutral to changes in saving and investment both in short-run and long-run.

Similarly, the ARDL bounds test showed that there exists no long-run cointegrating relationship for saving on growth and investment and they are neutral to saving in the long-run. In the short-run also the causality seems to be neutral from growth and investment on saving (see row 4 in Table 5) as suggested by low calculated F-statistic. This suggests that the changes in saving in India are neutral to changes in growth and investment both in short-run and long-run.

Table 5. Granger Causality Test using VECM (1951 to 2015)

Regressand / Regressors	$\sum_{j=1}^{p} \Delta G_{t-j}$	$\sum_{j=1}^{p} \Delta I_{t-j}$	$\sum_{j=1}^{p} \Delta S_{t-j}$	EC_{t-1}
	=0: F-stat (p-value)	=0: F-stat (p-value)	=0: F-stat (p-value)	ε=0: t-stat (p-value)
ΔG	---	0.309 (0.578)	0.580 (0.809)	---
ΔS	1.272 (0.259)	1.691 (0.194)	---	---
ΔI	1.162 (0.281)	---	3.214 (0.057)***	-2.322 (-0.043)**

Notes: a. ** and *** denotes significance at 95% and 90% confidence levels, respectively.
b. Lag length was based on SBC.
Source: Same as Table 1.

The ARDL bounds test showed that there exists a long-run cointegrating equilibrium relationship for investment on growth and saving and they are non-neutral to investment in the long-run. In the short run, the investment equation suggests the causality seems to be non-neutral from saving on investment (see row 5 in Table 5) as suggested by high calculated F-statistic indicating a unidirectional causality running from saving to investment. However, growth is found to be neutral to the changes in investment suggesting that the changes in investment in India are neutral to changes in growth in short-run.

Further, the error-correction term included in the investment equation was found to be negative and statistically significant, endorsing the results obtained under the bounds test of cointegration that investment is caused by growth and saving in India (see row 5 in Table 5).

4. SUMMARY AND POLICY IMPLICATIONS

The present paper has examined the long-run cointegration relationship between real domestic investment, savings and growth in India. It also tested the null hypothesis of non-causality between the selected macroeconomic variables during 1951-2015. The ARDL bounds test has established a long-run cointegrating relationship between saving, investment and growth in India when investment is chosen as the dependent variable. However, reverse long-run cointegrating relationship between the three selected time series was not found when domestic saving and growth are used as the dependent variables. The evidence from Gregory and Hansen residual test for cointegration with regime shifts also confirmed the results obtained from the bounds testing approach.

The estimated long-run elasticities from all the three techniques and the short-run elasticities of ARDL have consistently suggested that the elasticity of domestic saving is higher in explaining the investments of India. Further, the CUSUM and CUSUMQ tests have again confirmed the long-run stability of equilibrium residuals and have reconfirmed the cointegrating long-run equilibrium relationship between the three variables for India. The Granger causality tests conducted between the selected three time series have suggested that there is no causal relationship between growth and investment in India. Similarly, no causality is noticed between growth and domestic saving in India. However, a unidirectional causality running from domestic saving to investment is confirmed suggesting that domestic savings still play an important role in India's capital formation.

The apparent policy implication from the study is that raising the level of domestic savings can be a high priority to ensure that financeable rate of capital accumulation is available to support India's investment. To increase the national savings rate in India, the economic determinants of savings (income and wealth) should be re-investigated mainly due to the changed economic environment. Since Indian economy is one of the most open economies across the globe, the policy makers should ensure that the increase in domestic savings is not devoted to finance investments abroad because the national savings need not necessarily be used to invest domestically in a world of unrestricted capital mobility. Therefore, in order to support domestic investments through domestic savings, the efficiency, productivity and profitability of Indian domestic investments should be improved.

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