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Household, Private and Public Savings and Investment, Foreign Capital Inflows and GDP Growth in India with Structural Breaks 1950-2005

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Abstract

The objective of this paper is to examine the short and the long-run interrelationships between sectoral savings and investment, foreign capital inflows and their roles in the growth process for India for the period 1950 to 2005. This paper uses the Autoregressive Distributed Lag (ARDL) procedure to test for both the long-run and short-run effects between the eight variables, along with any endogenously detected structural breaks. This is in response to shortcomings relating to previous studies which predominantly analyse savings and investment aggregates only, over long time periods which contain structural changes, using bivariate estimation techniques, which are short-run in nature. The analysis firstly tests for the short-run dynamic effects of savings and investment on growth (consistent with the Solow-Swan model) and the long-run effects of savings and investment on growth (in line with the endogenous AK models of growth). The empirical estimations indicate that none of the three sectoral measures of savings and investment have any positive impact on GDP growth in India. This result is robust in the short-run and the long-run, providing no evidence for both the short-run dynamic effect of savings and investment on growth (the Solow model) and the long-run (permanent) effect of savings and investment on growth (the AK model of growth) in India. Foreign capital inflows is the only variable found to affect GDP growth, in the both the short and long-run. A feedback effect exists between foreign capital inflows and GDP growth, although it is much smaller than from GDP growth to foreign capital inflows. The Carroll-Weil hypothesis and a strong accelerator effect of GDP are supported in the Indian context. GDP growth is affecting household and private savings in the long-run; and GDP has a large effect on household investment in the long-run and public investment in the short-run. There is also evidence that household savings has a positive effect on private sector investment in the long-run; and public sector investment in both the long and short-run. While the direction of these relationships from savings to investment is consistent with the growth models, there is the serious missing link from investment to economic growth. Overall, the findings do not support policies designed to increase household, private or public savings and investment in order to promote economic growth in India. This is further strengthened by the findings that GDP has large elastic effects on household investment in the long-run and public investment in the short-run. Further to this, public investment has a negative impact on GDP growth in the long-run; however it is only significant at the ten percent level. There is therefore, no statistical evidence of the popular endogenous explanation that investment is the driver of long-run economic growth in India.

Keywords

Household, Private, Public, Savings, Investment, Foreign, Capital, Inflows, GDP, Growth, India, Structural, Breaks, 1950, 2005

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HOUSEHOLD, PRIVATE AND PUBLIC SAVINGS AND INVESTMENT, FOREIGN CAPITAL INFLOWS AND GDP GROWTH IN INDIA WITH STRUCTURAL BREAKS 1950-2005

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ABSTRACT

The objective of this paper is to examine the short and the long-run interrelationships between sectoral savings and investment, foreign capital inflows and their roles in the growth process for India for the period 1950 to 2005. This paper uses the Autoregressive Distributed Lag (ARDL) procedure to test for both the long-run and short-run effects between the eight variables, along with any endogenously detected structural breaks. This is in response to shortcomings relating to previous studies which predominantly analyse savings and investment aggregates only, over long time periods which contain structural changes, using bivariate estimation techniques, which are short-run in nature. The analysis firstly tests for the short-run dynamic effects of savings and investment on growth (consistent with the Solow-Swan model) and the long-run effects of savings and investment on growth (in line with the endogenous AK models of growth).

The empirical estimations indicate that none of the three sectoral measures of savings and investment have any positive impact on GDP growth in India. This result is robust in the short-run and the long-run, providing no evidence for both the short-run dynamic affect of savings and investment on growth (the Solow model) and the long-run (permanent) affect of savings and investment on growth (the AK model of growth) in India.

Foreign capital inflows is the only variable found to affect GDP growth, in the both the short and long-run. A feedback effect exists between foreign capital inflows and GDP growth, although it is much smaller than from GDP growth to foreign capital inflows. The Carroll-Weil hypothesis and a strong accelerator effect of GDP are supported in the Indian context. GDP growth is affecting household and private savings in the long-run; and GDP has a large effect on household investment in the long-run and public investment in the short-run.

There is also evidence that household savings has a positive effect on private sector investment in the long-run; and public sector investment in both the long and short-run. While the direction of these relationships from savings to investment is consistent with the growth models, there is the serious missing link from investment to economic growth.

Overall, the findings do not support policies designed to increase household, private or public savings and investment in order to promote economic growth in India. This is further strengthened by the findings that GDP has large elastic affects on household investment in the long-run and public investment in the short-run. Further to this, public investment has a negative impact on GDP growth in the long-run; however it is only significant at the ten percent level. There is therefore, no statistical evidence of the popular endogenous explanation that investment is the driver of long-run economic growth in India.

Keywords: Savings, investment; structural breaks and economic growth.

JEL Classifications: F43, E21, E22, C22.

1. Introduction

There has been a renewed interest in the concept of economic growth and, given this, attention has focused on the factors that lead to higher growth. Saving, investment and foreign capital inflows among other sources have been viewed as important determinants of economic growth and as a result, there has been extensive empirical research on these three determinants. In recent years, the motivation for this interest is the growing concern over the falling savings rates in the major Organisation for Economic Cooperation and Development (OECD) countries, the growing divergence in saving and investment rates of the developing countries, and the increasing emphasis of the important role of different types of investment in the more recent economic growth literature. Foreign capital inflows are also receiving attention because of their potential to supplement domestic savings to finance investment and promote economic growth. Further to this, the relationship between savings, investment and growth play a central role in the neoclassical growth models of Solow-Swan (1956), Ramsey (1928), Cass (1965), and Koopmans (1965). The relationship also features prominently in the AK models of Harrod (1939), Domar (1946), Frankel (1962) and then by Romer (1986). All these growth models emphasise capital accumulation as the source of growth and that higher saving rates should foster economic growth because higher savings imply higher capital investment. But these are closed economy models, and extending them to the case of small open economies with international capital markets will eliminate the effect of local saving on growth. Further to this, Feldstein and Horioka (1980) emphasise the powerful empirical association between saving and investment.

The purpose of this paper is to examine the interrelationships between sectoral savings, sectoral investment, foreign capital inflows and growth in India. The relationships between these variables, taking into account structural breaks for India from 1950 to 2005,¹ allows testing for the short-run dynamic effects of savings and investment on growth, in line with the Solow-Swan model. The second purpose tests the long-run (permanent) effects of savings and investment on growth, consistent with the endogenous AK model of growth.

There are many Indian studies which have examined the relationship between savings, investment and growth. However, these studies provide only partial analyses of the possible relationships between the three variables. For example, Sinha (1996)

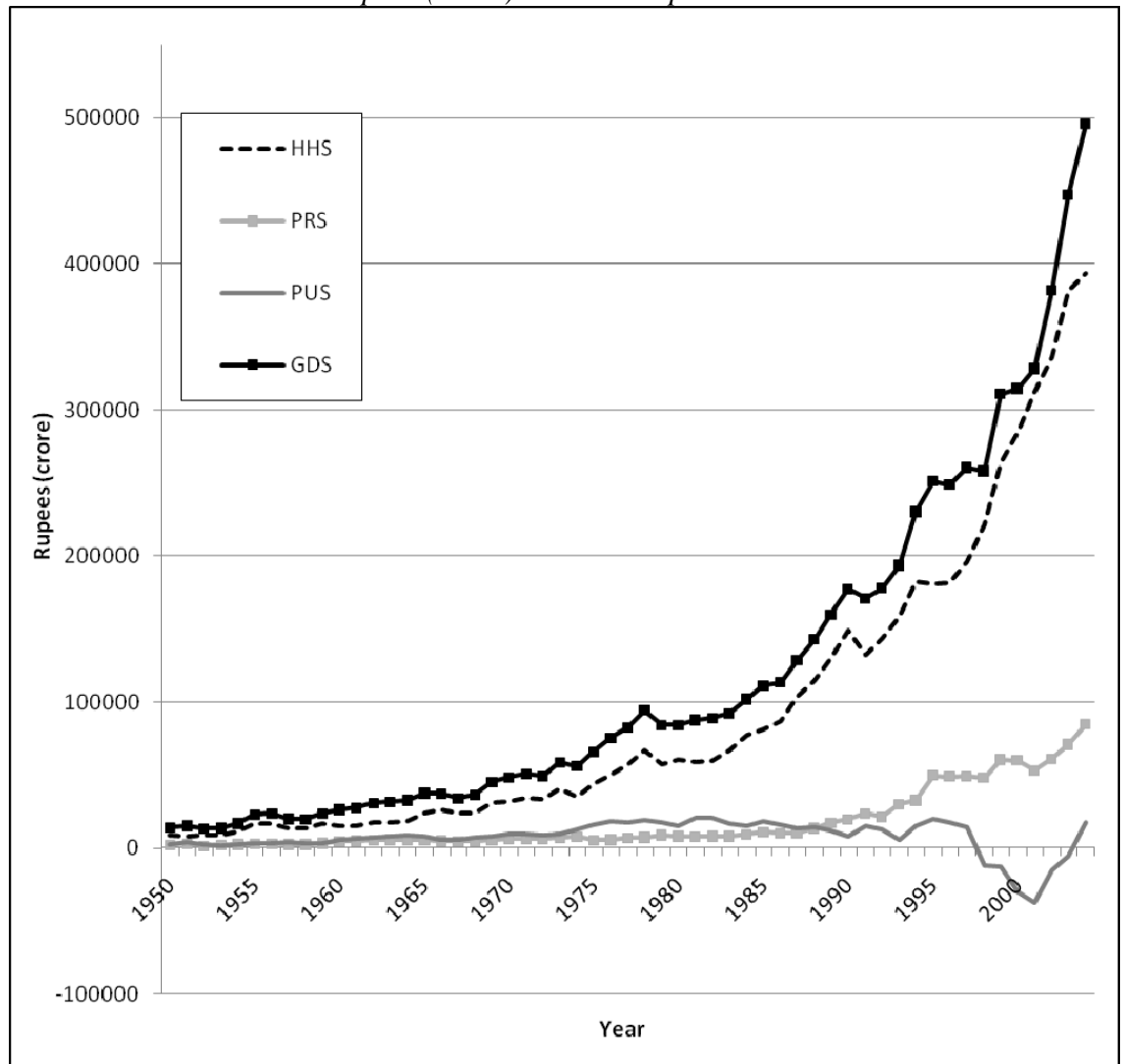
¹ The Indian data is in financial years, 1950/51 to 2004/05.

considers the growth of private and gross domestic savings on economic growth; Mühleisen (1997) examines sectoral savings but not investment; Agrawal (2000) studies private and total savings and investment rates; Mahambare and Balasubramanyam (2000) analyse savings but not investment and economic growth; Sahoo *et al.* (2001) consider total savings only; Sandilands and Chandra (2003) analyse private and public investment, but not savings; Saggar (2003) in his econometric estimations, combines household and private corporate sectors; Sinha and Sinha (2007) who do look at the three sectors for savings do not take into account the role played by investment. With the exception of Sinha (2002), Sessaiah and Sriyval (2005) and Verma (2007), none of the Indian studies examine the relationship between savings and investment in India; but these three studies only consider the measures in aggregate levels.

Further to this, Figures 1 and 2 show that the household sector is very important in the Indian economy with household savings increasing to over 85 percent of total gross domestic savings and household investment contributing 30 to 40 percent of total gross domestic investment. Studies which do not explicitly detail the household sector in empirical analysis will not only miss these important effects, but the estimates will be subject to misspecification bias. Figure 1 also shows the relative sizes of the other sectors are varying over time with the share in public sector saving falling since the 1960s, reaching negative rates after 1998/99, reflecting the continuing deterioration in the fiscal position of the government. This contrasts with the increasing relative importance of household and private corporate savings. The variation in the relative sectoral investment shares is even higher according to Figure 2 and the contribution of public investment is also declining since the late 1980s. Note the reversal in the shifts for household and private corporate investment in the mid 1990s. The data shown in Figures 1 and 2 describe a dynamic process involving changing relative shares and growth rates across sectors over a fifty five year period.

Figure 1: Sector-Wise Savings and Total Gross Domestic Savings

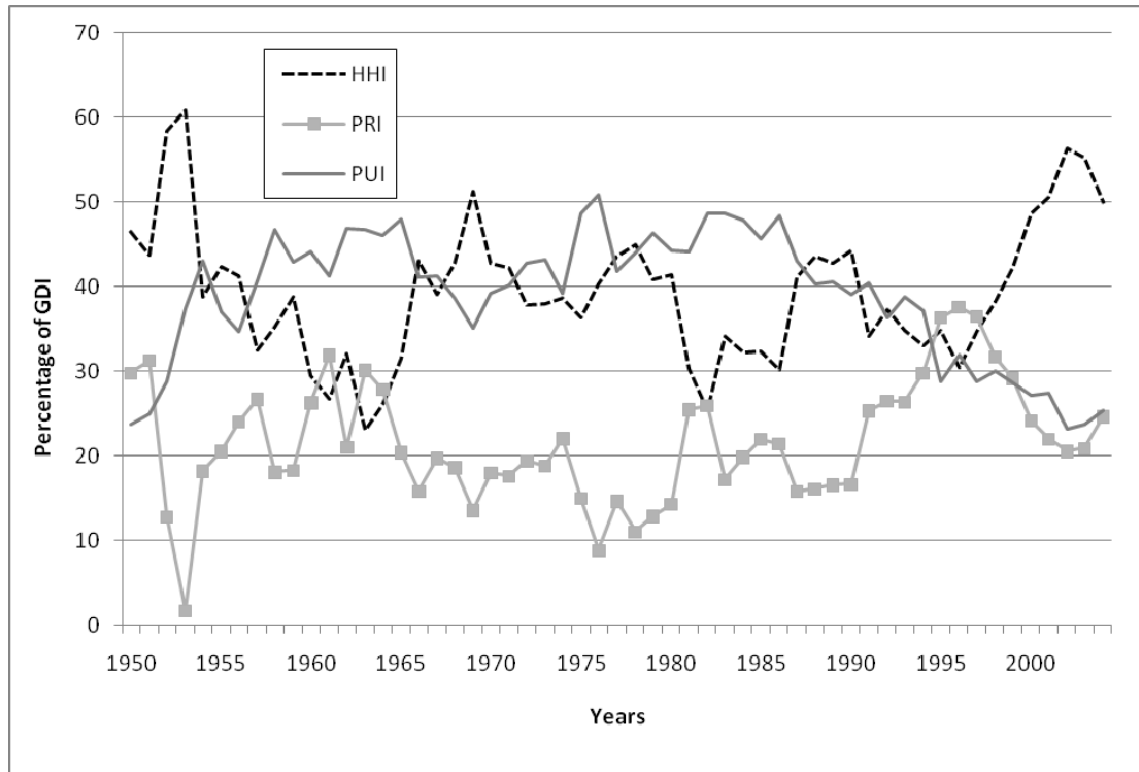
Rupees (crore) in constant prices



Source: National Accounts Statistics of India (2006) plus author's calculations.

Note: HHS: Household savings; PRS: Private savings; PUS: Public savings; GDS: Gross Domestic Savings.

Figure 2: Components of Gross Domestic Investment



Source: National Accounts Statistics of India (2006) plus author's calculations.

Note: HHI: Household investment; PRI: Private investment; PUI: Public investment; GDI: Gross Domestic Investment.

All data used in this study are annual observations for the period from 1950/51 to 2004/05. The nominal savings and investment data for the household, private corporate and public sectors have been taken from the *National Accounts Statistics of India* (2006). The nominal foreign capital inflows come from the *Centre of Monitoring Indian Economy* (2006). All variables are transformed into constant prices² and Naperian logs. These include household savings (LHHS), private savings (LPRS), public savings (LPUS), household investment (LHHI), private investment (LPRI), public investment (LPUI), foreign capital inflows (LFCI) and real GDP (LGDP).

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 endogenous structural break in time series data; while results 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.

² Real GDP figures were obtained from the Reserve Bank of India (2006). We used the GDP at factor cost deflator for household sector savings and investment; the GDCG (unadjusted) deflator for private sector savings and investment and foreign capital inflows; and the GDP at market prices deflator for the public sector savings and investment. All data are in Rupees for the 1993/94 base year.

2. Unit Root Test and Structural Change

Given that the ADF test for stationarity of a time series is biased towards the non-rejection of the null hypothesis of $I(1)$ if structural change is present, this paper employs Lee and Strazicich's (2003) one and two-break unit root test. Firstly, the Lee and Strazicich (2003) two break minimum LM unit root test that allows for the possibility of two structural breaks under both the null and the alternative hypothesis is conducted to test for stationarity.³ Throughout, model C is considered, which allows for two changes in the level and trend. If both the breaks are significant, the results are reported in Table 1 as is the case for LPRI and LGDP. LPRI and LGDP are found to be stationary with two significant breaks in level (B_{jt}) and/or trend (D_{jt}).⁴ As only one break is significant for variables, LPUS, LHHI and LPRI, the Lee and Strazicich (2004) one break minimum LM unit root test appears more appropriate. Results indicate that LPUS is stationary with a break in 1997; LHHI and LPUI are non-stationary with a break in 1991 and 1977 respectively. None of the break dates for LHHS, LPRS and LFCI are significant. Therefore, the traditional ADF test is performed to determine the stationarity for these two variables. The results reveal that LHHS is stationary, whilst LPRS and LFCI are non-stationary.

The break dates for GDP (1964 and 1980); and the investment variables of LPRI (1962 and 1980), LPUI (1977) and LHHI (1991) coincide with the war in 1962 against China; the nationalization of six major banks in April 1980; the green revolution; and the balance of payment crisis of 1990 before the formal deregulation in 1991. The break date of LPUS in 1997 is consistent with the observation in Figure 1 where LPUS reaches negative figures in 1999 before rebounding back in 2003.

³ The Lee and Strazicich (2003) two break test is explained in the appendix.

⁴ t values are significant at least 5 percent.

Table 1: Two/One-Break Minimum LM Unit-Root Tests or ADF Tests, 1950-2005

Model C: Break in both Intercept and Slope

Variable	Lag, \hat{k}	\hat{T}_B T_{B1}, T_{B2}	Test Statistic	Result
LHHS	3	1961, 1970N	-7.3551	
LHHS	6	1974N	-3.6140	
LHHS+	ADF		-4.0291	Stationary with no break
LPRS	0	1964N,1989	-4.9966	
LPRS	6	1975N	-3.8125	
LPRS+	ADF		-1.9893	Unit Root with no break
LPUS	5	1988N,1999	-9.6468	
LPUS*	7	1997	-5.2308	Stationary with one break
LHHI	7	1969N, 1979	-6.2563	
LHHI*	8	1991	-3.2312	Unit Root with one break
LPRI	7	1962,1980	6.2569	Stationary with two breaks
LPUI	3	1967,1987N	-6.072	
LPUI*	8	1977	-4.1051	Unit Root with one break
LFCI	3	1961N, 1982N	-5.1295	
LFCI+			-2.1952	Unit root with no break
LGDP	3	1964, 1984	-7.3791	Stationary with two breaks

The critical values depend somewhat on the location of the break, ($\lambda = T_B / T$). The critical values at the 5% significance level for LPRI ($\lambda = (0.2,0.8)$)= -5.71; LGDP is $\lambda = (0.2,0.6)$ = -5.74. LPUS, LHHI LPUI = -4.51 and -4.47. A maximum of 8 lags was specified in GAUSS. Critical values taken from Lee and Strazicich (2003/4).

* Results are based on one-break LM unit root test developed by Lee and Strazicich (2004).

+ Results are based on the traditional ADF tests with the critical value of -3.4953 at the five percent level.

N = break date is not significant.

3. Autoregressive Distributed Lag (ARDL) Cointegration Approach

Along with the structural break dates, the results in Table 1 show that the eight variables are of a mixed order of integration, a combination of $I(0)$ and $I(1)$ regressors. Therefore, we test for cointegration using the ARDL modelling approach. The main advantage of the ARDL model is that it can be applied with the mixed order of integration (such is our case) while other cointegration techniques require all variables to be of equal degree of integration, i.e. $I(1)$. Thus, the ARDL approach avoids the pre-testing problems associated with the standard cointegration tests (Pesaran *et al.*, 2001). A further advantage of the ARDL is that it is a more statistically significant approach for determining cointegrating relationships in small samples (such is our case), while the Johansen cointegration technique requires larger samples to be valid (Ghatak and Siddiki 2001). The error correction representation of the ARDL model is as follows:

$$\begin{aligned} \Delta LGDP = & \alpha_0 + \sum_{j=0}^n b_j \Delta LGDP_{t-j} + \sum_{j=0}^n c_j \Delta LHHS_{t-j} + \sum_{j=0}^n d_j \Delta LPRI_{t-j} + \sum_{j=0}^n e_j \Delta LPUS_{t-j} + \\ & \sum_{j=0}^n f_j \Delta LHHI_{t-j} + \sum_{j=0}^n g_j \Delta LPRI_{t-j} + \sum_{j=0}^n h_j \Delta LPUI_{t-j} + \sum_{j=0}^n i_j \Delta LFCI_{t-j} + \delta_1 LGDP_{t-1} + \\ & \delta_2 LHHS_{t-1} + \delta_3 LPRS_{t-1} + \delta_4 LPUS_{t-1} + \delta_5 LHHI_{t-1} + \delta_6 LPRI_{t-1} + \delta_7 LPUI_{t-1} + \\ & \delta_8 LFCI_{t-1} + \delta_9 D64 + \delta_{10} D84 + \varepsilon_{1t} \end{aligned}$$

The parameters δ_i where $i = 1-10$ are the corresponding long-run multipliers, while the parameters $b_j - i_j$ 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. $H_0 : \delta_1 = \delta_2 = \delta_3 = \dots \delta_{10} = 0$) 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 lower bound critical value, then we cannot reject the null of no cointegration (long-run relationship) among the variables.

The ARDL bounds testing approach involves two steps for estimating the long-run relationship. The first stage is to establish an existence of a long-run relationship among the variables in question. If a long-run cointegrating relationship exists, the second stage estimates both the long-run and short-run elasticities. The estimated error-correction term also provides valuable information regarding the short-term adjustment to its long-run equilibrium.

Since we have fifty-five annual observations, the maximum lag of two was chosen. These structural breaks were then taken into account to test for the long-run relationship using the bounds testing approach to cointegration. The F-statistics in Table 2 indicate the existence of a long-run relationship with their respective right hand side variables when LHHS, LPRS, LPUS, LHHI and LPRI are the respective dependent variables. With regards to LGDP, LPUI and LFCI, the F-statistics show inconclusive result. In this case the error-correction term will be a useful way of establishing cointegration (Bannerjee *et. al*, 1998 and Bahmani-Oskooee and Nasir, 2004). Under the inconclusive cases, the subsequent estimations of long-run and short-run parameters will yield further information of the significance of these variables. The short-run coefficients enable the testing of short-run dynamics of savings and investment on growth, in line with the Solow-Swan model; while any significant long-run coefficient allows us to test the longer term effect of savings and investment on growth, consistent with the endogenous AK model of growth.

The next step is to estimate the long-run and short-run coefficients of the ARDL model by normalising on each of the eight variables. As we have fifty-five annual observations, this study uses the Akaike Information Criteria (AIC) method with the maximum (ρ) lag of two. The empirical results of the long-run and short-run coefficients on all the eight variables, LGDP, LHHS, LPRS, PUS, LHHI, LPRI, LPUI and LFCI for India are obtained by normalizing on each variable in turn. These are presented in tables 3 and 4.

Table 2: F-Statistics for Testing the Existence of a Long-Run Relationship among the Variables

Equation	F-Statistic	Conclusion
$F(LHHS / LPRS, LPUS, LHHS, LPRI, LPUI, LFCI, LGDP)$	4.2216*	Cointegration
$F(LPRS / LHHS, LPUS, LHHS, LPRI, LPUI, LFCI, LGDP)$	4.2789*	Cointegration
$F(LPUS / LHHS, LPRS, LHHS, LPRI, LPUI, LFCI, LGDP, D1)$	4.1314**	Cointegration
$F(LHHS / LHHS, LPRS, LPUS, LPRI, LPUI, LFCI, LGDP, D1)$	5.7609**	Cointegration
$F(LPRI / LHHS, LPRS, LPUS, LHHS, LPUI, LFCI, LGDP, D1, D2)$	4.8676***	Cointegration
$F(LPUI / LHHS, LPRS, LPUS, LHHS, LPRI, LFCI, LGDP, D1)$	2.4272**	Inconclusive
$F(LFCI / LHHS, LPRS, LPUS, LHHS, LPRI, LPUI, LGDP)$	2.5196*	Inconclusive
$F(LGDP / LHHS, LPRS, LPUS, LHHS, LPRI, LPUI, LFCI, D1, D2)$	3.0721***	Inconclusive

The relevant critical value bounds are obtained from Table CI (v) Case V: unrestricted intercept and unrestricted trend Pesaran *et al.* 2001) at the five percent for *k= 7 (2.69 and 3.83); **k= 8 (2.55 and 3.68); and ***k= 9 (2.43 and 3.56). At the ten percent for *k= 7 (2.38 and 3.45); **k= 8 (2.26 and 3.34); and ***k= 9 (2.16 and 3.24).

+ Inconclusive results at the ten percent level.

3.1. Gross Domestic Product (GDP)

Tables 3 and 4 indicate that only LFCI has a positive long and a short-run impact on LGDP in the Indian economy. A one percent increase in LFCI will have a significant positive but a small long-run impact on LGDP by 0.07; and a short-run impact of 0.04 percent, significant at the one percent level.

The results indicate the absence of any positive significant long-run or short-run relationship between any forms of savings and investment variables and real GDP. In terms of investment, these results do not support the endogenous growth view that private sector investment drives long-run economic growth. Further to this and though only significant at the ten percent level, the results indicate that public investment has a negative long-run impact on GDP growth. This counters Barro's argument that the public provision of infrastructure promotes long-run economic growth. Overall, there is no evidence of the short-run transitory effect of savings and investment on growth, consistent with the Solow-Swan model; or the long-run (permanent) effect of savings and investment on growth, consistent with the endogenous AK model in India.

The short-run error correction, $ecm(-1)$ shows the short-run adjustment of gross domestic product to its own deviation from long-run equilibrium. This is of the correct sign and statistically significant, indicating that deviations from the long-run rate of gross domestic product are corrected by over 53 per cent in the next period, which is a relatively fast pace of adjustment back to equilibrium.

3.2. Gross Domestic Savings

This section, with each of the three sectors of savings being the dependent variable, allows us to test the relationship between sectoral savings and sectoral investment and the existence of the Carroll-Weil hypothesis (1994). To test these two key relationships for India, we normalise in turn on each of the sectoral savings of household (LHHS), private (LPRS) and public (LPUS) sectors.

Tables 3 shows that LGDP in the long-run has an large elastic effect of 5.04 on LHHS and 2.84 on LPRS respectively, significant at the one percent level. These values support the Carroll-Weil hypothesis where growth is affecting savings and not vice-versa.

When household savings (LHHS) is the dependent variable, the results indicate that all the three sectors of investment are affecting LHHS in the long-run. Household (LHHI) and private investment (LPRI) is affecting LHHS negatively, while public investment (LPUI) is positively affecting household savings. A one percent increase in LHHI and LPRI will decrease LHHS by a large 1.62 and 1.09 percent; while a one percent increase in LPUI will lead to an increase in LHHS by 0.86 percent in the long-run, all significant at the one percent level. This indicates a strong direct effect between public investment and household savings.

The empirical results in Table 3 also shows that in the long-run public investment (LPUI) affects private savings (LPRS) negatively with the elasticity of -0.45; while private investment (LPRI) affects private savings (LPRS) positively with an elasticity of 0.19, both significant at the five percent level.

Along with this, the results show that a one percent increase in foreign capital inflows (LFCI) positively increases private savings (LPRS) by 0.21 percent in the long-run, at the five percent level of significance. The elasticity of 0.21 indicates that borrowing from overseas will add to private corporate savings. However, in the short-run, a one period lag of foreign inflows (LFCI) affects LPRS negatively. A one percent increase in LFCI affects LPRS negatively by -0.29 percent, significant at the one

percent level. This indicates substitution between private savings and foreign inflows in the short-run for India. The estimated coefficient of $ecm(-1)$ is equal to -0.54, implying that a deviation from long-run equilibrium following a short-run shock is corrected by about 54 percent in the following year.

The results shows a significant relationship from sectoral investment to sectoral savings in that public investment (LPUI) has a significant long-run and short-run impact on public savings (LPUS) in India over the last 55 years. A one percent increase in LPUI will lead to increase in LPUS by large 8.46 percent in the long-run and by a smaller, but still significant elasticity of 4.92 in the short-run, significant at the five percent level. indicating a strong link between public investment and public savings. The short-run results also show that one period lagged household investment ($LHHI_{t-1}$) negatively affects LPUS by an elasticity of -4.29, significant at the one percent level.

The structural break date of 1997 is statistically significant and has a negative sign implying that there is a reduction of large 4.70 in $\Delta LPUS$ in the period 1997 to 2005, at the five percent level; hardly surprising since LPUS reached negative figures during this period. Apart from the robust long-run relationship, our short-run error correction model is statistically well behaved. The error correction represents the speed of adjustment of $\Delta LPUS$ to its long-term equilibrium following a shock. Moreover, this significant error correction confirms the existence of a stable long-run relationship between the significant regressors and the dependent variable, LPUS. The $ecm(-1)$ suggests that following a shock, 58 percent of the adjustment back to long-run equilibrium is completed in one year.

3.3. Gross Domestic Investment

We normalize on the two significant investment variables of household investment (LHHI) and private investment (LPRI) along with the inconclusive variable of public investment (LPUI) to examine the long and short-run coefficients of each of these variables.

Firstly, the results indicate that there is a long-term inverse relationship between household investment (LHHI) and private investment (LPRI). Tables 3 and 4 show that crowding out exists between LHHI and LPRI in the long and short-run, where LPRI crowds-out LHHI with an elasticity of -0.45; and LHHI crowds-out LPRI with double the elasticity of -0.97, both significant at the one percent significance level. The

crowding-out effect is weaker in the short-run, where LPRI crowds-out LHHI by the elasticity of -0.25, significant at the one percent level, but LHHI crowds-out LPRI with double the elasticity of -0.51, though this is only significant at the ten percent level.

Secondly, the short-run results in Table 4 indicate a significant crowding-in affect between private (LPRI) and public (LPUI) investment. A one period lagged LPUI crowds-in LPRI by 0.89 and LPRI crowds-in LPUI by a much smaller elasticity of 0.09, both significant at the one percent significance level. This perhaps indicates that the private sector is less than enthusiastic in investing in infrastructure and expects the government to invest first and then only will the private sector follow suit.

The results in Table 3 show that GDP growth has a long-run elastic effect on household investment (LHHI). A one percent increase in LGDP will increase LHHI by 2.19 percent, significant at the one percent level. This positive LHHI elasticity of 2.19 indicates a large accelerator effect from growth to household investment. The structural dummy variable of 1991 is also significant at the five percent level. This indicates that the structural change, which happens at the time of the break, has a negative long-run impact on household investment.

The short-run results indicates that household savings (LHHS) and one period lagged LHHS have a negative impact on LHHI with elasticities of -0.34 and -0.30, significant at the one percent level. The short-run negative relationship between the two variables could imply that as household savings in India increases, a greater proportion is consumed rather than invested. Finally, crowding-out exists between the household savings and household investment in the short-run.

The empirical estimations also show that one period lagged of private investment (LPRI) positively affects household investment (LHHI) in the short-run, where a one percent increase in LPRI will lead to an increase in LHHI by 0.14 percent, at the one percent level of significance. This small elasticity between LPRI and LHHI can be explained with increasing productivity by private firms causing private investment to increase which increases household income. The structural break of 1991 is once again statistically significant and has a negative sign implying that there is a reduction of 0.27 in Δ LHHI in the financial reform period of 1991 to 2005, at the five percent significance level.

The error correction term, $ecm(-1)$ shows the short-run adjustment of each variable to its own deviation from long-run equilibrium. The coefficient of -1.00 for

LHHI suggests that deviation from the long-term investment path is fully corrected in the next, an indication that once shocked, convergence to equilibrium is instantaneous.

The empirical results in Table 3 show that private investment (LPRI) has long-run elasticity of 0.55 with respect to household savings (LHHS), significant at the five percent level. This finding is firstly, in line with the standard growth models that household savings promote capital formation;

Unlike the long-run elasticities, the short-run estimates indicate that the household savings (LHHS) and one period lagged LHHS negatively affect private investment (LPRI). This short-run negative relationship between these two variables implies that as household savings in India increase, a greater proportion is being consumed rather than invested. The negative effect of household savings (LHHS) on investment (LPRI and LHHI) is not consistent with the standard Solow growth model which predicts that sectoral savings promotes sectoral capital formation in both the short and long-run. However, the short-run estimates do indicate that a one period lagged private savings positively affects private investment with a sizeable elasticity of 0.56, significant at the five percent level. This finding is consistent with Bacha (1990) and Jappelli and Pagano (1994) who claim that savings contribute to higher investment and higher GDP growth in the short-run. However the link from investment to GDP growth is missing here.

The other important result in the short-run is that of a one period of lagged public investment (LPUI) has large elastic effect of 0.89 on private investment (LPRI); supporting the theory that government investment in infrastructure enhances the productivity of private investment.

The error correction, $ecm(-1)$ represents the speed of adjustment to restore equilibrium in the dynamic model following a disturbance, has a negative sign and statistically significant at the one percent level. This ensures that the series is non-explosive and that a long-term equilibrium is attainable. The coefficient of -1.05 for LPRI suggests that deviation from the long-term investment path is fully corrected (minor overshooting) in the next, an indication that once shocked, convergence to equilibrium is complete.

Two significant positive effects are found in both the short and long-run with LPUI being the dependent variable; household savings (LHHS) and private investment (LPRI). Firstly, public investment (LPUI) has a long-run elasticity of 0.95 and a short-run elasticity of 0.27 with respect to LHHS, significant at the five and the one percent levels, supporting the growth models. This strong complementarity relationship

between the two is also brought out in the results whereby a positive feedback exists between public investment and household savings, whereby LPUI affects LHHS by similar amount of 0.87.

Secondly, a one percent increase in private investment (LPRI) has a long-term impact of 0.33 and a short-run impact of 0.09 on public investment (LPUI), significant at the five and the one percent levels. The other key result in the short-run is that a one period lagged LGDP increases LPUI by a large 1.44 percent, significant at the one percent level, contradicting the view that investment promotes economic growth.

The dummy variable of 1977 shows that there is a slight reduction of 0.15 in Δ PUI in the period 1977 to 2005, significant at the five percent level. The short-run error correction elasticity, $ecm(-1)$ shows the short-run adjustment of public investment to its own deviation from long-run equilibrium. This is of the correct sign and statistically significant, indicating that deviation from the long-run rate of public investment is corrected by 29 per cent in the next period. Moreover, a significant error correction confirms the existence of a stable long-run relationship between the significant regressors and the dependent variable, LPUI.

3. 4. Foreign Capital Inflows

The results in Table 3 indicate that investment (private) and GDP growth are affecting foreign capital inflows in the long-run. A one percent increase in LPRI and LGDP increases LFCI by 0.82 and a large 5.37 percent respectively, significant at the five and ten percent level. This result points to a feedback between foreign capital inflows and GDP growth in the long-run. Though only significant at the ten percent level, the impact of growth in attracting foreign inflows is much stronger than that of foreign capital inflows in inducing economic growth. It can be argued that India as developing country is more attractive to foreign investors because of its growth potential. On the other hand, the growing economy of India has resulted in stronger association and inflows of foreign capital.

The short-run elasticities tell a similar story to the long-run where private investment and GDP growth have an affect on foreign capital inflows, but once again this is only significant at the ten percent level. The error correction term, $ecm(-1)$ confirms that a stable long-run relationship exists between foreign capital inflows, GDP growth and the three sectors of savings and investment. The speed of adjustment is -

0.44 implying that that a deviation from the long-run equilibrium level of foreign capital inflows in one year is corrected by about 44 per cent in the next year.

The diagnostic tests indicate that the model passes most of the tests for serial correlation, functional form, normality and heteroscedasticity. The high values of R^2 for all the ARDL models show that the overall goodness of the fit is extremely high. The F-statistics which measure the joint significance of all regressors in the models are statistically significant at the one percent level. Lastly, the Durbin-Watson statistic for all the models is close or more than two. Also, the stability of the regression coefficients is evaluated using the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMQ). According to Bahmani-Osookee (2001), the null hypothesis that the regression equation is correctly specified cannot be rejected if the plot of these statistics remains within the critical bounds of the five percent level of significance. The plots of both the CUSUM and CUSUMQ for all the eight variables are within the boundaries.⁵

4. Conclusion

This paper considers the interdependencies between household, private corporate and public sector savings and investment, foreign capital inflows, real GDP and the relevant endogenously determined structural breaks. The analysis is applied to all these variables over the period 1950 to 2005. The paper makes three important contributions: The first contribution is to test the variables for stationarity with two endogenously determined structural breaks in the time series. The second is to test for the long-run relationship among the variables using the bounds testing approach to cointegration. Finally, the ARDL modeling approach is used to estimate the long and short-run elasticities of the variables, including the error correction term.

The Lee and Strazicich (2003) one or two break minimum LM unit root tests and the ADF test indicate that the variables are of a mixed order of $I(0)$ and $I(1)$ process. Moreover, the endogenously determined structural breaks indicate that changes in the variables took place at different time periods, with the variables of LHHS, LPRS and LFCI showing no significant breaks. However, significant breaks were found for household, private and public investment; public savings and GDP.

These structural breaks were then taken into account to test for the long-run relationship using the bounds testing approach to cointegration. The F-statistics indicate

⁵ These results and plots are available on request.

the existence of a long-run relationship with their respective right hand side variables when LHHS, LPRS, LPUS, LHHI and LPRI are the respective dependent variables. With regards to LGDP, LPUI and LFCI, the F-statistics show inconclusive result. Therefore, next step of determining the long-and short-run estimates was undertaken, which can be summarised in the following eight conclusions.

Firstly, the results indicate that foreign capital inflows is the only variable that is affecting growth in both the short and long-run in India. The results are robust in that none of the three measures of savings nor investment have a positive impact on GDP growth in either the short or the long-run. These findings do not support policies designed to increase household, private or public savings and investment in order to promote economic growth in India. This is further strengthened by the findings that GDP has large elastic effects on household investment in the long-run and public investment in the short-run. Further to this, public investment has a negative impact on growth in the long-run, however significant at only the ten percent level. There is therefore no evidence of the popular endogenous explanation that investment is the driver of long-run economic growth in India.

Secondly, the Carroll-Weil hypothesis is supported in the India context where growth is affecting sectoral savings and not vice-versa. GDP growth has a large elastic affect on both household and private savings of 5.04 and 2.80 respectively in the long-run, significant at the one percent level.

The third major finding identifies that GDP has a large effect on household investment with a long-run elasticity of 2.19; and public investment with a short-run elasticity of 1.43, at the one percent significance level. This relatively large response by investment indicates a strong accelerator effect of GDP growth on the household and public sector investments.

Significant interrelationships exist between the three sectors of savings and investment which are summarised in the fourth and fifth conclusions. Fourth, household savings has a positive affect on private sector investment in the long-run; and public sector investment in both the long and short-runs. The empirical estimations also indicate that one period lagged private sector savings positively affects private sector investment in the short-run. While these relationships from savings to investment are consistent with the growth models, there is the serious missing link from investment to growth.

Fifth, public sector investment has a positive impact on its own sector savings, with a large elastic response of 8.46 in the long-run and 4.09 in the short-run. Public sector investment also affects household saving positively but with lower elasticities in both the long and short-run. However, the household and private sector investments have a negative impact on household savings in both long and short-run. Further to this, public investment affects private sector savings negatively in the long-run; while private sector investment affects its own sector savings positively in the long-run.

In sum, relationships between sectoral savings and investment can be summarised as firstly, household savings and public investment crowd-in each other in both the long-run and short-run; and secondly, a crowding-out exists between (i) household sector savings and investment; and (ii) household savings and private investment in the short-run.

The sixth conclusion points to significant relationships between sectoral investments and to a lesser extent sectoral savings. There is long-run inverse relationship between household investment and private investment. This evidence of long-run crowding-out is significant at one percent level. While in the short-run, there is a significant crowding-in effect between private and public investment, at the one percent level of significance. The expectation here is that government needs to invest in infrastructure first and then only the private sector will follow. The only relationship between sectoral savings is that public sector savings and household savings lead to a small increase in private sector savings.

Seventh, with regards to foreign capital inflows, only public sector investment and GDP growth affect the foreign inflows, in both the long and short-runs. These results once again point to a feedback between the two variables in both the long and short-run. Though only significant at the ten percent level, the impact of growth in attracting foreign capital inflows is much stronger than the reverse. Only private sector investment is found to affect foreign capital inflows.

Lastly, foreign capital inflows have a positive influence on private sector savings in the long-run. This can be explained in terms of borrowing from overseas leads to an increase in private corporate savings. However, in the short-run, a one percent increase in one period lagged foreign capital inflows will lead to a decrease in private savings by 0.29, indicating substitution between the two. This is in contrast to the increase in private savings by 0.21 in the long-run.

The short-run adjustments to long-run equilibrium show that real GDP, foreign capital inflows, household, private and public savings and investment exhibit stable equilibrating behaviour, with deviation from the long-term household and private investment path been fully corrected in the next, an indication that once shocked, convergence to equilibrium is complete. Finally, the dummy variable analysis shows significant decreases in annual growth rates in public savings as well as in household and public investment.

Overall, the analysis of Indian sectoral savings and investment with endogenously determined structural breaks does not support the short-run dynamics of the Solow-Swan model or the long-run (permanent) effect of savings and investment on growth as per the endogenous AK models of economic growth. The analysis not only provides support for the Carroll-Weil hypothesis; but there is also a strong Keynesian accelerator feedback from GDP growth to household investment (in the long-run) and public investment (in the short-run). In addition to this, there is a negative (weak) long-run affect of public investment on GDP growth, which counters Barro's argument that the public provision of infrastructure promotes long-run economic growth. Accordingly, the policy prescriptions to promote economic growth in India are not straightforward.

There is evidence that savings determine investment, in that household savings has a positive impact on private investment and public investment in both the short and long-run; and private savings determine same sector investment in the short-run. These findings may be considered to support the growth models whereby domestic savings promote domestic investment. However, the link from investment to economic growth is missing in this explanation.

There is also evidence of offsetting reduction in the rates of growth in investment (household and public investment). Combined with the lack of any identified link from investment (especially private sector investment) to output and the apparent negative influence of public investment, means that the growth propagation mechanism is unclear for the Indian economy. The empirical results obtained in this chapter 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.

However, the empirical estimations in this chapter shows that the effect of foreign capital inflows on savings and investment follows a process, in which the foreign inflows effects growth, which in turn has a positive impact on household and private

savings; and household and public investment. Though the affect on GDP growth by foreign capital inflows is significant at the one percent level, the elasticities are small, 0.07 in the long-run and 0.04 in the short-run. These results suggest that Indians are consuming rather than investing.

Further to this, the analysis indicates that household savings drive private investment, which in turn increases foreign capital inflows (to supplement investment), which promotes private corporate savings. The feedback in the opposite direction increases private investment and private savings. Thus, there is strong evidence that it is not only foreign capital flows which are driving the Indian economy. Domestic savings, private and public investment are just as important. However, their strong interdependencies do not lead to a strong collective influence on real GDP growth.

Table 3: Long-Run Coefficients

Long-Run Elasticities 1950 to 2005: Unrestricted Intercepts and Unrestricted Trends								
Explanatory Variables ²	Dependent Variable ¹							
	LGDP	LHHS	LPRS	LPUS	LHHI	LPRI	LPUI	LFCI
LGDP		5.0423***	2.8440***		2.1910***			5.3663*
LHHS						0.5539**	0.9484**	
LPRS								
LPUS								
LHHI		-1.6209***				-0.9661***		
LPRI		-1.0881***	0.1912**	8.4609**	-0.4514***		0.3274**	0.8239**
LPUI	-0.1218*	0.8618***	-0.4455**					
LFCI	0.0730***		0.2064**					
Trend	0.0398***		-0.0847**					-0.3183***
Dummy 1				-8.0680***	-0.2700**			

Notes: ¹ The cointegrating vector is identified by normalising on each explanatory variable.
² All tests of significance are reported under the assumption of normality:
*** Significant at the 1 percent level: ** 5 percent level: * 10 percent level.

Table 4: Short-Run Coefficients

Short-Run Elasticities 1950 to 2005: Unrestricted Intercepts and Unrestricted Trends								
Explanatory Variables ²	Dependent Variable ¹							
	LGDP	LHHS	LPRS	LPUS	LHHI	LPRI	LPUI	LFCI
ΔLGDP_t								2.1050*
ΔLGDP_{t-1}							1.4363***	
ΔLHHS_t					-0.3412***	-0.4607**	0.2745***	
ΔLHHS_{t-1}					-0.2999***	-0.9293***		
ΔLPRS_{t-1}						0.5639**		
ΔLHHI_t		-0.5362***				-0.5052*		
ΔLHHI_{t-1}				-4.2941***				
ΔLPRI_t		-0.3107***			-0.2499***		0.0948***	0.1580*
ΔLPRI_{t-1}		0.1846***			0.1409***			
ΔLPUI_t		0.4905***		4.9185**				
ΔLPUI_{t-1}						0.8940**		
ΔLFCI_t	0.0393***		-0.2887***					
Trend	0.0214***		-0.0454**					-0.1393***
Dummy				-4.6907***	0.2713**		-0.1456**	
ecm(-1)	-0.5374***	-0.5691***	-0.5355***	0.5813***	-1.005***	-1.0478***	-0.2894**	-0.4375***

Notes: ¹ The cointegrating vector is identified by normalising on each explanatory variable.
² All tests of significance are reported under the assumption of normality:
*** Significant at the 1 percent level: ** 5 percent level: * 10 percent level.

APPENDIX

Minimum Lagrange Multiplier Unit Root Test with Two Structural Breaks

In this study, the LM test of Lee and Strazicich (2003) which allows for two breaks in both level and trend is employed. The null hypothesis of a unit root is tested against the alternative hypothesis of trend-stationarity. Following Lee and Strazicich (2003), the LM unit root test can be obtained from the regression:

$$y_t = \delta' Z_t + X_t, \quad X_t = \beta X_{t-1} + \varepsilon_t \quad (1)$$

Where, Z_t consists of exogenous variables and ε_t is an error term that follows the classical properties. Model C allows for two structural breaks in intercept and slope, given by, $Z_t = [1, t, D_{1t}, D_{2t}, T_{1t}, T_{2t}]$, where $D_{jt} = 1$ for $t \geq T_{Bj} + 1, j = 1$ and 0 otherwise. Here, T_{Bj} represents the break date. The term D_{jt} is an indicator dummy variable for a mean shift occurring at time T_{Bj} , while T is the corresponding trend shift variable. Lee and Strazicich (2003) use the following regression to obtain the LM unit root test statistic:

$$\Delta y_t = \delta' \Delta Z_t + \phi \bar{S}_{t-1} + \mu_t \quad (2)$$

where $\bar{S}_t = y_t - \hat{\psi}_x - Z_t' \hat{\delta}_t, t = 2, \dots, T, \hat{\delta}$ the coefficients in the regression of Δy on $\Delta Z_t, \hat{\psi}$ is given by $y_t - Z_t' \delta$, and y_t and Z_t , respectively. The unit root null hypothesis is described by $\phi = 0$ and the LM test statistic is given by: $\tau = t -$ statistic testing the null hypothesis $\phi = 0$. The critical values for the two break case are tabulated in Lee and Strazicich (2003).

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