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Savings, investment, foreign capital inflows and economic growth in India 1950-2005

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CERTIFICATION

I, Reetu Verma declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the School of Economics of the Faculty of Commerce, University of Wollongong, is wholly my own original work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Reetu Verma
October 2008

DEDICATION

This dissertation is dedicated to

my boys

Rahil and Nikhil

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ABSTRACT

The main objective of this thesis is to examine the short and the long-run interrelationships between savings, investment, foreign capital inflows and economic growth in India for the period 1950 to 2005. 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). Secondly, the investigation is extended to examine the interrelationships between sectoral savings and investment and their roles in the growth process.

Since independence, the Indian economy has been subject to numerous wars, structural changes, regime shifts and economic reforms during the sample period. Therefore, there is a need to apply unit root tests which take into account endogenously determined structural breaks. This study not only applies the traditional unit root tests of the Augmented Dickey-Fuller and the Phillip-Perron, it goes further by applying Perron's (1997) innovational outlier and additive outlier model tests; and the Lee and Strazicich (2003) Minimum Lagrange Multiplier unit root test. These tests determine endogenously the likely time of the major structural breaks in the Indian economy which removes the bias of incorrectly non-rejecting the null of unit root.

Unit root tests indicate that the variables under consideration are of mixed stationary and non-stationary order. Furthermore, these tests reveal that the major economic changes in the country occurred during the 1960s and 1980s with the Green revolution (starting in 1967), along with the wars with China (1962) and Pakistan (1965); the severe droughts (1965-1967); the balance of payments crisis (1966); the economic reforms that took place under Rajiv Gandhi's tenure in the mid-1980s and the

balance of payments crisis of 1990, before the formal deregulation of the Indian economy which started in 1991.

Endogenous growth models are estimated to examine the interrelationships between gross domestic product (GDP), gross domestic savings, gross domestic investment and foreign capital inflows. The analysis is further extended to include the three sectors of savings and investment, household, private corporate and public. The estimations are undertaken with both cointegration and error-correction modelling, in the presence of structural breaks. These empirical estimations combine the short-term information with the long-run, consistent with the Solow and the endogenous AK models of growth.

As the variables under consideration are of a mixed order of stationarity and non-stationarity, this study uses the bounds testing approach to cointegration to determine the long-run relationship between variables. The study also examines the long-run and short-run coefficients using the autoregressive distributed lag approach through the error correction mechanism.

The empirical estimations indicate firstly, that neither savings nor investment, including 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.

Secondly, 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.

Third, the Carroll-Weil hypothesis and a strong accelerator effect of GDP are supported in the Indian context, only when gross savings and investment are disaggregated into the household, private corporate and public sectors. 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.

Fourth, foreign capital inflows are found to be negatively related to gross domestic savings, indicating a substitution affect between the two. But a feedback effect exists between gross domestic investment and foreign capital inflows, in both the short and the long-run, with domestic investment attracting foreign capital inflows much stronger than the reverse.

Lastly, as per the Feldstein and Horioka (1980) proposition, gross savings are driving gross investment in the long-run; however evidence of perfect capital mobility is found 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, 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 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.

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey-Fuller
AO	Additive Outlier
ARDL	Autoregressive Distributed Lag
ECM	Error Correction Model
FCI	Foreign Capital Inflows
FDI	Foreign Direct Investment
F-H	Feldstein and Horioka
GDI	Gross Domestic Investment
GDP	Gross Domestic Product
GDS	Gross Domestic Savings
GFCI	Rate of growth of foreign capital inflows
GGDI	Rate of growth of gross domestic investment
GGDS	Rate of growth of gross domestic savings
GNP	Gross National Product
HHI	Household Investment
HHS	Household Savings
IO	Innovational Outlier
LFCI	Real, logged measure of foreign capital inflows
LGDP	Real, logged measure of gross domestic product
LHHI	Real, logged measure of household investment
LHHS	Real, logged measure of household savings
LM	Lagrange Multiplier
LP	Lumsdaine and Papell
LPRI	Real, logged measure of private investment
LPRS	Real, logged measure of private savings
LPUI	Real, logged measure of public investment
LPUS	Real, logged measure of public savings
MIMAP	Micro Impact of Macro and Adjustment Policies
OECD	Organisation for Economic Cooperation and Development
OLS	Ordinary Least Squares
PP	Phillips-Perron

PRI	Private Investment
PRS	Private Savings
PUS	Public Savings
PUI	Public Investment
RBI	Reserve Bank of India
VAR	Vector Autoregressive
VECM	Vector Error-Correction Model

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The concept of economic growth is central to the policy strategies of most developing economies. Whilst economic growth is viewed by some from a short-term perspective, it is long-term growth that has been the basis of the accumulation of wealth and power for nations throughout history. It is also the basis for sustained creation of jobs and higher living standards that is desired. The last two decades has seen a renewed interest in the concept of economic growth and attention has focused on the factors that lead to higher growth. Savings and investment among other sources have been viewed as important determinants of economic growth. Theoretical models of growth have established a link between savings and growth through capital accumulation. The Harrod (1939) and Domar (1946) growth models indicate that the growth rate of output is directly related to the savings and investment. According to the Solow (1956)-Swan (1956) growth models, increases in saving transform into capital formation and so in the short-run, growth rates become positive. This transitory effect of the Solow-Swan models is in contrast to the endogenous growth theory of Romer (1986) and Lucas (1988). In their endogenous growth models, the impact of a rise in savings and investment on the growth rate can be permanent. All these growth models emphasise capital accumulation as the source of growth and tell us 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 open economies with international capital markets can reduce the impact of local savings on growth. In an open economy, the strong link predicted by the growth models between domestic savings and domestic investment may disappear as domestic savings can be transferred to wherever the return is higher. In such cases, the investment activities do not have to be financed by domestic savings. Therefore, the relationship between savings and investment depends on the degree of openness of an economy to international capital movements. Further to this, Feldstein and Horioka (1980) emphasise the powerful empirical association between saving and investment. Their empirical findings show that the correlation coefficient between savings and investment is close to unity indicating very low capital mobility.

Development and growth theories are replete with examples of how savings, investment and foreign capital inflows play a critical role in promoting economic growth. However, no definite consensus from the empirical studies has emerged regarding their relationship to growth. Even with the enormous empirical literature on the relationship between these variables, these studies have many shortcomings:

1. The earlier Indian studies only test for the short-term Granger causality between two variables. However, the standard Granger causality tests do not contain the error-correction term and thus are criticized as they do not check the cointegrating properties of the two variables.
2. Recently, some Indian studies do examine the long-run relationship by checking the cointegrating properties, but once again these studies only test for the relationship between two variables. For example, the relationship between savings and growth is examined without taking into account the effect of investment; or the relationship between investment and growth is considered without taking into account the effect of savings. Given the importance of the economic relationship between savings, investment and growth in the traditional growth models, examining only two variables in either the short-run or the long-run is not

justified. The first two points also indicate a failure of the studies to combine the long-run information with short-term dynamics necessary in examining economic growth.

3. In line with the above points and given the importance of the economic relationship between savings, investment and growth in the neoclassical and endogenous growth models, the literature review indicates that most studies do not even refer or relate their results to these growth theories. The neoclassical models of Solow-Swan allow the analysis of short-run (transitory) effects of savings and investment on growth whilst the endogenous AK models analyse the long-run (permanent) effects of savings and investment on growth.
4. The majority of the studies fail to take into account structural breaks when examining the relationship between the relevant variables. Studies use either the Augmented Dickey Fuller or the Phillip-Perron tests to examine stationarity of the variables, which have been criticized on the grounds of having low power and size distortion (Maddala and Kim, 2003). Further to this, these unit root tests do not take into account for structural breaks in the variables which lead to misleading results (Perron, 1989).
5. Lastly, given the importance of savings and investment for the three sectors, household, private and public; there are no comprehensive studies which analyse the interdependencies between sectoral savings and investment and their role in the growth process.

1.2 Objectives of the Study

The primary purpose of this study is to examine the interrelationships between savings, 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. The analysis is further extended to examine the interrelationships between sectoral savings and investment and their role in the growth process, again in both the short and the long-run.

As will be explained in chapter two, the relationships between these variables will be tested in terms of the following hypotheses:

- Increases in savings and investment promote economic growth.
- Economic growth causes savings whilst savings do not cause growth (Carroll-Weil, 1994).
- There is a strong association between savings and investment (Feldstein-Horioka, 1980).
- Foreign capital inflows have a positive impact on economic growth.
- Foreign capital inflows substitute for domestic savings.
- There is a complementarity relationship between domestic investment and foreign capital inflows.

Keeping in mind the limitations of previous research in India discussed above, this study makes five major contributions:

1. The current study focuses on the key economic interrelationships between savings, investment, foreign capital inflows and growth, consistent with the short-run transitory effects of Solow-Swan model and the long-run (permanent) effect of the endogenous AK model of growth;

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

2. The Lee and Strazicich (2003) Lagrange Multiplier unit root test, which endogenously determines two structural breaks is conducted;
3. This study tests for long-run relationships between gross domestic savings, gross domestic investment, foreign capital inflows and GDP growth, taking into account the above two structural breaks using the bounds testing approach to cointegration;
4. As an extension to above, long-run relationships is also tested by the bounds testing procedure for the disaggregated measures of savings and investment, foreign capital inflows and GDP growth with the relevant structural breaks;
5. This study also examines the long-run and short-run coefficients using the Autoregressive Distributed Lag (ARDL) approach through the error correction mechanism. The error correction mechanism integrates the short-run dynamics with the long-run equilibrium without losing the long-run information.

1.3 Structure of the Thesis

This thesis comprises seven chapters. Chapter two presents a comprehensive survey of the literature on the relationships between economic growth, savings, investment and foreign capital inflows. The chapter divides the literature into five parts: (i) the relationship between gross domestic savings and growth; (ii) the relationship between gross domestic investment and growth; (iii) the relationship between savings and investment; (iv) the relationship between foreign capital inflows and growth; and (v) the relationships between sectoral savings, investment and growth.

Chapter three discusses the trends, breaks and patterns for each of the four aggregate variables, gross domestic savings, gross domestic investment, foreign capital inflows and GDP growth. This provides an overview of the Indian economy for the last

55 years to set the stage for the empirical analysis in the later chapters. Savings and investment are then disaggregated into the three sectors, household, private corporate and public. The trends and breaks of each of these sectors are also discussed and the chapter concludes by highlighting the different growth differentials between the variables.

Chapter four tests for non-stationarity of these measures, firstly by using the traditional unit root tests and secondly, in the presence of structural breaks. This chapter, as a significant contribution to the study, surveys the recent development of unit root hypotheses in the presence of structural change at the unknown time of the break. Until now, most empirical research concerning growth has been conducted using conventional econometric tests. Because the Indian economy has faced significant structural changes over the last 55 years, applying the traditional unit root tests will result in misleading empirical findings. Therefore, this chapter applies recent unit root tests to investigate the non-stationarity of the variables. These methodologies include Perron's (1997) Innovational Outlier Model and the Additive Outlier Model which endogenously determine one structural break; and the Lee and Strazicich (2003), Minimum Lagrange Multiplier Unit Root Test with two structural breaks.

An endogenous growth model (derived in Appendix A) which details the important relationships of the aggregate measures of gross domestic savings, gross domestic investment, foreign capital inflows and GDP growth is estimated in chapter five. As a major contribution, this chapter estimates both the short-run and the long-run relationships between the variables taking into account the endogenously determined structural breaks. In order to explore these interrelationships in India, the bounds testing approach to cointegration is applied. Further to this, the long-run and short-run coefficients are estimated using the ARDL approach through the error correction mechanism.

Chapter six makes another major contribution to this study, by further exploring the interdependencies between sectoral savings and investment, foreign capital inflows, real GDP and structural breaks for the Indian economy. The important interrelationships between all these eight variables, modelled in Verma and Wilson (2004) is estimated, again using the cointegration and error-correction techniques. The model provided in Appendix D, supplements this chapter.

The final chapter summarises the major findings of the study and discusses their policy implications. Finally, suggestions for future work are provided at the end of the chapter.

CHAPTER TWO

LITERATURE REVIEW

2.1 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.

In light of the above, this chapter surveys the relevant literature regarding the relationships and the role played by savings, investment and foreign capital inflows in promoting GDP growth, paying particular attention to the relevant growth theories. The literature review is divided into five parts; the relationship between savings and growth is discussed in section 2.2; relationship between investment and growth in section 2.3; relationship between savings and investment in section 2.4; the relationship between foreign capital inflows and growth in section 2.5; and section 2.6 provides a discussion on the few studies relating specifically to sectoral savings and investment. Finally, summary of the chapter and concluding remarks are presented in section 2.7.

2.2 Savings and Growth

Economists have long known that saving rates and growth rates are positively correlated across countries. Houthakker (1961, 1965) and Modigliani (1970) presented initial empirical evidence long ago, about the positive correlation between saving and output for a large number of countries and many subsequent papers have confirmed this correlation. The recent revival in empirical research on the determinants of economic growth has further reinforced these early findings.

The policy implication of the Harrod (1939), Domar (1946), Solow (1956) and Swan (1956) models for development is that countries which manage to increase their saving rate and therefore investment, will increase their rate of growth. The effect of higher savings is to increase the availability of funds for investment. The more capital goods that the nation has at its disposal, the more goods and services it can produce. The assumption here is that higher saving precedes economic growth and higher saving causes economic growth.

The popularity of the Solow-Swan model led to strong macroeconomic policy recommendations for development. As a result, for many years, the World Bank recommended that developing countries should pay close attention to policies that lead to higher saving rates in order to boost economic growth. However, many studies have cast doubt on the conventional wisdom that savings leads to economic growth including Gavin, Hausmann and Talvi (1997), Saltz (1999), Narayan and Narayan (2003) and Mohan (2006). In fact, Gavin *et al*. (1997) argue that "Higher growth rate precedes higher saving rather than the reverse" and "The most powerful determinant of saving over the long-run is economic growth" (p.13). This view has raised much economic debate. In a review of his paper, Cohen (1997) declares "The paper by Gavin *et al*. (1997) is dangerous. It deduces that policy makers should not promote saving" (p.45).

Earlier studies such as Fry (1980, 1995), Giovanni (1983, 1985), Lahiri (1989), Carroll and Summers (1991) and Edwards (1996) have found a positive correlation does exist between the savings rate and income and/or growth rate. Further to this, studies of Bacha (1990); Otani and Villanueva (1990); DeGregorio (1992); and Jappelli and Pagano (1994) employ Ordinary Least Squares (OLS) regression using cross-section data and accomplish that higher savings led to higher economic growth. However, a comprehensive summary of the available evidence by Bosworth (1993) on the determinants of saving, investment, and growth concludes that causality from growth to saving is much more robust than that from saving to growth.

Schmidt, Serven and Solimano (1996) provide a policy-orientated view of theoretical and empirical work of the determinants of savings and investment, and their link to growth. They conclude that the recent literature supports the view that savings and growth reinforce each other and the causality runs in both directions. The authors suggest for higher savings to match the required level of capital accumulation for stable economic growth.

However, the view that growth appears to cause saving has found support in several papers, starting with the study by Carroll and Weil (1994). Carroll and Weil (1994) conduct Granger causality tests (in levels and first differences) on five year-averages of savings and growth rates over their pool time series cross-section sample of 64 countries. They find the economic growth rate Granger causes savings, the result known as the Carroll-Weil hypothesis thereafter.

Since then, many studies examined the savings-growth nexus including Edwards (1995). Edwards examines data from a panel of 36 countries over the period 1970-1992. Using lagged population growth, political instability, openness, and other lagged variables as instruments, he concludes that the rate of output growth has a significant, positive effect on saving. This result is further reinforced by Gavin *et al*. (1997) who argue that:

> "Higher growth rate precedes higher saving rather than the reverse … According to this view, Latin America's chronically low rate of saving is primarily the consequence, more than the cause, of the region's history of low and volatile economic growth" (p.13).

A study to investigate the causal relationship between real output and savings for Sweden, UK and USA is conducted by Anderson (1999). The results indicate mutual long-run relationship between the two variables for Sweden and UK. He also finds short-run bi-directional causality for USA and uni-directional causality from savings and output for UK. But no significant evidence of short-run causality is found for Sweden. The author concludes that the causal chain linking savings and output might differ across countries.

Saltz (1999) investigates the direction of causality between savings and growth rate of real GDP for 17 Latin American and newly industrialized countries for the period of 1960-1991. The study finds that for nine countries, the causality is from the economic growth rate to growth rate of savings. For only two countries is the direction of causality reversed. There are four countries where no causality was identified, and for the other two countries bi-directional causality is detected. The author lends support to the Carroll-Weil hypothesis that higher growth rates of real GDP contribute to a higher growth of savings.

In a paper summarizing the conclusions from a three-year World Bank project on the determinants of saving and growth across the world, Loayza, Schmidt-Hebbel and Serven (2000) in a cross-section of countries find that the growth rate is among the most robustly significant variable explaining the national saving rate. These results hold for OECD countries and less developing countries sub-samples as well as for the full sample of countries.

Other studies in the World Bank's saving project revisit the correlation between saving and growth. Attanasio, Picci and Scorcu (2000) examine the dynamic relationship between economic growth, the investment rate and the saving rate using annual time series for a large cross-section of countries. By employing a variety of samples and econometric techniques, they consistently find that growth Granger-causes savings, although the effect appears to be quantitatively weak. They also find that increases in saving rates do not always precede increases in growth. However, Rodrick (2000) who examines both long-lasting and short-lived episodes of saving takeoffs, shows that sustained increases in saving typically are followed by accelerations in growth that persist for several years, but eventually disappear, consistent with the Solow model. In contrast, sustained accelerations in growth are associated with permanent saving hikes.

Anoruo and Ahmad (2001) utilize cointegration with the vector error-correction (VECM) to explore the causal relationship between economic growth and growth rate of domestic savings for African countries.[1] The results of the Johansen and Juselius cointegration tests suggest that there is a long-run relationship between economic growth and growth rate of savings. The authors find that in four out of the seven countries, economic growth Granger causes the growth rate of domestic savings. However, they obtain a bi-directional causality in Côte d'Ivoire and South Africa. Only in the Congo, did the opposite result that the growth rate of domestic savings Granger causes economic growth.

Further support for the Solow growth model in that savings effect growth is found by Alguacil, Cuadros and Orts (2004). Using Granger non-causality test procedure developed by Toda and Yamamoto (1995) and Dolado and Lütkepohl (1996), Alguacil *et al.* (2004) analyse the saving-growth nexus for Mexico. They find evidence in favour of Solow's model prediction that higher saving leads to higher economic growth. However, the authors confirm that the saving-growth nexus in this country seems to be related to the inclusion of foreign direct investment in the model.

However, the studies of Claus, Haugh, Scobie and Törnquist (2001) and Narayan and Narayan (2003) all tend to support the Carroll-Weil hypothesis (1994). Claus *et al.* (2001) investigate the link between savings, investment and growth in New Zealand. They find that domestic saving does not appear to have constrained investment and hence growth in New Zealand. They go on to say that "it is unlikely that higher levels of domestic saving would lead to higher investment and improved growth. Promoting

[1] Congo, Côte d'Ivoire, Ghana, Kenya, South Africa and Zambia.

growth would not alone provide justification for interventions to raise domestic saving" (p.2). Narayan and Narayan (2003) examine the savings behaviour in Fiji using the ARDL cointegration approach. They find evidence of the Carroll-Weil hypothesis in that economic growth has the biggest impact on savings rate, suggesting that savings will increase with an increase in economic growth.

Sheggu (2004) uses cointegration and the VECM model to examine the causal relationship between real economic growth and growth rate of real gross domestic savings for Ethiopia. The long-run relationship between real GDP and real gross domestic savings is explored by utilizing the Johansen procedure. The results of the cointegration tests indicate that there is a long-run relationship between real GDP and real savings in Ethiopia and a bi-directional causal relationship exists between the two.

Adebiyi (2005) provides empirical evidence regarding savings and growth relationship in Nigeria using a quarterly data spanning between 1970:1 and 1998:4. He investigates the causal links between saving and growth using Granger causality tests and impulse response analysis of vector autoregressive models. The evidence from impulse response analysis and Granger causality tests shows that growth, using per capita income, is sensitive to and has an inverse effect on savings.

Many studies concentrate on the savings-growth relationship in Asia including Baharumshah, Thanoon and Rashid (2003) and Agrawal (2000). Baharumshah *et al.* (2003) base their study on five Asian countries using VECM from 1960-1997.[2] They find that growth rate of savings does not Granger cause economic growth rate in the countries, except in Singapore. Agrawal (2000) on the other hand examines the savings rate and the growth rate of real gross national product (GNP) for five South Asian

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2 Singapore, South Korea, Malaysia, Thailand, and the Philippines.

countries[3] using Vector Autoregressive (VAR) specifications. He finds that higher savings rates Granger cause higher growth rates of real GNP in Bangladesh and Pakistan lending support to the traditional Solow-Swan view. However, for India and Sri Lanka, Agrawal finds evidence to support the Carroll-Weil hypothesis that higher growth rates Granger cause higher savings rates.

Agrawal (2001) uses VECM and VAR procedures, once again tests for Granger causality between savings and growth, this time for seven Asian countries[4] including India. He finds that causality runs primarily from growth to savings but there is bi-directional causality in Indonesia, Malaysia and Taiwan. For India, the author finds that the direction of Granger causality is from growth of real GNP per capita to the savings rate.

Mohan (2006) also supports the Carroll-Weil hypothesis. He conducts Granger causality tests between savings and economic growth using annual data from 1960 to 2001 for 22 countries. He finds that economic growth rate causes the growth rate of savings in 13 countries. The opposite results in support of the growth models prevailed in only two countries; while five countries show a bi-directional causation. The author concludes by stating that "the study favours the hypothesis that the causality is from economic growth to growth rate of savings".

Aghion, Comin and Howitt (2006) develop a theory where domestic saving affects economic growth even in a world of capital mobility. The authors find that in relatively poor countries, catching up with the production frontier requires the involvement of a foreign investor, who is familiar with the frontier technology, together with effort on the

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[3] Bangladesh, India, Nepal, Pakistan and Sri Lanka.
[4] India, Indonesia, Malaysia, Singapore, South Korea, Taiwan and Thailand.

part of a local bank, who can directly monitor local projects to which the technology must be adapted. In poor countries,

> "local savings matter for innovation, and therefore growth, because they allow the domestic bank to co-finance projects and thus to attract foreign investment. But in countries close to the frontier, local firms are familiar with the frontier technology, and therefore do not need to attract foreign investment to undertake an innovation project, so local saving does not matter for growth" (p.1).

In their empirical work, they show that lagged savings is significantly associated with productivity growth for poor but not for rich countries. Further, they show that savings is significantly associated with higher levels of foreign direct inflows and equipment imports and that the effect that these have on growth is significantly larger for poor than rich countries.

Recent studies which specifically test for the savings-growth nexus in India include Mühleisen (1997), Mahambare and Balasubramanyam (2000), Sahoo, Nataraj, and Kamaiah (2001), Saggar (2003), Sinha and Sinha (2007) and Verma (2007). Using annual data for the period 1950/51 to 1998/99, Sahoo *et al*. (2001) examine the causal nexus between savings and economic growth in India including one trend break in savings and GDP growth. Using error correction models, they find one-way causality from GDP to gross savings in real terms. The authors conclude that "savings as the engine of growth" is refuted in the Indian context. Their result is consistent with Mahambare and Balasubramanyam (2000) who conclude "the Granger causality test suggests that causality runs from growth to savings" for India.

The studies of Mühleisen (1997), Saggar (2003) and Sinha and Sinha (2007) examine the causality between GDP growth and the different sectors of savings, which is discussed in section 2.6. Lastly, Verma (2007) considers the long-run relationship between savings, investment and economic growth for India using annual time series data for the period 1950/51 to 2003/04. Once again, her results support the existence of the Carroll-Weil hypothesis for India that growth causes savings and not vice-versa.

In summary, savings and growth are strongly positively correlated across countries. However, the empirical evidence concerning the temporal precedence between saving and growth in countries is mixed. Bacha (1990), DeGregorio (1992), Otani and Villanueva (1990) and Attanasio *et al*. (2000) all find that a higher growth rate of savings is associated with higher growth. These findings are consistent with the conventional growth models that stipulate that domestic savings promote economic growth. However, studies by Carroll and Weil (1994), Jappelli and Pagano (1994), Gavin *et al.* (1997), Sinha and Sinha (1998), Bosworth (1993), Saltz (1999), Anoruo and Ahmad (2001), Narayan and Narayan (2003) and Mohan (2006) find evidence that economic growth Granger cause savings. Importantly, the consensus that emerges from the Indian studies of Agrawal (2001), Sahoo *et al*. (2001) and Verma (2007) all tend to support the Carroll-Weil hypothesis that savings do not cause growth, but economic growth causes savings.

However, there are three limitations in the above studies which this study overcomes. Firstly, most of the Indian studies only consider the issue of short-term Granger causality. Of those who consider the long-run relationship in India between the two variables such as Sahoo *et al*. (2001) Sinha (2002) and Verma (2007) do so by taking only a single trend break into account. Secondly, irrespective of whether a short-run or a long-run relationship is examined, the Indian studies only examine the relationship between savings and growth, ignoring the important role played by investment in the process.[5] Lastly, given the importance of savings to growth in the traditional growth models, it is surprisingly that most of these studies do not relate their results to the popular growth models.

2.3 Investment and Growth

The eighties saw the emergence of the new endogenous growth theories of Romer (1986) and Lucas (1988). The AK models are the simplest endogenous growth models that show that capital investment can generate sustained economic growth. This model allows for policies to have long-term (permanent) effects on growth. However, the literature survey below indicates equal amount of studies that either reject or do not reject the hypothesis that investment is the driver of long-run economic growth.

The strong relationship between fixed capital formation shares of GDP and growth rates since World War II has led many authors, including De Long and Summers (1991, 1993) to conclude that the rate of capital formation (or of the capital formation in the form of equipment) determines the country's economic growth. Further to this, King and Levine (1994) characterised capital fundamentalism as "the belief that the rate of physical capital accumulation is the crucial determinant of economic growth". Inspired by the endogenous growth models, cross-country regression studies find a strong relationship between the average GDP growth rate and the average share of investment in GDP.

Levine and Renelt (1992) use cross-country data to show that investment is the only variable that is robustly correlated with the growth in output. Whilst most argue the causal link is from investment to output, there is some evidence that output

[5] With the exception of the author in her paper, Verma (2007) published in the South Asia Economic Journal.

influences investment through an accelerator effect. Hall and Jones (1999) argue that most cross-sectional variation in per capita output is due to variation in the productivity with which factors are combined, rather than differences in factor accumulation. Further to this, King and Levine (1994) provide evidence that capital accumulation alone is neither a necessary nor sufficient condition for the "take-off" to rapid growth; and Jones (1995) concludes that the "AK model does not provide a good explanation of the engine of growth in the studied countries". Jones (1995) basically argues that a key prediction of AK models is inconsistent with the data. Unlike the earlier exogenous growth models, AK models predict that permanent changes in government policies affecting investment rates should lead to permanent changes in a country's GDP growth. Jones tests this prediction by comparing investment as a share of GDP and the growth rate of GDP for 15 countries that belong to the OECD. Using data for the post-World War II period, Jones argues that AK models are inconsistent with the time series evidence because during the postwar period, rates of investment, especially for equipment, have increased significantly, while GDP growth rates have not.

Li (2002) follows Jones (1995) to explore the empirical validity of AK type endogenous growth models, where he examines the long-run relation between growth and investment. He uses data for twenty-four OECD countries, 1950-1992, and five major industrialized countries, 1870-1987. Contrary to Jones's (1995) findings, Li (2002) finds that the broadly measured rate of investment exerts a long-run positive effect on the growth rate. The panel-data evidence from OECD countries also supports an extended AK model based on the Uzawa (1965)/Lucas (1988) two-sector model with transitional dynamics. Li (2002) rejects the hypothesis that the effect of investment is only transitory and suggests that the long-run relation between growth and investment is consistent the AK model. This is supported by Bernanke and Gürkaynak (2002) and

Bond *et al*. (2004) who also consider the relationship between the investment rate and output growth and find evidence of a permanent effect of investment rate on economic growth, thereby rejecting the transitory effect of the Solow model.

However, Diego (2006) confirms the work of Jones (1995) which provides strong evidence against the empirical validity of AK type model. Diego (2006) revisits the work of Jones (1995) and Li (2002) by employing recently developed unit root tests which accommodate for the existence of a structural break in the data for 26 OECD countries over the period 1950-1992. The estimation of autoregressive distributed lag growth models consistently renders insignificant long-run coefficients on the investment rates. Overall, he concludes that "the analysis of deterministic and stochastic trends in output growth and investment rates do not render broad support for the empirical validity of AK models" (p.1).

Blomström, Lipsey and Zejan (1996) divide the post WWII period into five year periods and find that per capita GDP growth in a period is more closely related to subsequent capital formation than the current and past capital formation. Their causality tests suggest that growth induces subsequent capital formation more than capital formation induces subsequent growth. Thus they conclude, "we find no evidence that fixed investment (or equipment investment) is the key to economic growth" (p.276). This is further supported by Lipsey and Kravis (1987) and Sinha (1999). Lipsey and Kravis (1987) results suggest that the observed long-run relationships between investment and growth were due more to the effect of growth on capital formation than to the effect of capital formation on growth. While Sinha (1999) by examining the relationship between export stability, investment and economic growth in nine Asian countries[6] using time series data, finds that in most cases, economic growth is found to be positively associated with domestic investment.

The causal patterns between the share of fixed investment in GDP and the growth rate of per capita real GDP on an individual country basis, using time series on each of the group of seven countries is examined by Ghali and Al-Mutawa (1999).[7] Using the data on the annual growth rate of real per capita GDP and the annual share of fixed investment in GDP over the period 1960-1995, their empirical results suggest that the causal relationship between these variables may vary significantly across the major industrialized countries that presumably belong to the same growth group. Most importantly, no consistent evidence is found that causality is running in only one direction. Rather, causality between fixed investment and growth seems to have a country specific nature and may run in either direction.

Chaudhri and Wilson (2000) examine the long-run relationship among savings, investment, productivity and economic growth in Australia over the 1861-1900 and 1949-1990 time periods. Using the Johansen-Juselius cointegration procedure, the authors conclude that there is no long-run relationship among the variables during the first period of 1861-1900, but there are two cointegrating vectors among the variables in the second period, 1949-1990. Using Granger causality tests, the study shows that there is a uni-directional causality running from GDP to savings and feedback causality between GDP and investment.

Feasel, Kim and Smith (2001) examine the relationships between the growth rate of per capita GNP, investment rates and the growth rate of exports in Korea from 1956-

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[6] India, Japan, Malaysia, Myanmar, Pakistan, Philippines, Sri Lanka, South Korea and Thailand.
[7] Canada, France, Germany, Italy, Japan, United States and the United Kingdom.

1996. The authors find that in the short-run, investment rates have strong impact on the growth rate of per capita GNP. However, in the long-run they find that any shocks in investment rates do no have effect on the growth rate of GNP. Their finding of transitory effects on investment rate of per capita output is consistent with the prediction of the Solow growth model.

Madsen (2002) tests for causality between investment and economic growth using pooled cross-section and time-series analysis for 18 OECD countries over the 1950 to 1999 period. The results show that growth is predominantly caused by investment in machinery and equipment, whereas investment in non-residential buildings and structures is predominantly caused by economic growth.

The causal relationships between economic growth, foreign direct investment (FDI) and gross domestic investment in 80 countries over the period 1971-1995 by using a panel VAR model is examined by Choe (2003). He finds that FDI Granger causes economic growth and vice versa; however the effects are more apparent from growth to FDI rather than the other way around. Choe also finds that investment does not Granger cause economic growth; but economic growth robustly Granger causes investment leading him to conclude that

> "These findings suggest that strong positive association between economic growth and FDI inflows or gross domestic investment rates do not necessarily mean that higher FDI inflows or gross domestic investment rates lead to rapid economic growth" (p.44).

Arby and Batool (2007) find a two-way causality between the growth rates of the investment and GDP in Pakistan. The real investment growth significantly impacts and is impacted by real GDP growth "implying the existence of both the Keynesian investment multiplier and the accelerator principle in case of Pakistan".

Earlier studies on investment and growth relationship in Pakistan include Khan (1996) who finds a significant impact of investment on economic growth from data of 95 countries (including Pakistan) for the 1970-1990 period. Another study by Khan (1988) finds that changes in output have minor impacts on private investment while general market conditions have stronger influences on private capital formation in Pakistan.

The two Indian studies that examine the relationship between investment and growth are the ones by Athukorala and Sen (2002) and Saggar (2003). Athukorala and Sen examine the role of investment in economic growth in India using an analytical framework developed using the endogenous growth theory of Scott (1989). They find strong support for the view that "the level of investment and its efficiency are the proximate causes of economic growth". This is in line with Saggar's Granger causality tests based on bivariate VARs between investment and output using the data from 1950/51 to 2000/01. He shows that total investment rate Granger causes real GDP growth rate.

In summary, the results are mixed and there is no definite consensus of the growth theories of Romer, Lucas and Barro that capital accumulation is the driver of long-run economic growth. However, once again, many of the above studies only consider the issue of Granger causality. Consistent with the Solow-Swan model, Granger causality only shows the short-term affects of investment on growth. There are only a few studies that examine the long-run relationship between investment and growth, consistent with the endogenous AK growth model. However, as for the studies on savings in the previous section, the Indian studies have two major limitations. Firstly, Saggar (2003) in his Granger causality test does not take into account any structural break; while the Athukorala and Sen (2002) consider two exogenous structural breaks. Secondly, the two

Indian studies only examine the relationship between investment and growth, ignoring the important role played by savings in the process.

2.4 Savings and Investment

The growth models suggest that it is the amount of capital accumulation that determines the growth of output and the amount of capital accumulation in an economy is ultimately constrained by its savings rate. As the economy increases its savings, more funds will be available for investment. Thus, the issue of correlation between saving and investment assumed importance in economics. In their seminal paper, Feldstein and Horioka (1980) (F-H henceforth) interpreted the correlation between saving and investment rates as evidence of low international capital mobility. The idea is that in a closed economy with low capital mobility, domestic savings finances all investment. However, in the open economy, the domestic savings is not necessary used to finance domestic investment as savings will be used to gain better returns around the world. In the words of F-H (1980) with perfect capital mobility

> "there should be no relation between domestic savings and domestic investment: savings in each country responds to the worldwide opportunities for investment while investment in that country is financed by the worldwide pool of capital" (p.317).

Since their seminal work, which upset the conventional wisdom by their finding that capital is not very mobile internationally among developed countries, an enormous literature has emerged on the issue savings-investment correlations.

One of the first to test the F-H proposition was Sachs (1981) who uses cross-sectional data to regress the change in current account balance rate, defined as the ratio of current account balance to GNP on the change in the investment rate. The equation is expressed as: $\Delta(\frac{CA}{Y})_i = \delta + \gamma\Delta(\frac{I}{Y})$ where CA stands for the current account balance, Y is GNP and I is investment. γ (negative) measures the proportion of changes in domestic investment that is financed by capital inflows. Sachs uses average data for 15 industrialized countries for 1968-1973 and 1974-1979 to calculate the changes in the two variables. He finds that γ equals to -0.65 and is statistically significant. This prompts Sachs to conclude that 65 percent of the change in investment during the period was financed by capital inflows rather than by saving.

Using the Unites States data from 1946-1987, Miller (1988) studies the relationship between savings and investment via the technique of cointegration. He finds that the two variables shared a cointegration relationship prior to the Second World War period and the long-run relationship did not exist after that, leading Miller to conclude that this could be explained by the increased international mobility after the war. Furthermore, Levy (2000) examines the short-run and long-run relationship finding evidence in favour of a long-run cyclical relationship between savings and investment. He also finds that savings-investment relationship is stronger in the post-war period than during the pre-war period.

In their study on savings-investment relationship, Frankel, Dooley and Mathieson (1986) use a sample of 64 countries[8] and find that in case of all the countries except a few less developed countries,[9] savings and investment are highly correlated and share a long-run equilibrium relationship. This result is supported by the studies by Dooley, Frankel and Mathieson (1987), and Frankel and MacArthur (1988) who point to a strong association between domestic savings and investment for the economies with

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[8] 50 developing and 14 developed countries.

[9] These countries were heavily dependent on foreign aid and assistance programs.

relatively open capital accounts. They find only a weak correlation between the two developing economies that rely heavily on foreign aid to finance their current account deficits. Thus, Dooley *et al*. conclude that the cross-section data finds “capital is more mobile for developing countries than for developed countries”. Wong (1990) using annual data for 45 developing economies for the 1975-1981 period also finds some support for the Feldstein and Horioka predictions. He finds however, that the saving-investment relationship is significantly affected by the non-traded goods sector. But Isaksson (2001) using data covering the 1975-1995 period and dividing 90 developing countries into four regions of Africa, Asia, Latin America and the Middle East finds that capital is relatively immobile for developing countries. Including foreign aid in the saving-investment regression was seen to have a positive effect on the saving coefficient.

Jansen (1996) uses an error correction model to study the saving-investment relationship and finds that the saving and the investment rates have a long-run relationship for most of the OECD countries. This is different to Chaudhri and Wilson (2000) and Sachsida and Mendonça (2006) who find no long-run relationship between savings and investment for Australia and Brazil respectively.

Cárdenas and Escobar (1998) analyse the determinants of savings in Colombia from 1952-1994. The evidence indicates that changes in national savings and changes in investment are perfectly correlated, and that savings Granger causes growth. Moreover, the study establishes a close inverse relationship between private and foreign savings. However, Ho (2000) extends the F-H model to test for capital mobility by drawing two samples from two different regimes for Taiwan. He concludes that the F-H (1980) model is supported for the more open regime.

Attanasio *et al*. (2000) discuss the correlations among savings, investment and growth rates using the data set gathered by the World Bank for 150 countries over the post WWII period. The authors conclude that three results emerged from their study which was extremely robust across data sets and estimation methods: (i) lagged saving rates are positively related to investment rates; (ii) investment rates Granger-cause growth rates with a negative sign; and (iii) growth rates Granger-cause investment rates with a positive sign.

AbuAl-Foul (2006) investigates the causality link between saving and investment in four MENA countries.[10] Using the Johansen and Juselius cointegration procedure, the study shows that saving and investment rates are not cointegrated indicating that saving and investment have no long-run relationship. Using the Ganger causality test based on VAR model, the results reveal that uni-directional causality between saving and investment exists for both Egypt and Jordan and that direction of causality runs from saving to investment. In addition, the results show that uni-directional causation from investment to saving is statistically supported in the Granger sense for Morocco. However, in the case of Tunisia, the results provide no statistical support in the Granger sense between saving and investment.

Using the cointegration and the VECM procedure for 37 countries from 1960 to 1998, Kisangani (2006) revisits the F-H Puzzle for Africa. He finds that the F-H hypothesis does not apply to most African countries. Kisangani finds that there is a long-term negative impact of savings on investment in nine countries. Furthermore, he finds that the effect of investment on savings is also negative for 12 countries. The author states that there is no positive long-term bi-directional effect between savings and investment, but there is negative bi-directional causality for six countries. Kisangani

[10] Egypt, Jordan, Morocco and Tunisia.

concludes by stating that "exogenous changes in national saving rates have a positive effect on investment is not supported for 31 countries out of 37 from the sample" (p.873).

Many studies investigate the observed correlation between domestic saving and investment in the European Union (EU) countries including Arginon and Roldan (1994), Apergis and Tsoulfidis (1997), Alexiou (2004) and Kollias, Mylonidis and Paleologou (2008). Arginon and Roldan and Apergis and Tsoulfidis find that savings and investment are cointegrated and causality flowing from savings to investment. However, Alexiou (2004) who conducts Granger causality tests for five EU countries[11] rejects the null hypothesis that net investment does not cause personal savings in all the five countries. However, he does not reject the null hypothesis that personal savings does not cause net investment in all countries, leading him to conclude that "investment is a variable of utmost importance".

Kollias *et al.* (2008) examine the saving-investment correlation using the ARDL approach and panel regressions for 15 EU member countries from 1962-2002. They find that a long-run relationship exists for only eight countries.[12] Panel regressions yield a savings-investment coefficient in the range of 0.148-0.157. The authors accept the F-H explanation and interpret this finding as evidence of high capital mobility.

Sinha (2002) studies the relationship between saving and investment rates for 12 Asian countries including India using the Johansen (1991) cointegration procedure. When a structural break is taken into account, Sinha finds that the two rates are cointegrated for Myanmar and Thailand. The causality tests with structural breaks shows inconclusive results for India; Sinha finds that the growth of savings rate causes

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[11] France, UK, Belgium, Germany and Netherlands.
[12] Austria, Belgium, Germany, Greece, Italy, Luxembourg, Spain and the UK.

growth of investment rate for Malaysia, Singapore, Sri Lanka and Thailand. Reverse causality holds for Hong Kong, Myanmar Malaysia and Singapore.

This reverse causality is also shown by Boon (2000) in his study which examines savings-investment relationship in The Association of Southeast Asian Nations (ASEAN)[13] region based on the time-series approach of cointegration and VECM. The estimated results show no short-run causal effect running from savings to investment for all the cases except Singapore. Instead the causal effect is running from investment to savings for the case of Indonesia and Thailand. For the case of Malaysia and the Philippines, there is no causal relationship between savings and investment at all.

Lastly, Cooray and Sinha (2007) study the relationship between the saving and investment rates for 20 African countries. They use both the Johansen cointegration tests and fractional cointegration test which indicate mixed results. The Johansen cointegration tests show that the saving and investment rates are cointegrated only for Rwanda and South Africa, implying that for the other 18 countries, there is evidence of capital mobility. However, the two rates are found to be fractionally cointegrated in only 12 of the 20 countries examined.

Before we consider the literature especially to India, it becomes necessary to point out that there is a strand of theoretical literature which departs from the Feldstein-Horioka approach. These theoretical explanations propose to account for a strong saving-investment correlation in the presence of high capital mobility. The studies argue that the saving-investment correlation is due to other macroeconomic factors such as country size (Baxter and Crucini, 1993), non-traded goods (Murphy, 1986; Wong, 1990), current account solvency (Coakley, Kulasi and Smith, 1996) and financial

13 Indonesia, Malaysia, Philippines, Singapore and Thailand.

structure (Kasuga, 2004). However, the empirical results resulting from these studies remain ambiguous.

Literature specific to India include the studies by Seshaiah and Sriyval (2005) and Verma (2007), who both examine the savings-investment relationship in India consistent with the F-H hypothesis. Seshaiah and Sriyval investigate the relationship between savings and investment using the Johansen (1991) cointegration approach in India from 1970/71 to 2001/02. They find the presence of a long-run relationship between savings and investment. The Granger causality test shows that savings are significantly affecting investment where as investment are not influencing savings. Their results are in line with Verma (2007) who concludes that her results "support the view that savings drive investment in both the short-run and long-run".

Overall, studies following the F-H study examine the relationship between savings and investment for different time periods, data sets and country samples; both time-series and cross-section studies exist. While F-H proposition emphasises the empirical association between savings and investment, no consensus explanation from the literature has emerged about the link or its direction. For India, there are only three known studies that investigate the relationship between savings and investment. Sinha (2002) and Seshaiah and Sriyval (2005) both use the Johansen technique to test for cointegration between savings and investment; while Verma (2007) uses the Autoregressive Distributed Lag procedure. Sinha finds inconclusive results regarding cointegration between the two; Seshaiah and Sriyval confirm a long-run relationship between the two variables, with Granger causality test showing that savings are significantly affecting investment; Verma also finds that savings determine investment. However, Seshaiah and Sriyval do not take into account any structural break whereas Sinha in its estimation has attempted to correct for structural breaks in the data exogenously. Given that Zivot and Andrews (1992) argue that the break points should be viewed as being correlated with the data, selecting the break exogenously could lead to an over rejection of the unit root hypothesis. Further to this, the Indian studies regarding the savings-investment relationship, ignore the effects of foreign capital inflows.

2.5 Foreign Capital Inflows and Growth

Foreign capital inflows are welcomed in developing countries to bridge the gap between domestic savings and domestic investment and therefore to accelerate growth (Chenery and Strout, 1966). North (1956) also finds that foreign capital plays an important role of directing real resources into the needed social overhead investment in sustaining an import surplus of consumer and capital goods that help in the period of development. On the other side, theory contends that foreign capital inflows exert significant negative effects on savings-growth efforts of the recipient country and thus makes the recipient country increasingly dependent on foreign capital on sustaining growth rates (Griffin 1970; Griffin and Enos 1970).

In line with this, Haavelmo (1963) suggests an inverse relationship exists between foreign capital inflows and domestic savings; Raham (1968) and Griffin and Enos (1970) in cross-country applications confirm that domestic savings is inversely associated with foreign inflows; and Weisskopf (1972) who examines the relationship of 44 underdeveloped countries during the post-war period, also suggests that the impact of foreign capital inflows on ex-ante domestic savings is negatively significant. Therefore, foreign savings seem to be a substitute for domestic savings. All of these authors argue that foreign capital inflows, instead of accelerating development, retard it, making the recipient country increasingly dependent on foreign capital. Further to this, Leff (1969) and Griffin (1970) argue that foreign capital could adversely effect the economic growth by substituting domestic savings.

Bosworth, Collins and Reinhart (1999) apply a regression analysis on sample of developing economies to analyse the effectiveness of various forms of foreign capital inflows. They find that while FDI has a strong positive impact on domestic savings and investments, some forms of foreign capital inflows have a negative impact on domestic savings and investment. This is confirmed by Papanek (1973) who analyses 85 developing countries in the 1950s and 1960s. His results show a significant impact of different types of foreign capital on national savings; private investment (-0.6), foreign aid (-1) and other capital inflows (-0.38).

However, Mikesell and Zinser (1973) and Bowles (1987) reject the crowding out effect of domestic savings by foreign capital. Bowles uses time series data from 1960 to 1981 for 20 less developing countries. He claims that

> "in half our sample of 20 countries, no causal relationship, in the sense of Granger, could be inferred between foreign aid and domestic savings. In the remaining countries, causal relationship can be inferred, but the direction of causality is mixed" (p.794).

The Feldstein-Horioka (1980) and Feldstein (1983) studies overwhelmingly reject the hypothesis of perfect capital mobility. Their cross-country evidence show the strong link between domestic savings and investment resulted only in a weak association between foreign investment and domestic saving.

The 1990s saw a renewed interest in the relationship between domestic savings, foreign savings and growth due to the surge in global financial flows especially in the East Asian economies and the developing countries in Latin America. Numerous cross-sectional studies emerged such as Edwards (1995), Held and Uthoff (1995), Scmidt-

Hebbel, Serven and Solimano (1996) and Reinhart and Talvi (1998). All of these studies strongly validate the crowding out effect of domestic savings by external capital inflows. The only difference was the magnitude varies from study to study.

A large amount of literature exists on this topic for Pakistan. Khan and Malik (1992) and Shabbir and Mahmood (1992) find that a foreign capital inflows cause a decline in national savings in Pakistan during the 1959/60 to 1987/88 period. This is in line with Ahmad and Ahmed (2002) who examine the relationship between savings rate and foreign capital inflows using cointegration techniques for Pakistan from 1972-2000. They also find inverse relationship between savings rate and foreign capital inflows. Short-run relationship between the two variables is also found to be negative.

Using a simultaneous equation model on aggregate time series data for Pakistan for the years 1970/71 to 2000/01 for foreign capital inflows, GNP and savings, Yasmin (2005) finds that there is a significant relationship between foreign capital inflows and growth. Further, the study finds the foreign direct investment has contributed positively to the country's economic growth. This result is supported by Mohey-ud-din (2006), who demonstrates that there is a strong positive impact of the foreign capital inflows on the GDP growth in Pakistan for the period 1975-2000. While Shabbir and Mahmood (1992) and Khan and Rahim (1993) conclude that foreign aid has accelerated the rate of growth of GDP in Pakistan.

Kamalankanthan and Laurenceson (2005) find that foreign capital inflows usually only equate to a small share of gross capital formation and hence conclude,

> "Inward FDI is an important vehicle for augmenting the supply of funds for domestic investment thus promoting capital formation in the host country. Inward FDI can stimulate local investment by increasing domestic investment through links in the production chain when foreign

> firms buy locally made inputs or when foreign firms supply or source intermediate inputs to local firms" (p.11).

Prasad, Rajan and Subramanian (2007) do not find any evidence that greater openness and higher capital flows lead to higher growth. The authors imply that a reduced reliance on foreign capital is associated with higher growth as there is a positive correlation between current account balances and growth among non-industrial countries. Alternative specifications also do not find any evidence of an increase in foreign capital inflows directly boosting growth.

On the other hand, Henry (2007) argues that the empirical methodology of most of the existing studies is flawed since these studies attempt to look for permanent effects of capital account liberalization on growth, whereas the theory posits only a temporary impact on the growth rate. Once such a distinction is recognised, empirical evidence suggests that opening the capital account within a given country consistently generates economically large and statistically significant effects, not only on economic growth, but also on the cost of capital and investment. The beneficial impact is, however, dependent upon the approach to the opening of the capital account, in particular, on the policies in regard to liberalization of debt and equity flows. Recent research demonstrates that liberalization of debt flows, particularly the short-term, dollar-denominated debt flows may cause problems. On the other hand, the evidence indicates that countries derive substantial benefits from opening their equity markets to foreign investors (Mohan 2006).

Pradhan (2002) estimates a Cobb-Douglas production function with FDI stocks as additional input variable form 1969-1997. He finds that FDI stocks have no significant impact. Similar qualifications apply to Agrawal (2005) who estimates a fixed effects model based on pooled data for five South Asian countries, among them is India, for the period 1965-1996. He finds that the coefficient of the FDI to GDP is negative, though not significant. However, this approach ignores that FDI is endogenous. Moreover, the inclusion of exports as a right hand side variable may bias the coefficient of the FDI variable downwards to the extent that the growth impact of FDI may run through export promotion.

Using structural cointegration model with VECM for aggregate data from 1974-1996, Chakraborty and Basu (2002) explore the two-way link between FDI and growth in India. They find that causality runs more from GDP to FDI and that in the long-run, FDI is positively related to GDP and openness to trade. Furthermore, they find that FDI plays no significant role in the short-run adjustment process of GDP. In an earlier study, Dua and Rashid (1998) report similar results. Kumar and Pradhan (2002) consider the FDI-growth relationship to be Granger neutral in the case of India as the direction of causation was not pronounced. However, the Granger causality tests presented by Bhat, Sundari and Raj (2004) provide no evidence of causality in either direction.

Paul and Sakthivel (2002) carry out the Johansen's Maximum Likelihood test for cointegration for India from 1950-2000. Their results of the error correction suggest the foreign capital is negatively related to domestic savings. A one percent rise in foreign capital is likely to reduce domestic savings by 0.66 percent subsequently.

Some of the studies referred to above do provide first indications that FDI effects in India have become more favorable in the post-reform period. In the analysis of growth effects in five South Asian countries,[14] the coefficient of the FDI-to-GDP ratio turns positive if the estimate of the production function is restricted to 1990-1996, that is, when economic liberalization gathered momentum in the region (Agrawal 2005).

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[14] Bangladesh, India, Nepal, Pakistan and Sri Lanka.

Similarly, Pradhan (2002) reports more favorable results based on FDI stock data for India when restricting the period of observation to 1986-1997.

Chakraborty and Nunnenkamp (2006) find that for the Indian economy as a whole, FDI stocks and output are cointegrated in the long-run. The authors find that at the aggregate level, Granger causality tests point to feedback effects between FDI and output both in the short and the long-run. However, the impact of output growth in attracting FDI is relatively stronger than that of FDI in inducing economic growth. In other words, they find that causation is mainly running from output growth to FDI stocks.

In summary, it appears that foreign capital inflows has stimulated economic growth on one hand and has substituted for domestic savings on the other hand. All these Indian studies examine the relationship between foreign direct investment and economic growth, with studies accounting for the fact that causation may run both ways but tend to find that higher growth leads to more FDI, rather than vice versa. However, there was an upsurge in FDI in India only after the deregulation of 1991, allowing the evaluation of only a short-term impact on growth. Before deregulation, India received substantial amounts of inflows in terms of foreign aid, commercial borrowing and capital resource from non-resident Indians. To overcome this deficiency of just examining one individual channel, this study will take into account foreign capital inflows since 1950, thus enabling us to determine the long-run relationship with domestic savings, domestic investment and growth.

2.6 Sectoral Savings and Investment

Sections 2.2 to 2.5 discuss the relationships between the aggregate measures of savings, investment and growth. However, there are some studies which disaggregate the data into sectors. The studies which examine the relationship between sectoral savings and investment and economic growth are reviewed below.

Sinha and Sinha (1998) study the relationship among private saving, public saving and economic growth in Mexico. Their results indicate that private saving and GDP have a long-run relationship. The multivariate causality test conducted by the authors indicates evidence of growth of GDP Granger causing the growth of private and public savings. No evidence of reverse causality is found.

Sinha (1999) also examines the relationship between the growth rate of savings and economic growth in Sri Lanka over the period 1950-1994. Using the Johansen-Juselius cointegration framework, he explores the long-run relationship between gross domestic savings and GDP as well as gross domestic private savings and GDP. The study indicates that the causality is from growth rates of gross domestic savings and gross domestic private savings to economic growth rate. Moreover, Sinha (1996) and Sinha (2000) did similar studies in Pakistan and the Philippines. He once again finds causality running from economic growth rate to growth rate of domestic savings.

Mavrotas and Kelly (2001) use the Toda and Yamamoto (1995) method to test for Granger causality using data from India and Sri Lanka. The relationship between GDP and private savings is examined and they find no causality between GDP and private savings in India. However, they find bi-directional causality exists for Sri Lanka.

The direction of association between saving and growth in South Africa over the period 1946-1992 using the Johansen VECM estimation technique is examined by Romm (2005). He not only finds that private savings rate has a direct effect on growth, but also finds that growth has a positive effect on private savings.

Sajid and Sarfraz (2008) examine savings and economic growth in Pakistan using quarterly data for the period 1973:1-2003:4 using the cointegration and the vector error correction techniques. Their cointegration results indicate a long-run equilibrium relationship between different measures of savings (private and public) and the level of output. The results of the VECM suggest uni-directional long-run causality from public savings to both measures of output (GNP and GDP) and from private savings to GNP.

Further to Feldstein and Horioka (1980) regressing on gross savings and investment, they in another part of the article, also regress the investment rate on three different types of saving rates, namely, household saving rate, corporate saving rate and the government saving rate. When the dependent variable used is either total investment rate or the private investment rate, there are no significant differences in the coefficients on the three different types of saving rates. However, when the dependent variable is corporate investment rate, then the coefficient on the corporate saving rate is found to be much more significant than the coefficients of either the household saving rate or the government saving rate. Most subsequent studies, however, do not distinguish between these three different types of saving.

The studies of Mühleisen's (1997), Sandilands and Chandra (2003), Saggar (2003), Verma and Wilson (2004), Verma and Wilson (2005) and Sinha and Sinha (2007) all examine the relationship between either sectoral savings or sectoral investment or both and economic growth in India.[15]

Mühleisen (1997) discusses trends in Indian savings behaviour and reviews policy options to increase domestic savings. He conducts Granger causality tests by running bivariate VARs on the growth in real GDP and the levels of total, public and private savings rates for the Indian economy from 1950/51 to 1994/95. Whilst these tests indicate there is significant causality from growth to savings, they consistently reject

15 The studies by Verma and Wilson (2004) and Verma and Wilson (2005) are studies undertaken by the author with her co-supervisor, during her PhD candidature. Both the studies are earlier work, which arose from this thesis.

causality from savings to growth for all forms of savings. Mühleisen also states that this outcome is robust with respect to variations in the VAR lags, the choice of growth variable and other forms of savings.

Saggar (2003) extends Mühleisen's (1997) period to 2000/01 in order to analyse the consequences of India's financial reforms in the 1990s. Saggar estimates bivariate VARs between the log of real GDP and total, public, private and foreign savings rates. His results support Mühleisen's conclusions in that causality runs from output to savings and not in the opposite direction.[16] In terms of foreign savings, Saggar finds no evidence of causality between the foreign savings rate and the real GDP growth rate, in either direction.

These results are also supported by Sinha and Sinha (2007) using multivariate Granger causality tests to examine the relationships among growth rates of the GDP, household, public and private corporate savings in India. The authors find that there is no causality flowing from the three different components of saving to the growth rate of GDP. However, they find evidence of the Carroll-Weil hypothesis and conclude that "higher saving is the consequence of higher economic growth and not a cause".

With regards to investment, Sandilands and Chandra (2003) investigate the issue of causality between the investment and growth using the OLS model and error correction from 1950 to 1996. Firstly, they find that a long-term relationship does exist between private investment and GDP; and the direction of long-term causality runs from growth of income to growth of private investment. Secondly, they find that there is no long-term relationship between real government investment and real GDP. However, they find by using Granger-causality tests that the growth of government investment has

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[16] Saggar finds in the case of the VAR in levels, that the causality from output to public savings is significant at the five percent level; whereas Mühleisen finds the causality from GDP to savings is significant at the one percent level for all savings rates.

a negative and significant impact on economic growth; while economic growth has a positive impact on the growth of government investment. Overall the authors conclude that “Indian capital accumulation is the result rather than the cause of growth”.

This result differs from Saggar’s (2003) study where he conducts Ganger-causality tests for India from 1950/51 to 2000/01 between real output growth and different measures of investment. He shows that private investment rates Granger cause real GDP growth but finds no evidence of causality from growth in real GDP to the different measures of investment.

Verma and Wilson (2004, 2005) consider per worker household, private corporate and public sector savings and investment, foreign capital inflows and economic growth for India for the period 1950-2001. The estimates in Verma and Wilson (2004) provide evidence that domestic per worker savings are driving per worker private investment in the Indian economy; and that per worker public investment is found to significantly promote per worker GDP, but crowded out some private investment. On the other hand, the study by Verma and Wilson (2005) finds strong direct links from sectoral per worker savings to investment in both the short and long-run; and per worker private corporate and household sector investment are not found to affect output in the short-run or long-run.

Even though, many of the Indian studies examine sectoral savings and investment, these studies provide only a partial analysis of the possible relationships between savings, investment and economic growth. For example, Sinha (1996) 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), Seshaiah 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.

Saggar (2003) and the studies by Verma and Wilson (2004, 2005) perhaps provides the most detail examination of all the three sectors of savings and investment plus foreign savings. But the study by Saggar has three limitations. Firstly, in his econometric estimations, combines household and private corporate savings; secondly, Saggar does not consider the possibility of any structural breaks; and lastly, his estimations, are based on bivariate VARs, thus he is not able to model interactions with more than two macroeconomic variables. Saggar in his study does go further by testing for cointegration between public, private and foreign savings rates, log of real GDP and finance ratio as a financial deepening variable using the Johansen maximum likelihood procedure. However, again this can be criticized on the grounds that the role of investment and the important issue of structural breaks are ignored.

Only the two studies of Verma and Wilson (2004, 2005) explicitly disaggregate the sectors in to three; household, private and public sectors for savings and investment. However, these two studies have three major limitations; firstly they use the Perron and Vogelsang's (1992) unit root test which takes into account only one endogenously determined structural break.[17] Secondly, the two papers by Verma and Wilson can be criticized on the grounds of 'double counting'.[18] Lastly, these two papers fail to consider the interrelationships between the aggregate measures of savings, investment, foreign capital inflows and growth in the Indian economy.

2.7 Summary and Concluding Remarks

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-Swan (1956) models indicate the short-run dynamic effects of savings and investment on growth. Bacha (1990), Jappelli and Pagano (1994) and others also claim 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 growth theories since the mid 1980s, typified by Romer (1986, 1990), Lucas (1988) and Barro (1990) reconfirm the view that the accumulation of capital are the drivers of long-run economic growth.

Understanding the link between saving and growth is relevant not only because it may hold the key to the positive correlation between saving and growth but also for its policy implications: if the central presumption of the Solow type models holds, and saving precedes growth, raising domestic saving should be a high priority to boost

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[17] This is criticized on the grounds that the authors did not use a more recently developed technique; and secondly, the authors restrict the search period for breaks between the years 1985-200 to capture only the financial reforms period.

[18] The estimates of the physical savings in the financial sector are identical to those of the household physical investment, which the authors did not take into account. Details of the data are discussed in chapter three.

economic growth. Alternatively, if higher saving follows higher income, the policy emphasis should be shifted away from saving and concentrated on removing other impediments to growth.

An additional question that needs attention is that empirical estimates of the relationship between these two variables cannot ignore the influence of foreign capital inflows over the saving-growth connection. Although in the long-run, domestic saving must be equal to investment, in the short- to medium-run, saving and investment need not to be equal in an open economy. In the presence of international capital mobility, domestic investment can be financed by domestic or foreign savings through inflows of international capital.

In summary, from the above literature review, no consensus has emerged for the empirical evidence on whether savings, investment or foreign capital inflows do indeed cause economic growth. In many cases, the empirical evidence does not confirm but also contradicts the view that high savings and investment have a favourable effect on growth.

As the literature review indicates, development and growth theories are replete with examples of how savings, investment and foreign capital inflows (particularly foreign direct investment) play a critical role in promoting economic growth. However, these studies have the following limitations which this study tries to overcome:

1. Most Indian studies look at the relationship between savings, investment, foreign capital flows and growth by commonly testing for Granger causality separately between two concerned variables. Bahamini-Oskooe and Alse (1994) criticize studies on Granger causality procedures on the grounds that they do not check the cointegrating properties of the concerned variables. If the variables are cointegrated then the standard causality techniques lead to misleading conclusions

as these tests will miss some of the “forecastibility” which becomes available through the error-correction term.[19] Secondly, the traditional tests use growth of the concerned variables and this is akin to first differencing. This filters out the long-run information. To remedy the situation they recommend cointegration and error-correction modelling to combine the short-term information with the long-run. The studies surveyed above fail to combine the long-run information with short-term dynamics.

2. Only limited Indian studies examine the long-run relationship between these variables. But these studies only look at the relationship between savings and growth, ignoring the important effects of investment; or between investment and growth ignoring the important effects of savings; or between savings and investment; or between foreign direct investment and growth. For example, Seshaiah and Sriyval (2005) only investigate the relationship between savings and investment without taking into account the role played by foreign capital inflows and their relation to growth. Given the important relationship between all of these variables in the theoretical models and hypothesis, examining the relationship between only two variables is not sufficient.

3. Very limited Indian studies take into account structural break(s) when looking at the relationship between the relevant variables.[20] Almost all of the studies either use Dickey-Fuller, Augmented Dickey Fuller or the Phillip-Perron test to examine stationarity of the variables, which have been criticized on the grounds of low

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[19] Standard Granger test do not contain the error-correction term.

[20] Besides for the studies by the author, only Sinha (2002), Sahoo *et al*. (2001) in their analysis take into account one structural break. Sinha (2002) identifies the break exogenously in his examination regarding their relationship between savings and investment; while Sahoo *et al*. (2001) use the Perron (1997) procedure to endogenously determine a single break in their examination regarding their relationship between savings and growth. However, neither of these two studies model interactions with other macro-economic variables.

power and size distortion (Maddala and Kim, 2003). Further to this, these unit root tests do not take into account for structural breaks in the variables which lead to misleading results (Perron, 1989).

4. Only two known Indian studies in their analysis of the relationships between savings, investment and growth relate their results to the popular growth theories of the neoclassical or the endogenous model.[21] Given the importance of the economic relationship between savings, investment and growth in the growth models, it is surprising that most of the studies do not even refer or relate their results to the economic theories of growth.

5. Very limited studies attempt to disaggregate gross domestic savings and investment into the three sectors of household, private corporate and public sectors. The few Indian studies which do disaggregate into sectors do so by combining the household and the private corporate sectors together.

To overcome the above limitations, this study will focus on the key economic interrelationships between gross domestic savings, gross domestic investment, foreign capital inflows and growth in India in light of the popular growth theories and various hypotheses. To fill the gaps, this study will (i) conduct unit root tests which endogenously determines two structural breaks; (ii) using the bounds testing approach to cointegration, test for the long-run relationship among the variables of savings, investment, foreign capital flows and growth taking into account the two relevant structural breaks; and (iii) carry out the long-run and short-run estimates using the

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[21] Besides the two studies by the author with E. Wilson (2004, 2005), the two known studies are by Authorakla and Sen (2000) and Sandilands and Chandra (2003); but they only test for the investment-growth relationship without taking into account the role played by domestic savings or foreign capital inflows.

ARDL approach through the error-correction mechanism. This econometric analysis will enable the distinction between the relevant hypotheses and growth models such as the short-run transitional dynamics of the Solow-Swan model and the long-run (permanent) affect of the endogenous AK model.

Further to this, the measures of savings and investment will be disaggregated into the three sectors of household, private corporate and public sectors and the relationships among these and foreign capital inflows and growth is examined. Overall, this thesis is a comprehensive study which examines all the important variables of savings, investment, foreign capital inflows and growth together for the Indian economy, taking into account potential structural breaks.

However, before any estimation is carried out, it is important to understand the trends and patterns of each of these variables. Therefore, the next chapter provides an overview of savings, investment, foreign capital inflows and growth in India since independence.

CHAPTER THREE

SAVINGS, INVESTMENT, FOREIGN CAPITAL INFLOWS AND GROWTH IN INDIA: TRENDS AND BREAKS 1950-2005

3.1 Introduction

The critical role of savings and investment (domestic and foreign) in the growth process is emphasised in the popular growth models and the important relationships between these variables are discussed in the previous chapter of literature review. This chapter provides an overview of these four variables for India during the post-independence period, from 1950 to 2005 in order to set the stage for the empirical analysis in the upcoming chapters. The chapter discusses the trends, paaterns and breaks of each of the variables of savings, investment, foreign capital inflows and GDP growth in turn to give an overall view of the Indian economy for the last 55 years.

Figure 3.1 shows a consistent increase in GDP since 1950 and it seems that growth has occurred at a faster pace since the 1980s. The growth rate in GDP which was around 3-4 percent since 1950s has consistently exceeded 5 percent throughout the 1980s and 1990s.[1] The growth has furthered increased in early 2000 with the last three years seeing growth averaging 8 percent per annum. As suggested by the growth models and the literature review in chapter two, growth can be the result of increases in savings and investment. The trend in the Indian economy has also been of a consistent increase in gross domestic savings and gross capital formation[2] as seen in Figure 3.1. Though foreign capital inflows have been relatively low compared to gross domestic savings and investment during much of this period, they have increased from less than 5 percent of GDP to over 10 percent since the 1980s and now are contributing over 15 percent of

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[1] The exception was during the adjustment and world recession year of 1991/92.

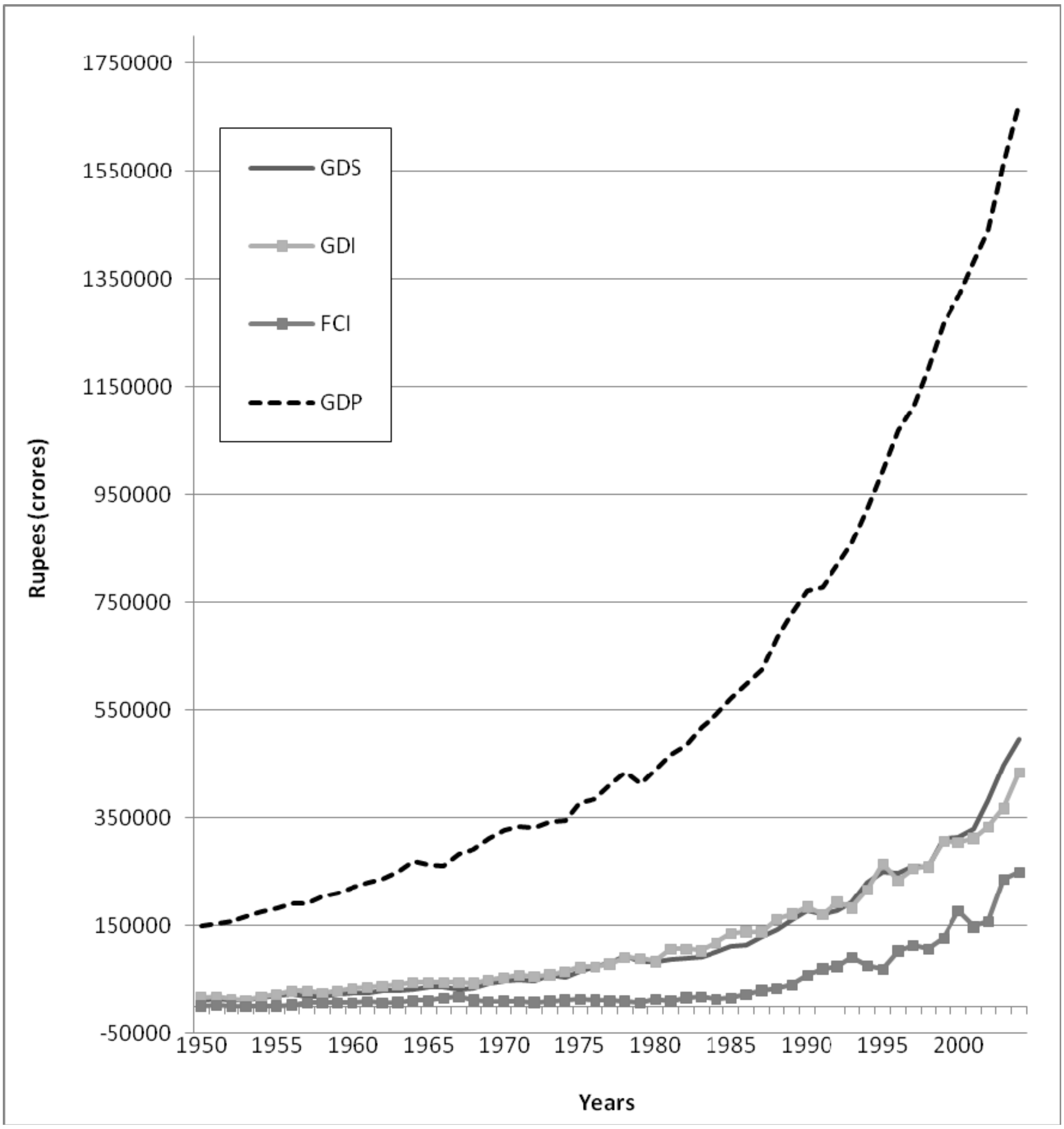
[2] Gross Capital Formation is referred from now on as Gross Domestic Investment.

GDP. Gross domestic savings and investment in India are estimated sector-wise into the three sectors of household, private corporate and public. Significant changes in trends and patterns of the three sectors of savings and investment and in their respective shares to the total domestic savings and investments are quite prominent as the later discussions will indicate.

This chapter is divided into the following eight sections. Section 3.2 gives an overview of GDP growth in India over the last five decades. Sections 3.3 and 3.4 examine the trends and patterns of each of the three sectors for gross domestic savings and gross domestic investment with a summary of the sectoral savings and investment provided in section 3.5. Section 3.6 gives an overview of foreign capital inflows entering the India economy. Section 3.7 provides some concluding remarks with section 3.8 discussing the Indian data.

Figure 3.1: Savings, Investment, Foreign Capital Inflows and Gross Domestic Product in India 1950-2005

Rupees (cores) in constant prices, Base year 1993/94



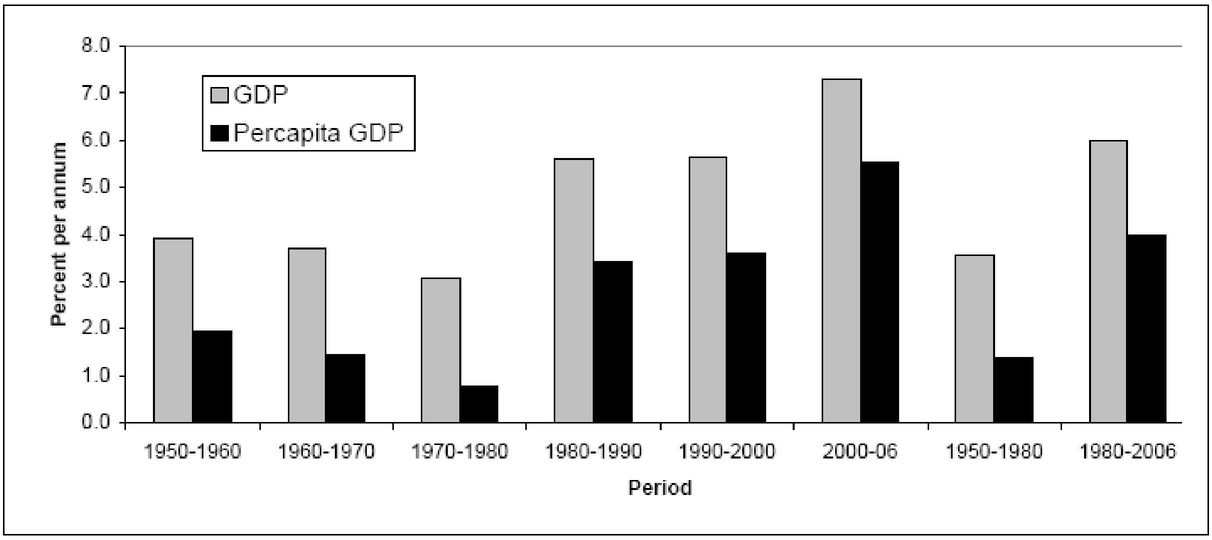
Source: National Accounts Statistics of India (2006), Reserve Bank of India (2006) and Centre of Monitoring India (2006) plus author's calculations.

Note: GDS: Gross domestic savings; GDI: Gross domestic investment; FCI: Foreign capital inflows; GDP: Gross domestic product.

3.2 Gross Domestic Product (GDP)

India's long-term growth and the annual growth rates of real GDP since independence are shown in Figures 3.2 and 3.3. Both figures suggest a continuous increase in real GDP growth over each decade since 1950, except for the decade of 1970. It has been said that there are only two significant phases in India's growth history since 1950:[3] the first phase from 1950 to 1980 and the second phase from 1980 to 2005. The authors have refereed these to the average GDP growth rate that prevailed during the two phases as the 'Hindu Rate of Growth' and the 'Bharatiya Rate of Growth'. The first phase which consists of a period of 30 years from 1950-1980 is characterised by slow growth in both absolute and per capita terms compared to the second phase of 1980-2005.

Figure 3.2: Long-Term Growth in India 1950-2005



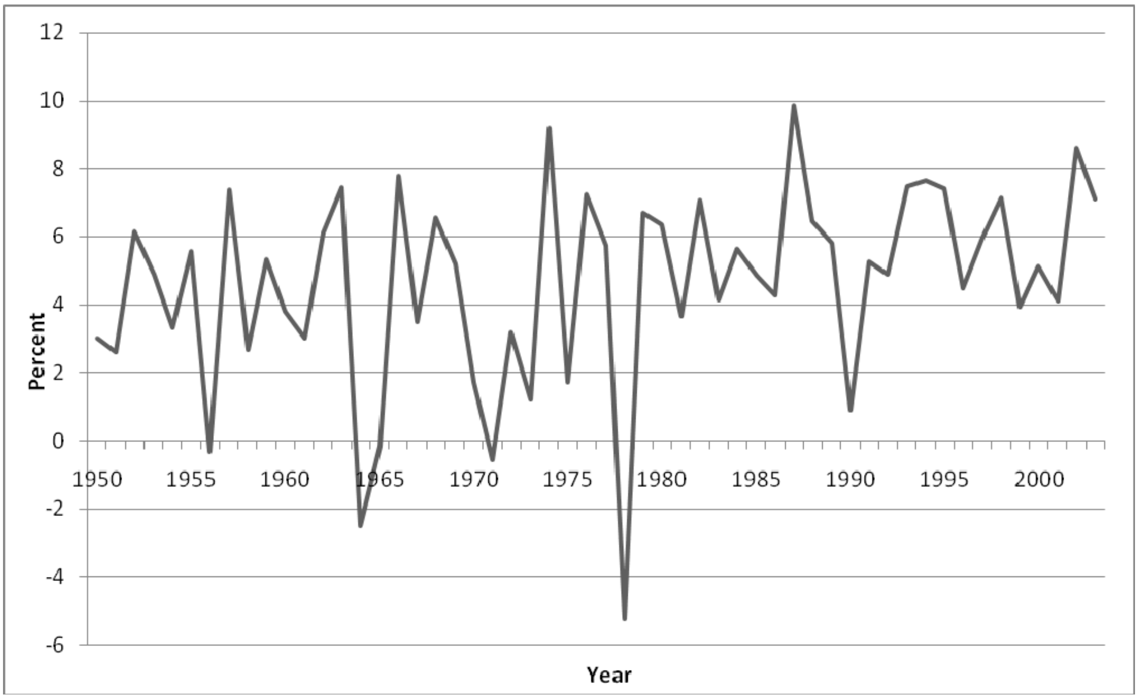
Source: Ahmed and Varshney (2007)

In the first phase, the average rate of growth of the Indian economy was 3.5 percent per annum and the average income, measured by per capita GDP grew at 1.3 percent per annum. The second phase of 1980-2005 is characterised by economic growth averaging

[3] This is further evidence of this as many authors including Wallack (2003), Sinha and Tejani (2004) and Virmani (2005) find that there is a break in growth in India's GDP around 1980.

nearly 6.0 percent per annum and per capita income growth rate more than double at close to 4.0 percent compared to the first phase of 1.3 percent. The second phase is called the 'Bharatiya Rate of Growth' to distinguish it from the 3.5 percent average growth rate during the first phase.

Figure 3.3: India's Annual Growth Rate of Real GDP 1950-2005



Source: Estimated by the author from the Reserve Bank of India (2007) database.

3.2.1 The First Phase of 1950-1980

The first phase is considered as the low growth environment with the average growth rates of 3.6 percent in the 1950s, 4.0 percent in the 1960s and a low average growth rate of 2.9 percent in the 1970s. However, these GDP growth rates are four times greater than the 0.9 percent growth estimated for the first half of the century of the British rule.[4] The growth rates in this phase were reasonably sustained with no extended period of decline. Only in the decade of 1970-1980, did the growth rate dip below 3 percent

[4] The period is from 1900-1946.

causing per capita annual income to virtually stagnate at below 1 percent. Overall, the growth rate for India in the first phase was far below potential and much less than the 7-8 percent achieved by some countries of Latin American and East Asia.

This phase was characterised by the effort to increase the role of the state in the economy. The 1960s saw India fight two wars: one with China in 1962 and with Pakistan in 1965. Two consecutive droughts in the years 1965-1967 resulted in large imports of food and a massive balance of payments crisis emerged in 1966 as the second five year plan of the large investment in heavy industry came to an end. The World Bank and the International Monetary Fund (IMF) assistance were under the condition of devaluation and economic liberalization. The rupee was devalued and the liberalization of import controls was announced, along with an increase in export taxes and decreased export subsidies. However, due to the large opposition and loss of seats in parliament, the liberalization measures were reversed in 1968 by the newly elected Prime Minister, Mrs Gandhi and were in fact intensified later to consolidate power. This period saw the intensification of controls as well as government interventions in agriculture in support of the green revolution through various subsidies and price support.

Mrs Gandhi relied on the major shift towards state control, nationalized major banks, coal mines and oil companies. She imposed tight restrictions on the operations of foreign companies which drove many out of the country, along with restricting investments by large firms to a handful of core sectors. Mrs Gandhi went further by introducing tight ceilings on urban landholdings and effectively outlawed layoff of workers by firms with 100 or more employees under any circumstances. As pointed out by Panagariya (2008), “many of the restrictions during this era proved politically difficult to undo later, and some of them continue to harm growth today”.

Overall, in this phase, investment grew strongly at 6.1 percent per annum by the growth of government fixed investment at 7.2 percent per annum. This phase saw a rapid growth of government consumption of 5.8 percent in contrast to the growth rate of private consumption of a modest 3.2 percent, a rate slower than of GDP. The initial government consumption and investment led to an increase in private consumption, but eventually this resulted in substitution for and crowding out of private consumption and investment. The GDP share of production originating in the public sector increased rapidly over this phase but then eventually fell.

Slow growth resulted in the 1970s despite an impressive savings performance due to extensive controls, inward looking policies and the inefficient public sector. There were other factors which contributed significantly to the low growth of 2.9 percent in the 1970s. These include droughts in 1972 and 1979 and the two oil price shocks of 1973 and 1979. Inflationary pressures in the economy remained acute with the balance of payments situation deteriorating significantly. Inflation rate reached unacceptable levels to 23 percent in 1973/74 while the government increasingly used the banking sector to finance its own deficits. These impacts affected the Indian economy negatively; evident in Figure 3.3 with growth rates of GDP reaching all time lows and negative in the late 1970s.

3.2.2 The Second Phase of 1980-2005

The mid-eighties saw the then Prime Minster, Mr. Rajiv Gandhi wanting to move the economy in a different direction. To the certain extent, this is when the opening of the economy started to take place.[5] The diversification phase which occurred under Rajiv Gandhi's tenure resulted in reforms in the money and treasury bills markets but little progress towards deregulation of capital and credit markets. However, Mr. Gandhi did not succeed due to the lack of support within his own party.

With the population growth declining from around 2.2 percent per year during 1950-1980 to 2 percent per year during 1980-1990, the rate of growth per capita of real GDP doubled in the eighties as compared to the first phase of 1950-1980. However, this growth was unsustainable as this resulted in debt-led growth. It ended in macroeconomic and balance of payments crisis in 1991. At the same time the gulf war broke out and oil prices escalated. Once again as it did in 1966, India went to the World Bank and the IMF for help. The conditions for assistance were the same as before, devaluation and liberalization, which the Indian government initiated. The Government undertook systematic reforms which included the financial sector reforms, devaluation of the Indian rupee, elimination of the import licensing and policies to actively seek foreign direct investment. This saw the growth of GDP reach a peak of 7.8 percent in 1996/97 and has averaged 8 percent per annum in the three years ending 2005/06. During the second phase from 1980 to 2005, economic growth averaged over 5.7 percent per annum and as a result, this phase is considered as a phase of market experimentation.

Overall, this phase saw the rate of growth of government consumption increase to 6.3 percent from 5.8 percent in the first phase and the private consumption also accelerating to 4.7 percent per annum from 3.2 in the first phase. However, investment growth remained virtually unchanged at 6.3 percent per annum relative to 6.1 percent

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[5] Unlike popular perception, policy movement towards less restrictive and freer markets did not begin in 1991. 1991 was the accumulation of process that commenced during the term of Rajiv Gandhi (1985-1989).

earlier. The fact that growth increased despite this small change is a sign that efficiency of investment must have improved in this phase. This is supported by notable growth in investment of machinery to 8.9 percent per annum in this phase compared to a 6.6 percent per annum in the first phase. The rate of growth of private fixed investment also increased from 3.6 percent in the first phase to 8.5 percent in the market reform phase.

3.2.3 Savings, Investment and Foreign Capital Inflows

From the growth models perceptive, it can be said that the upward trend in domestic growth over the longer term and indeed in the short-run in India is associated with the consistent trends of increasing share of domestic savings and investment over the decades as seen in Figure 3.4. Figures 3.4 and 3.5 indicate that gross domestic saving and investment as well as foreign capital inflows have consistently increased as a percentage of GDP over the period of study. Gross domestic savings and gross domestic investment have increased continuously from an average of 9.6 percent and 12.5 percent of GDP respectively during the 1950s to the 23 percent range in the 1990s. Currently both gross domestic savings and investment are contributing close to 30 percent of GDP. Foreign capital inflows which were less than 2 percent of GDP in 1950s, reached a high of 6.5 percent during 1965-67,[6] thereby remaining at below 4 percent till the late 1980s. In the 1990s, foreign capital inflows averaged 9 percent of GDP and currently are contributing over 15 percent of GDP to the Indian economy.

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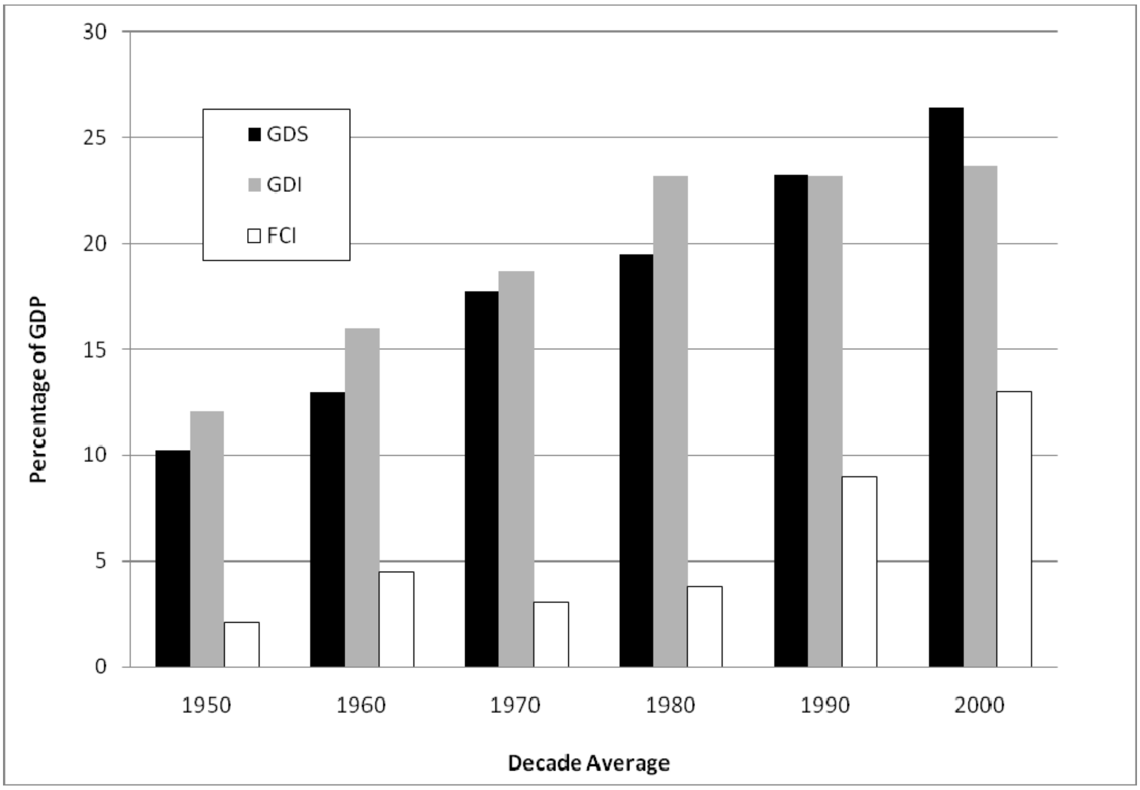
6 This is the same period as the two consecutive droughts.

Figure 3.4: Trends in Savings, Investment and Foreign Capital Inflows in India 1950-2005

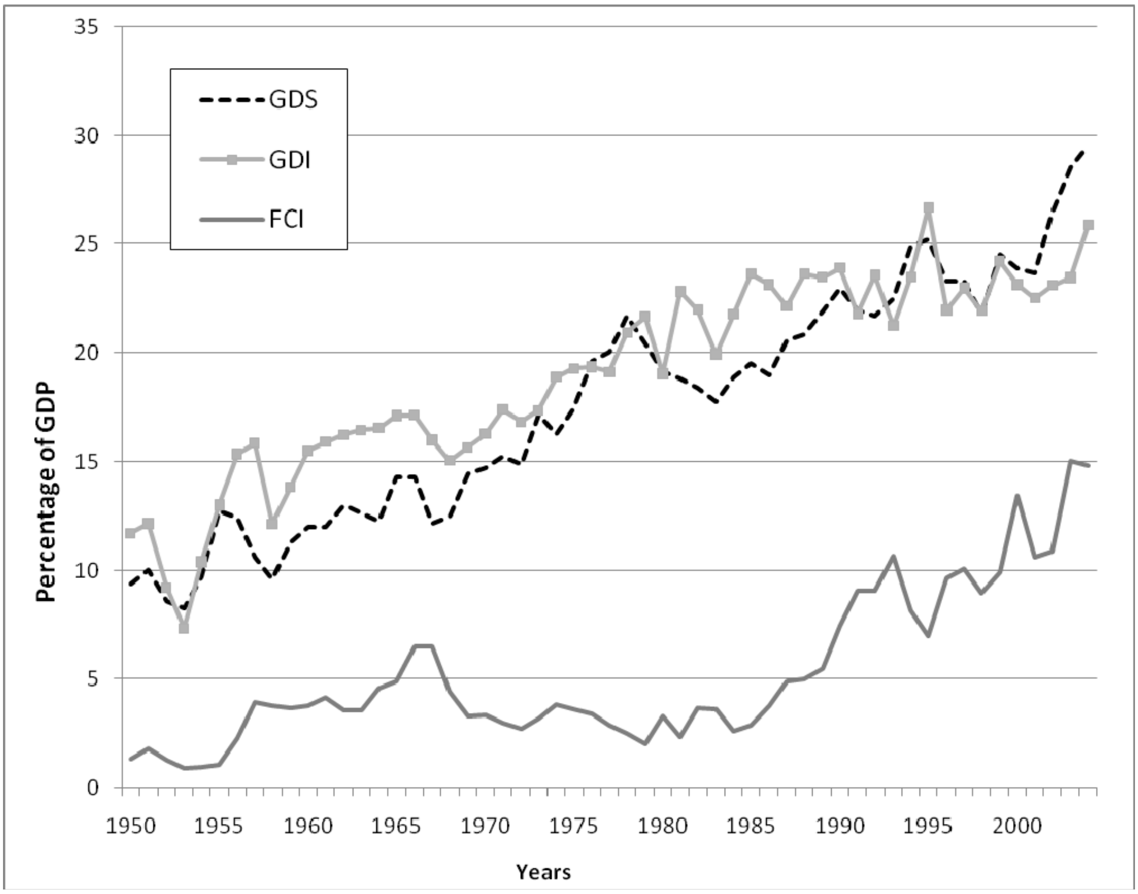


Source: Estimated by the author from the National Accounts Statistics of India (2006), Centre of Monitoring Indian Economy (2006) and author's calculations.

Note: 2000 refers to the average of 2000-2005. GDS: Gross domestic savings; GDI: Gross domestic investment; FCI: Foreign capital inflows.

Figure 3.5: Savings, Investment and Foreign Capital Inflows in India 1950-2005

Percentage of GDP



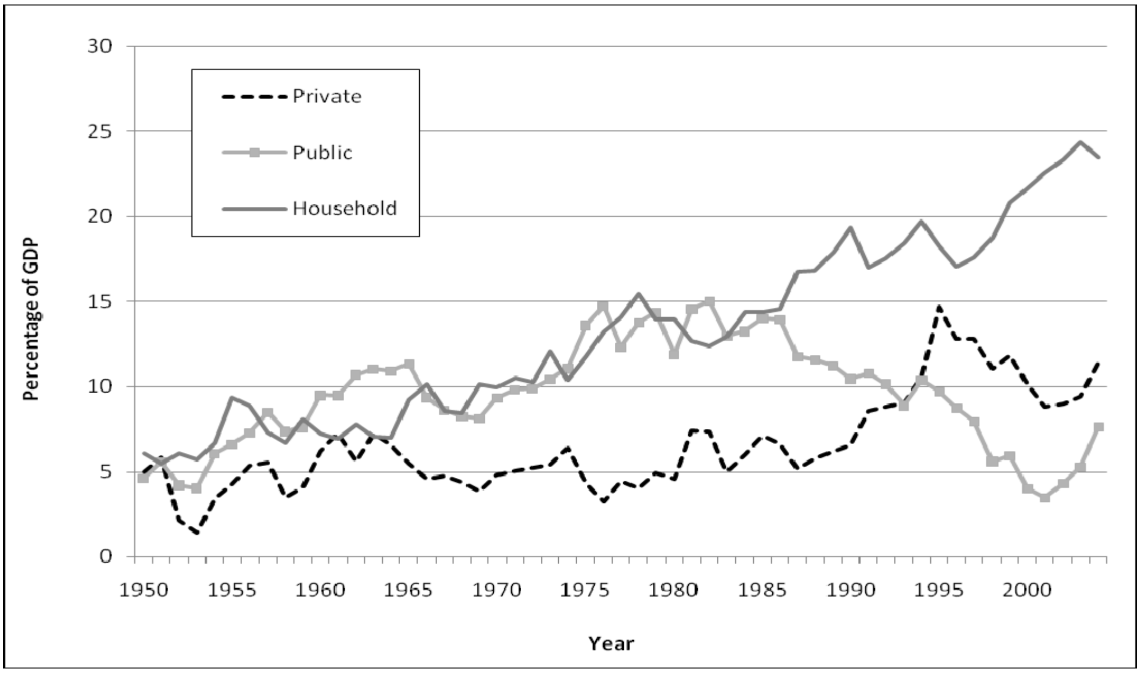
Source: National Accounts Statistics of India (2006) and the Centre of Monitoring Indian Economy (2006) and author's calculations.

Note: GDS: Gross domestic savings; GDI: Gross domestic capital formation; FCI: Foreign capital inflows.

Given this close relationship between gross domestic savings and gross domestic investment in India, it becomes important to examine the share of each of the three sectors of the Indian economy; namely household, private corporate and the public sectors. Since independence, both the public and the private sectors have shown considerable fluctuations over the years, while the household sector only shows a consistent increase. Figure 3.6 shows that the private sector share in the Indian economy was low ranging from an average of 4.1 percent of GDP in the 1950s to 5.6 percent in the 1960s to 4.8 percent in the 1970s. It was in the 1980s that the private sector share started to increase; and in the 1990 it averaged over 10 percent of GDP. At the same time, the public sector which was averaging at nearly 12 and 13 percent in the 1970s and 1980s respectively fell to an average of below 9 percent in the 1990s. Currently, the public sector share is on average contributing over 5 percent of GDP. Only the household sector has continuously increased throughout the period under study. The household sector share as a percentage of GDP was a low 7 percent in the 1950s, increasing to 15 percent in the 1980s and now contributes to around 25 percent of GDP. Subsequently, the relationships between each of the three sectors of savings and investment are examined in detail below.

Figure 3.6: Household, Private and Public Sectors Share in the Indian Economy

Percentage of GDP



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

3.3 Gross Domestic Savings

Gross domestic savings in India has shown a steady and substantial rise from the 1950s where this growing trend in the savings rate has increased from a low of 10 percent of GDP in the early 1950s to 17 percent in the early 1970s, then to over 25 percent by the mid-1990s and now nearly 30 percent of GDP (see Figure 3.5).

The overall savings rate in India took a sharp upturn in the 1970s, marginally increased thereafter and then again took an upturn from the mid-1980s. The first upturn in the 1970s can be attributed to the rapid expansion of banks, reaching out to all areas of India, after the nationalization of 14 banks in 1969. This contributed to an increase in savings by Indians as a result of lowering the transaction cost of saving. The 1970s was also characterised by a jump in remittances from the Indian expatriates from the Gulf countries, which also partially contributed to the increase in savings. Lastly, the Green Revolution in the 1967-1978 period substantially contributed to increase in rural incomes and this undeniably had a spillover effect to increase savings.

The second expansion from the mid-1980s to present can be attributed to the initial economic reforms initiated in 1985 by then Prime Minister Rajiv Gandhi and thereafter the financial deregulation in 1991. 1984/85 to 1995/96 saw a remarkable phase of growth of the Indian economy with the average real GDP growth of 5.6 percent per annum. Consistent with strong relationship between savings and growth discussed in chapter two, this period also saw the savings rate increase from 18 percent of GDP to over 25 percent of GDP as shown in Figure 3.5. This jump has been substantiated by the hypotheses that, in the long-run, economic liberalization did promote savings through economic growth (Mahambare and Balasubramanyam, 2000).

Although average savings rates have been higher in the 1990s than the 1980s (Figure 3.5), Saggar (2003) rightly points out that the underlying linear trend has been fairly flat in the ten years since reform. This is in contrast to the upward sloping linear trend in the pre-reform period of 1980/81 to 1990/91. The rise in the savings rates in the 1990s over the 1980s has been magnified by the fact that gross domestic savings rate rates in the 1980s were lowered by an unprecedented five year decline in gross and net saving rates during 1979/80 to 1983/84, due to the drought in 1979. Savings rates however did improve from 1984/85 to 1990/91. The savings again dropped in the early 1990s at the onset of the external balance of payment crisis in 1991/1992 but then started to recover from 1993/94, indicating that the initial gains on the savings front after the financial reforms appear to have been lost. The failure to sustain the gains made in aggregate savings in the reform period is largely due to the dismal showing in public sector savings. However, the loss of the public sector share in the 1980s was more than compensated by higher savings in both the household and private corporate sectors.

The proportion of the three components of the national saving throws more light on the structure of savings in India. Table 3.1 given below shows the decade averages regarding the percentage wise savings of each of the three sectors to the Indian economy. The table and Figure 3.7 reveal that household sector savings has accounted for the lion's share of total domestic saving rate since independence. The table further shows a decline in the public sector saving rate reaching negative rates in 1998/99 while the private corporate savings rate improved.

Table 3.1: Average Shares of Gross Domestic Saving

Percent

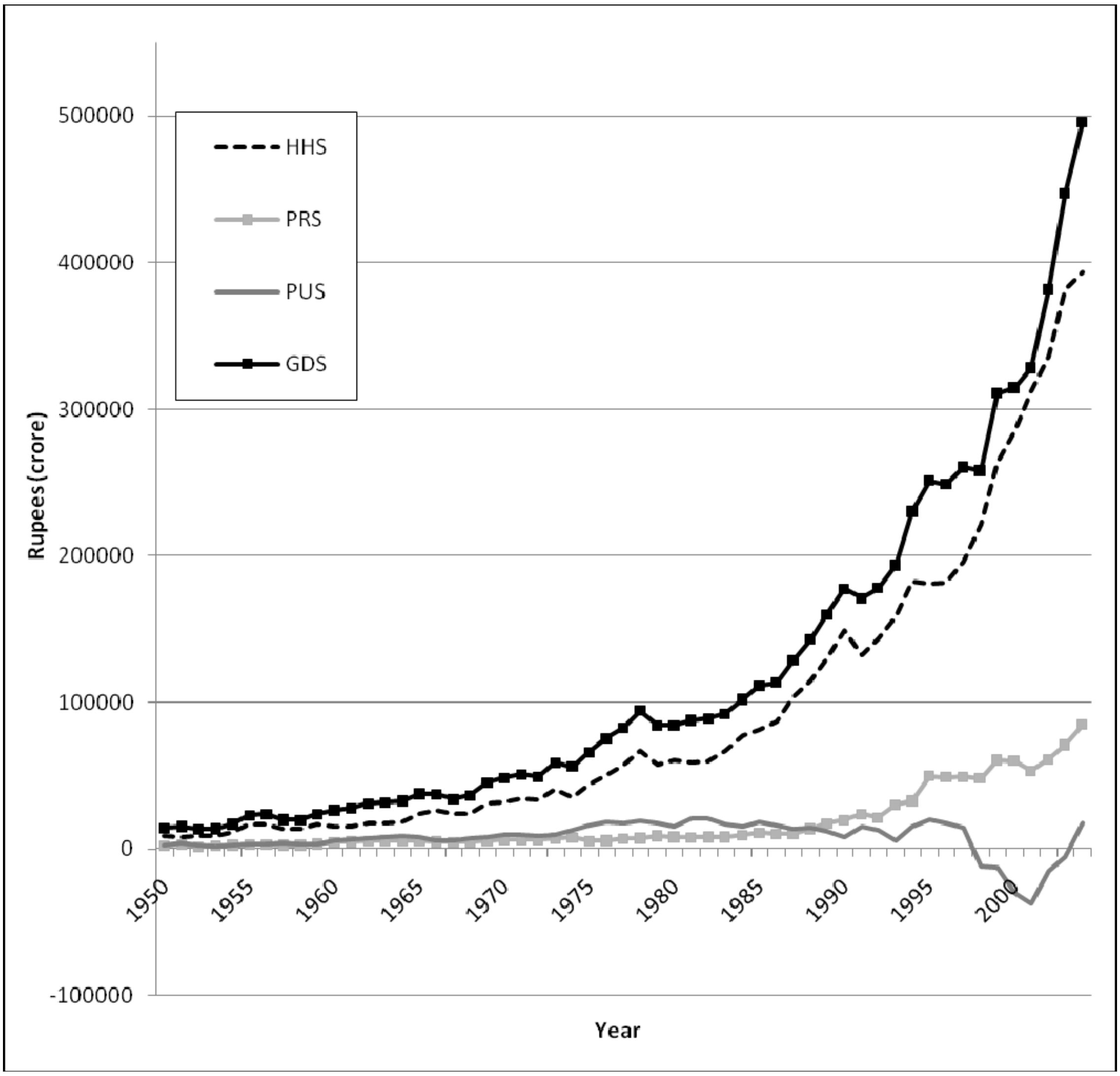
Period	Household Savings	Private Savings	Public Savings
1950/51-1959/60	68.13	14.38	17.49
1960/61-1969/70	63.34	15.15	21.50
1970/71-1979/80	68.34	10.78	20.87
1980/81-1989/90	74.94	9.25	15.87
1990/91-1999/2000	79.44	16.29	4.27
2000/01-2004/05	87.75	16.38	-4.58

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

As mentioned earlier, gross domestic savings and investment in India is estimated sector-wise into household, private corporate and public sectors. For the public and private corporate sectors, based on their published accounts; and for the household sector, as a residual in regard to both its saving in physical assets and financial assets. The private corporate sector includes joint stock companies in the private business sector, industrial credit and investment corporation and cooperative institutions. Savings of the corporate sector is represented by the retained earnings of this sector. The government sector consists of the central and state government, the local authorities and various government and department undertakings; hence the saving of this sector relates to the budgetary surplus on current account of the central government, state government, local authorities, the current surplus of various government departments and retained projects of government undertakings. The trends and patterns of each of the three sectors are therefore reviewed in turn below.

Figure 3.7: 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.

3.3.1 Household Sector Savings

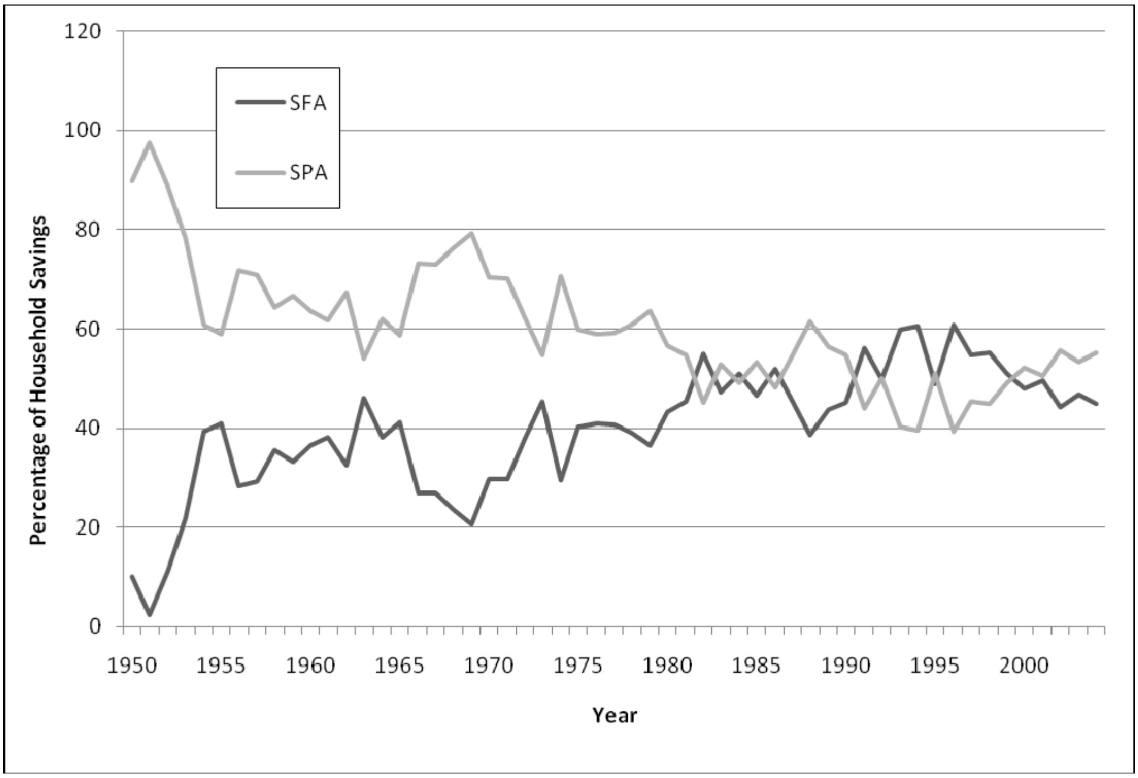
The household sector comprises of individual, non-corporate business and private collectives like temples, educational institutions and charitable foundations. The savings of the household sector consists of savings in the form of financial assets and physical assets. Financial assets comprises of currency, net deposits, shares and debentures, net claim on government in the form of small saving, investment in central and state government securities, life insurance fund and pension and provident fund. The savings of the household sector in the form of physical assets consist of investment in land, building, gold and jewellery, business and industry, livestock and consumer durables. Throughout the post-independence period (Table 3.1 and Figure 3.7), the household sector has accounted for the major share of total domestic savings rate. In fact, since 1991, the share of total household savings to total savings has been more than three quarters.

Figure 3.8 indicates that savings in physical assets constituted the largest portion of household savings compared to savings financial assets since the 1950s. The rural households were keen on acquiring farm assets, but the portfolio of urban households constituted consumer durables, gold, jewellery and house property (MIMAP survey, 1994/95).[7] The cumulative effect in raising the financial savings in the country according to Reserve Bank of India (RBI) (1998) is due to a number of factors. These include the development of the financial infrastructure, strengthening of the cooperative credit institutions, taking over of the banks associated with the former princely states and transferring them into the public sector (1954), strengthening and consolidation of the banking system (1950s and 1960s), nationalization of the insurance companies, establishment of unit trust of India, major term lending institutions for agriculture and industry (1964) and nationalization of the major scheduled commercial banks (1969/1970).

[7] Micro Impact of Macro and Adjustment Policies in India (MIMAP).

Figure 3.8: Components of Household Savings

Percentage



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

Note: SFA: Savings in financial assets; SPA: Savings in physical assets.

The share of financial saving in total household savings increased from 21 percent in 1970 to 45 percent in 1991 and then reaching a peak of 61 percent in 1997. During the same period, there has been a downward drift in the share of physical saving from 79 percent in 1970 to 39 percent in 1991. However, since then the trend towards savings in physical assets took an upturn again, now contributing 55 percent of total household savings as compared to 45 percent of financial assets (Figure 3.8). The change occurred with the introduction of new private sector banks in recent years, who introduced retail credit for housing. This was followed by the public sector. Further to this, a shift to savings in physical assets shows that at present households savings in the system are been driven not by current incomes but on expected future cash flows.

The gains in household financial saving in the 1990s have come about from net deposits, shares and debentures and life fund. Bank deposits turned out to be the most popular abode of saving whose share improved from an 8.1 percent in early seventies to 16.3 percent in late nineties. During the same period the share of shares and debentures also increased from just 0.8 percent to 3.9 percent in late nineties. Similarly, the share of contractual savings increased during the same period from 10.3 percent to 14.5 percent of the total gross domestic saving. As seen from Table 3.2, bank deposits have increased from 0.3 per cent in the 1950/51 to 3.5 percent of GDP in the 200/01. Net claim on government that includes small savings instruments witnessed a jump from 0.3 percent in 1960/61 to 1.8 percent of GDP in 200/01. Contractual saving rates in the form of pension and provident funds continued its step-wise growth to 2.3 percent of GDP in 2000/01 compared with 1.1 percent in 1970/71 while the currency holdings as a percentage of GDP declined marginally from 1.1 percent in 1980/81 to 0.7 percent in 2000/01.

Table 3.2: Component of Savings in Financial Assets

Percentage of GDP

Years	Currency	Net Deposits	Shares and Debentures	Net claim on Government	Life Insurance Funds	Provident and Pension Funds
1950/51	0.8	0.3	0.5	-0.8	0.2	0.2
1960/61	0.8	0.1	0.4	0.3	0.3	0.7
1970/71	0.8	0.6	0.2	0.0	0.4	1.1
1980/81	1.1	2.1	0.3	0.4	0.6	1.5
1990/91	1.1	3.0	1.5	1.3	0.9	2.0
2000/01	0.7	3.5	0.5	1.8	1.6	2.3

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

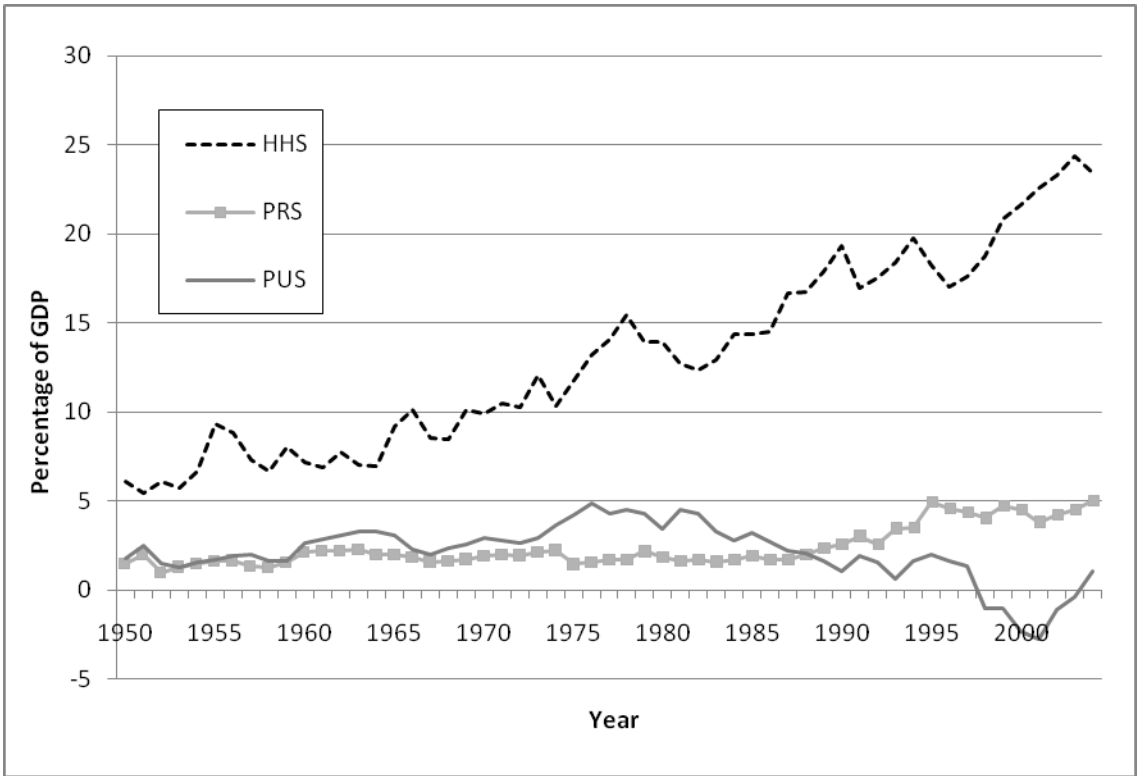
3.3.2 Private Corporate Sector Savings

The components of the private corporate savings sector include joint stock, non-financial and financial companies, and cooperative banks and societies. There has been growth in private corporate savings over the past two decades after the decline from mid-1960s to 1980. Private corporate saving rate which hovered between 0.6 percent and 2.0 percent of GDP during 1950/51 to 1988/89 began showing an upward trend thereafter peaking at 5.0 percent of GDP in 1995/96 (Figure 3.9). Since then the private corporate saving declined to below 4.0 percent of GDP, before improving to 4.5 percent in 2003/04. On the average basis, private corporate savings rate at 3.8 percent in the ten years of reforms starting 1991/92 was more than double that of the 1.8 percent in the 1980s. The private sector now contributes 17 percent of gross domestic savings as opposed to only 9 percent in 1980/81 (Table 3.1).

Chakarvarty (1990) points that the low private corporate saving rate during eighties was due to the typical behaviour of the India corporate sector relying more on borrowed funds as against owned funds. However, private saving has shown a steady increase over the last two decades due to liberalized environment with increased internal and foreign competition as well as foreign direct investment in various sectors; the profits of corporate sector have been high leading to increased saving.

Figure 3.9: Sector-Wise Savings

Percentage of GDP



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

Non-financial stock companies contribute the bulk of private corporate savings, accounting for 85 percent of the total private corporate savings. The companies improved their savings rate from 1.4 percent in 1980/81 to 4 percent of GDP in 2000/01 as can be see from Table 3.3. Cooperative banks and credit societies contribution to savings as a percentage of GDP is low but has remained steady at 0.2 percent since the 1980s. Overall, the private corporate savings has shown a steady increase over the last twenty years, although it remains only at about 5 percent of GDP.

Table 3.3: Private Savings and its Component

Percentage of GDP

Years	Joint Stock	Non-Financial	Financial Companies	Cooperative Banks and Societies
1970/71	1.3	1.3	0.0	0.1
1980/81	1.5	1.4	0.0	0.2
1990/91	2.4	2.3	0.2	0.2
2000/01	4.0	4.0	0.0	0.2

Source: National Accounts Statistics of India (2006).

3.3.3 Public Sector Savings

Public sector savings rate steadily increased from a low of 1.7 percent in the 1950s to 4.5 percent of GDP in 1980/81. Since then the public savings have shown a declining trend. As can be seen from Figure 3.9, there seems to be a break around 1998 when public sector savings reached negative figures before improving again in early 2000. The public sector savings is split into (i) public authorities consisting of government administration and departmental enterprises; and (ii) non-departmental enterprises which include government companies and statutory corporations including port trusts. The share of the public savings to total savings declined from a peak of 27 percent in 1964 to a mere 7 percent in the mid-1990s, contributing negatively since 1998/99. The reason for the decline in public savings since the 1980s can be attributed to the sharp deterioration in the savings of the public authorities as can be seen from Figure 3.10. It is the component of the government administration department that has seen a sharp decline since 1986 (see Table 3.4 and Figure 3.10). According to Virmani (1990), a decline in public savings was attributed to poor performance of government non-statutory corporations, mounting government employment and wage bill and rising trend in government purchases of goods and services. However, the public sector has seen a steady improvement in the savings of the non-departmental enterprises. Large proportion of the latter could be explained by the returns to the public sector from its near monopoly over the financial resources of the organised economy and the oil industry (Athukorala and Sen, 2002).

Gross savings of the government administration as a percentage of GDP declined from the peak of 2.5 percent in 1978/79 to a low of -2.5 percent in 1990/91 when central revenue deficit touched 3.3 percent of GDP. Overall, total public saving weakened in the early 1990s to reach a low of 0.6 percent of GDP in 1993/94, a significant reduction compared with the levels of 4.5 percent of GDP seen in the early 1980s.

Table 3.4: Public Savings and its Component

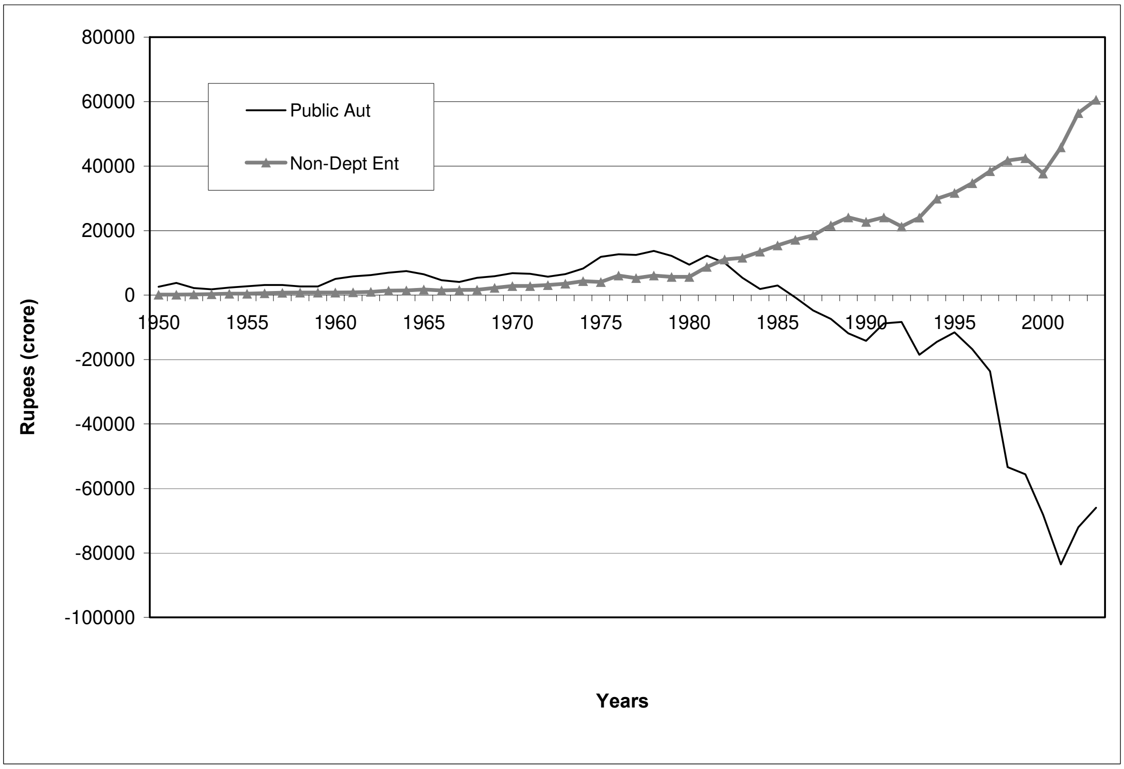
Percentage of GDP

Years	Government Administration	Departmental Enterprises	Non-departmental Enterprises	Total public Sector
1950/51			0.1	1.8
1960/61			0.4	2.6
1970/71	1.5	0.6	0.9	2.9
1980/81	2.0	0.2	1.3	3.4
1990/91	-2.5	0.6	2.9	1.1
2000/01	-5.4	0.2	2.9	-2.3

Source: National Accounts Statistics of India (2006). Government administration and departmental enterprise figures are only available from 1970s.

Figure 3.10: Public Sector Savings in India

Rupees (crore) in constant prices



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

Note: Public Auth: Public Authorities; Non-Dept Ent: Non-Departmental Enterprises.

Overall, not only does the household sector saving provides the bulk of national savings in India; the improvement in the Indian economy's savings rate is almost wholly a product of an increase in savings by the household sector. This further supported by Mohan (2008) who points out that "a remarkable feature of the macroeconomic story since independence has been the continuous rise in the household savings over the decades".

Over the long-term, the household savings has continually increased, the public sector saving rate declined while the private corporate saving rates have accelerated in the post-reform period. The share of private corporate saving to total national saving increased from 8 percent in 1980/81 to over 17 percent in 1998/99 while the share of public saving has declined from 16 percent to negative figures in the same period. The declining trend of public sector saving is attributable to the negative saving of government administration. Despite this overwhelmingly important contribution of the household sector to national savings, the literature review in chapter two indicates that Indian studies combine the household and the private savings together in their estimations.

3.4 Gross Domestic Investment

The gross domestic investment in India has shown an increasing trend since 1950s (Figure 3.5); increasing from 10.5 percent of GDP in 1950/51 to around 19 percent in the mid-1970s, and then to over 26 percent by mid-1990, before dipping slightly to 23 percent in the early years of 2000. Currently national investment contributes close to 30 percent of GDP. As can be seen from Table 3.5 and Figure 3.11 the relative contributions of the household, private and public sectors to gross domestic investment has changed considerably in the period under consideration. The overall increasing trend in investment, expressed as a percent of GDP, has been driven by the household and public sectors since 1950. The household investment contributed to an average of 44 percent to gross domestic investment in 1950s before dipping to below 35 percent in decade of 1960-1970 (Table 3.5). Since then, there has been steady increase in the contribution to investment from the household sector which competed with the public sector, before taking off again in the mid-1990s. The household sector now contributes to over 50 percent to the total investment while the private corporate and the public sectors contribute 24 and 27 percent respectively.

Table 3.5: Average Shares of Gross Domestic Investment

Percent

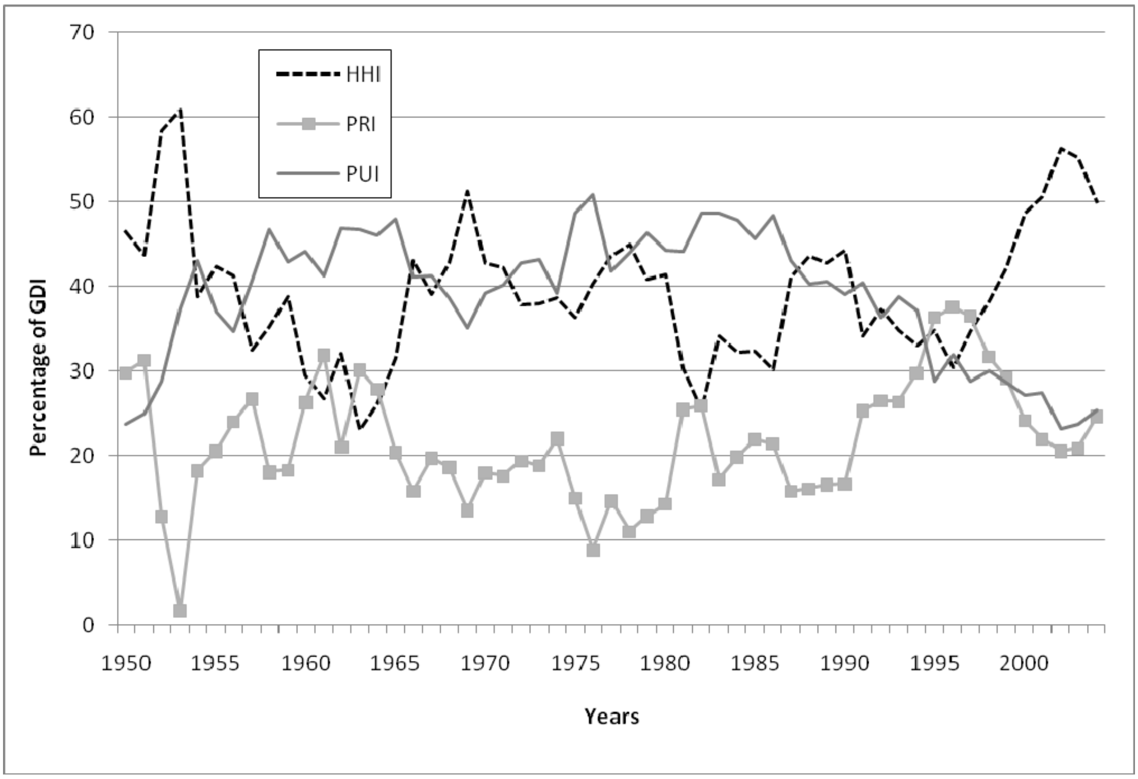
Period	Household Investment	Private Investment	Public Investment
1950/51-1959/60	43.84	20.17	35.99
1960/61-1969/70	34.55	22.55	42.90
1970/71-1979/80	40.58	15.84	43.57
1980/81-1989/90	35.40	19.48	45.12
1990/91-1999/2000	36.41	26.62	33.97
2000/01-2004/05	52.15	22.48	25.37

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

Since independence, India focused on improving economic growth through a state-centrally planned growth strategy of rapid industrialization through capital-intensive industries. Not only did the government invest in the traditional areas of public investment, such as the infrastructure, it also competed with in private sector in commercial and industrial activities. As a result of this growth strategy, the Indian economy grew. However, this public sector led growth came at the cost of a large budget deficits financed by domestic borrowing. The government sector borrowed large amounts which came primarily from the private sector. The government borrowing from the private sector resulted in fewer funds being available for private sector investment. Therefore, the government investment and private investment moved in opposite directions for a long-time. As can be from Figure 3.11, during 1969-1987, while government investment grew, the private investment remained fairly stagnant. On the other hand, during 1987-2005, the government investment remained stable, allowing the private investment to grow. Given this, it appears that crowding out between the public and private sector investment has played a major role in the Indian economy.

Therefore it becomes important to examine the interrelationships between the three sectors of investment, each of them are reviewed in turn below.

Figure 3.11: Components of Gross Domestic Investment



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

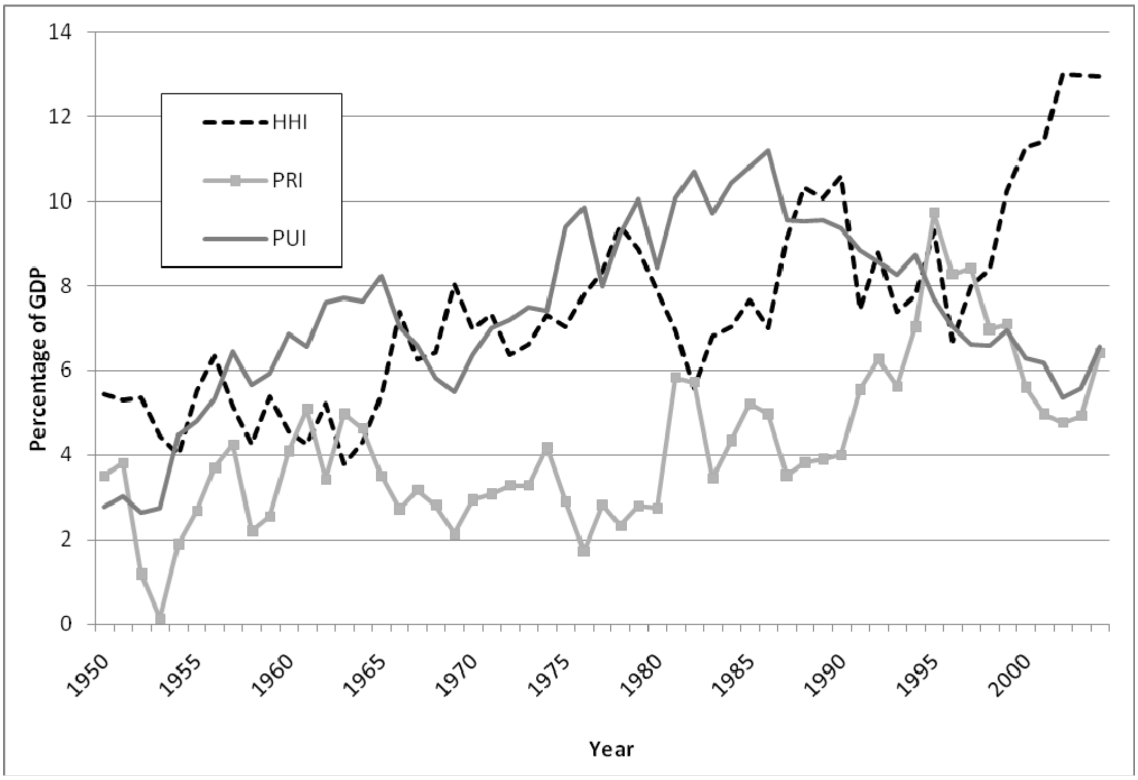
Note: HHI: Household investment; PRI: Private investment; PUI: Public investment; GDI: Gross Domestic Investment.

3.4.1 Household Sector Investment

Household investment contributed to 46 percent of total gross domestic investment in 1950 and has remained steady at this rate except in the early 1960 where it fell to 30 percent (Table 3.5). With regards to the percentage of GDP, household investment was 5.5 percent of GDP in 1950 and then fell to 4.6 percent in 1960. Since then it has seen a steady rise, now contributing to over 12 percent of GDP (Figure 3.12). It has been said that the "hero of the reforms with respect to investment at any rate has been the Indian household sector" (Balakrishnan, 2005). Not only has household investment grown, but its share of capital formation relative to the other two sectors has increased substantially since the nineties. In marked contrast to both the private and public sectors, the household sector has registered a steady increase in investment. From Figure 3.12, a break in the household sector can be considered to have occurred around 1990 which saw a fall in household sector investment due to the balance of payment crisis in 1990; however by the end of the decade, household investment is at least fifty percent higher than 1991.

Figure 3.12: Sector-Wise Investment and Total Gross Domestic Investment

Percentage of GDP



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.

3.4.2 Private Corporate Sector Investment

Private corporate sector investment contributed to 30 percent of total gross domestic investment in 1950/51 and a low of 14 percent in 1980 as public investment picked up and now it contributes to around 26 percent of total investment in the country. Private investment shows an increasing trend over the years from 2.1 percent of GDP in 1950 to 2.4 percent in 1980/81, to 4.1 percent in 1990/91 and an increase to 5.1 percent in 2000/01 (Figure 3.12).

There is no doubt that the reforms were aimed primarily at the private sector as the private sector saw a spectacular rise in 1992/93. Most of the investment were in machinery and equipment and saw an increase from an average of 2.8 percent in the 1980s to 5.8 percent in the 1990s. The private sector's investment in construction as a percentage of GDP doubled from 0.5 percent to 1 percent of the same period while inventories declined from 0.9 percent to 0.4 percent. This change maintained its direction but not the pace till the mid-nineties, touching a peak of 9.6 percent in 1995 and then declining to 5.6 percent of GDP in 2003/04.

Public sector investment started strongly in 1950/51 contributing 30 percent to total gross domestic investment. However private domestic investment shows a declining trend, reaching a low of nine per cent in 1976/77. The private sector contribution started to increase from the early 1990s as there was a decline in the public sector contribution. However the last couple of the years show private contributions to gross domestic investment declining as the public contributions start to increase again.

3.4.3 Public Sector Investment

The public sector's investment rate improved from 2.8 percent of GDP in 1950/51 to around 7 percent of GDP in the early 1970s and 10.7 percent in the early 1980, and to a doubling of the gross domestic investment rate from 10.7 percent on 1950/55 to 22.5 percent in 1980-85. However, since then the public investment has shown a declining trend (Figures 3.11 and 3.12), even though the gross domestic investment has increased (mostly due to the increase in household and private investment). Public sector investment rate have declined since 1986/87 when it reached a peak of 11.2 percent of GDP, up from 5.5 percent in 1969/70. The decline in public sector investment since mid-1980s has been sustained and more prolonged than the decline that was registered in latter half of 1960s. Cuts in infrastructure investment are likely to have contributed to the slowing of the private investment as there appears to be a "crowding in" effect (RBI, 2002).

No volatility has been seen in the public sector, only a steady decline since the 1991 reforms. By the end of the decade, the investment ratio for the public sector is the third lower that the beginning. Gross capital investment in public sector averaged only 7.8 percent in the 1990s and 7.6 percent of GDP in the ten year reform period. Public sector investment rates for both construction and machinery and equipment suffered declines of similar magnitude. The public sector now only contributes 31 percent of total gross domestic investment as opposed to 44 percent in the early 1980s.

Due to these significant contributions by the three sectors, household, private corporate and public sectors to gross investment, and the important relationships of crowding-in and crowding-out between the three sectors, it becomes important to examine the interrelationships between the three sectors of investment in the Indian economy.

3.5 Summary of Savings and Investment Analysis

The above discussion on saving and investment in India shows a continuous rise in gross domestic savings and gross domestic investment for the Indian economy. However, significant changes in patterns of the three sectors of savings and investment, household, private corporate and public are observed since independence. The changes in the sectors are quite visible in their respective shares to the total domestic savings and investments. The household share in national savings has increased considerably over the decades. The share of the private corporate sector has also increased but by a smaller magnitude. Lastly, the public sector savings and investment shares have deteriorated significantly over the period and at times dissavings has resulted. Overall, the analysis reveals that the household sector has a dominant position in the Indian economy. The changes in the savings and investment patterns of the three sectors over the period "make the position of household more crucial" and "The huge share, which households' hold in the total national savings, shows that any changes in the households' assets portfolio can exert considerable impact upon the savings and investment patterns in the Indian economy" (Palakkeel, 2007).

Given this huge importance of the household sector to the Indian economy, it is surprising that studies do not pay attention to the household sector on its own. The Indian studies tend to combine the household and the private sectors together for estimation purposes. In addition, the literature review in chapter two fails to show any studies that examine the important role that all the three sectors of savings and investment play in the growth process in India.[8] This study aims to overcome these deficiencies in the literature.

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[8] The only studies which attempt to do this are the earlier studies by the author (with E. Wilson), as identified in the literature review.

3.6 Foreign Capital Inflows

The other major determinant of growth, foreign capital inflows are receiving attention because of their potential to finance investment and promote economic growth. Even though the contribution of foreign capital inflows in India has remained relatively low throughout the period under consideration compared to savings and investment, foreign capital inflows has seen a substantial rise in the Indian economy. Foreign capital inflows were less than 1 percent of GDP in 1950/51, increasing to three percent in 1980/81 after a fall in the 1970s and then increasing to over 10 percent in early 2000 to over 15 percent of GDP currently (Figure 3.5). This clearly establishes the growing magnitude of capital inflows into India.

Since 1950s, external assistance has been the mainstay of foreign capital inflows into India where foreign aid played an important role in India's economic development in the 1950-1980 period. The 1960s saw the proportion of net foreign aid to capital inflow registering over 60 percent and at times 90 percent (93 percent in 1969/70). During the period 1955 to 1976, India received the maximum food aid of any country, over US $50 million tonnes of agriculture commodities, mainly from the Unites Sates. Also, commercial borrowing with capital resource from non-resident Indians started flowing from mid-1970s.

Further to this, the deregulation of the early nineties saw the Indian economy open to foreign participation in all major sectors, attracting substantial foreign capital. Since the mid-1990s, foreign investment has replaced foreign aid in accounting for a share of over half the total external capital inflow. Hoverer, until the 1980s, external financing was confined to external assistance through multilateral and bilateral sources, mostly on concessional terms to or through the government. In brief, until the eighties:

- Financing of investments was almost wholly through domestic savings with some recourse to foreign flows;
- Almost total reliance on official, especially multilateral flows, mainly on concessional terms;
- Reluctance to permit foreign investments or private commercial flows;
- Greater emphasis on import-substitution rather than export-promotion; and
- Recourse to IMF facilities to meet extraordinary situations. These include the two consecutive droughts in 1960s, oil shock of 1979, an extended fund facility in the 1980s and the Gulf crisis of 1990s.

Combined with the large fiscal deficits of the eighties, political uncertainties and the gulf crisis, India experienced a severe liquidity crisis in the balance of payments. The crisis brought about by the drying up of commercial source of financing, withdrawal of non-resident deposits, large depletion of reserves and significant short-term debt overhang. Other factors that affected the management of balance of payments included the loss of the exports market in West Asia, recessionary tendencies in the industrialized countries and the serious disruption of trade with the former USSR. However, Dr. Rangarajan Report of the High Committee on balance of payments brought about the reform of the external sector.

The debate over capital inflows and its effect on domestic savings discussed in the literature review has seen renewed interest in India as capital mobility became significant after the deregulation of the Indian economy in 1991. Gross domestic savings which grew from 18 percent of GDP in 1980 reached a maximum of 25 percent in 1995 started declining continuously since then till early 2000. This downturn is savings was at the same time as when the foreign capital inflows started to accelerate quite significantly after the reforms. This is consistent with the literature review which indicates a substitution between domestic savings and foreign inflows.

The deregulation of the early nineties saw the Indian economy open to foreign participation in all major sectors attracting substantial foreign capital. The easing of restrictions on private capital inflows has led to significant increases in both foreign direct investment and portfolio investment since 1991/92. The major contributor to the significant increases in overall capital inflows to India has been in the form of private capital. However, foreign investment levelled off after 1997 due to inefficient infrastructure, rigid labour laws and cumbersome administrative procedures, to name a few. These and other factors have impeded foreign investment in India, which is still small relative to India's large population and economic activity.[9]

Overall, a radical transformation in the nature of capital flows into India is seen from in the post deregulation period from 1991. From a mere absence of any private capital inflows till 1992, today such inflows represent a dominant proportion of total flows.[10] The official flows shown as external assistance (grants and loans from bilateral and multilateral sources) represented 75-80 percent of flows till 1991. But by 1994, this has come down to about 20 percent and has further fallen to below 5 percent by late 1990s (Chakrabarti, 2001).

During the last 10 years, India has attracted more than US $40 billion of foreign investment. Flow of private capital flows to India are currently running at about US $10 billion per year, of which 55 percent constitute foreign direct investment and portfolio flows. About 460 foreign institutional investors have been allowed to enter the Indian market and with the liberalization of the portfolio investment led to a surge in inflow of

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9 India still only receives one-tenth of what China receives in terms of foreign investment.
10 With the exception of those by non-resident Indians.

capital for investment in the primary and secondary market for Indian equity and corporate bond market. India has attracted about $22 billion in portfolio investments since 1993-94 and more than $18 billion in foreign direct investment.

3.7 Summary

The two significant phases in India's growth history since 1950 have been referred to as 'Hindu Rate of Growth' and the 'Bharatiya Rate of Growth'. In the first phase, from 1950 till 1980, the average rate of growth of the Indian economy was 3.5 percent per annum and the average income, measured by per capita GDP grew at 1.3 percent per annum. Gross domestic savings in this period did double from 10 percent of GDP in the 1950s to 20 percent in 1980; supported by higher domestic investment and a modest influx of foreign inflows in the form of assistance. This compared to the second phase of 1980 to 2005, economic growth averaged over 5.7 percent per annum and per capita income growth rate during this phase is more than double at 3.6 percent compared to the first phase of 1.3 percent. This phase is called the 'Bharatiya Rate of Growth' to distinguish it from the 3.5 percent average growth rate during the first phase. The last few years has seen a further rise in GDP to 8.7 percent. In fact, as evident from Figures 3.2 and 3.3, since independence, the performance of the Indian economy shows a constant increase in real GDP over each decade, except of the fall in the 1970s.

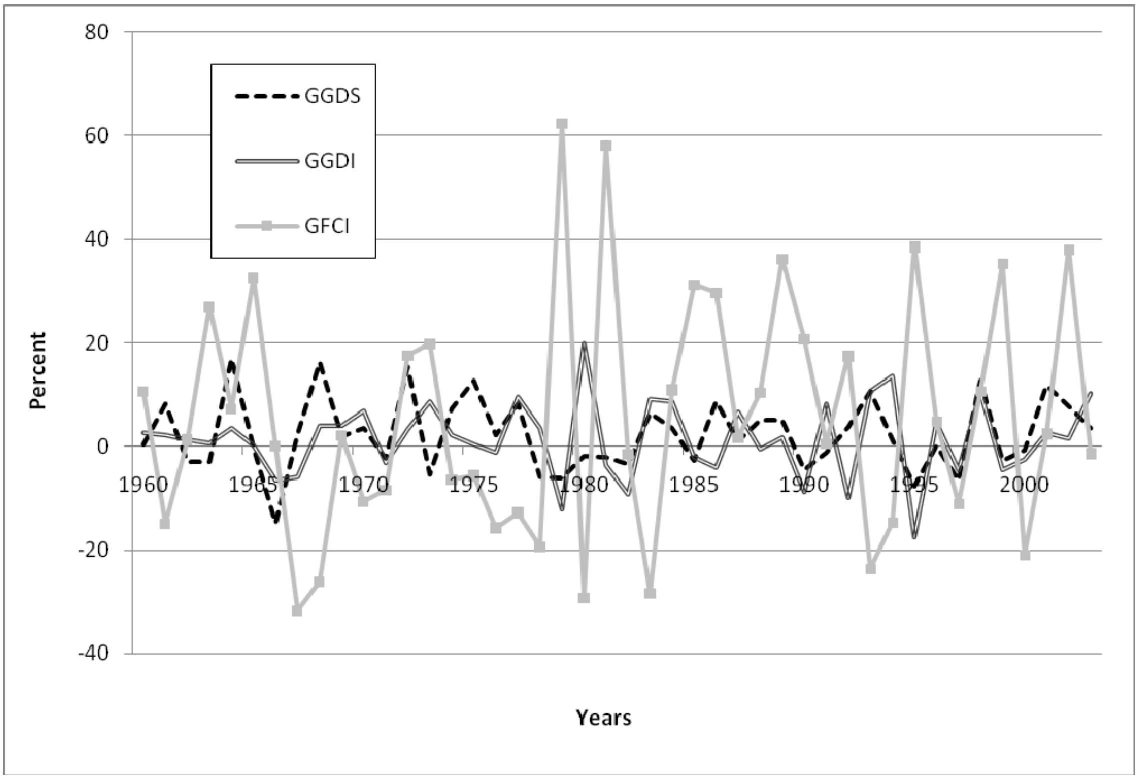
From the growth models perceptive and the literature review discussed in chapter two, it can be said that the upward trend in domestic growth is associated with the consistent trends of increasing domestic savings and investment over the decades. The savings and investment pattern in India is consistent with the Feldstein-Horioka proposition that domestic investment has continued to be determined overwhelmingly by domestic savings.

Gross domestic savings has increased continuously from an average of 9.6 percent of GDP during the 1950s to nearly 30 percent of GDP currently; while over the same period, the gross domestic investment rate has also increased continuously from 12.5 percent in the 1950s to close to 30 percent. From this, it can be said that a significant feature of these trends in savings and investment growth rates is that Indian economic growth has been financed predominantly by domestic savings. However, Figure 3.13 shows that the rate of growth of gross domestic savings and investment as a percentage of GDP (GGDS and GGDI) has not been anything dramatic or significant.

On the other hand, foreign capital inflows (GFCI) not only show a dramatic increase it its growth rates as a percentage of GDP but it also indicates significant increases in the 1980s, 1990s and in early 2000. Further to this, as evident from Figure 3.13, foreign inflows have been much more variable than either gross domestic savings or gross domestic investment. The observations for this chapter indicate firstly, that growth rates of saving and investment have been considerably lower but less variable than the growth rates in foreign capital inflows and GDP (Figures 3.3 and 3.13); and secondly, the growth differential has widened in the later decades (Figure 3.1).

Figure 3.13: Rate of Growth of Gross Domestic Savings, Gross Domestic Investment and Foreign Capital Inflows

Percentage of GDP at constant prices



Source: Author's calculations from various publications.

Note: GGDS: Rate of growth of gross domestic savings; GGDI: Rate of growth of gross domestic investment; GFCI: Rate of growth of foreign capital inflows.

The review in this chapter also shows a dynamic process involving changing relative shares and trend across sectors over a fifty-five year period for India. The analysis shows significant changes in the savings and investment patterns of the three sectors over the past five decades in the Indian economy with the household sector being the most dominant. Therefore, it is also important to examine the relationship between sectoral savings and investment. Along with this, two important issues arise from the discussion in this chapter which needs to be addressed. Firstly, the above sample, although having relatively few observations, covers over five decades. This long span in time introduces the problems of non-stationarity, low power of the traditional unit root tests (with relatively few observations) and bias in these tests caused by the presence of structural change (which is to be expected over the extended period). This study in the chapter four will as a significant contribution, analyse the development of testing for stationarity under structural change, originally proposed by Perron (1989). It will then conduct Perron's (1997) Innovational Outlier Model and the Additive Outlier Model which endogenously determines one structural break; and also conduct the Lee and Stratizich (2003) two break unit root test, which endogenously determines the time of two break points. Secondly, given the trending nature of the time series, it is essential to incorporate cointegration estimation techniques to determine long-run equilibrium relationships. It is also important that proper analysis is conducted which includes short-run disequilibrium behaviour via the error correction mechanisms. These estimations will be undertaken in chapters five and six.

3.8 A Note on the Indian Data

This study uses annual data for the period of 1950/51 to 2004/05 for its estimation purposes. The data for domestic savings and investment were taken from the National Accounts Statistics of India (2006). Data for foreign capital inflows are obtained from the Centre of Monitoring Indian Economy (2006), whilst GDP figures are available from the Reserve Bank of India (2006). All the variables, except for GDP (which was already in constant prices), are converted into constant prices with appropriate deflators. The study uses the GDP at factor cost deflator for the household sector savings and investment; the GDP at market prices deflator for the public sector savings and investment; and the GDCG (unadjusted) deflator for the private corporate savings, private corporate investment and foreign capital inflows.

All data are in Rupees for the 1993/94 base year and all variables are converted to Naperian logs. To estimate savings and investment in India, the economy is divided into three broad sectors. These are the household sector, the public sector and the private corporate sector. The household, private and public sector savings are then added up to give gross domestic savings. Similarly, household, private and public sector investments are added to give the total as gross domestic investment. The transformed variables comprise the real, logged measures of household savings (LHHS) and investment (LHHI); private savings (LPRS) and investment (LPRI); public savings (LPUS) and investment (LPUI); gross domestic savings (LGDS) and investment (LGDI), foreign capital inflows (LFCI) and real GDP (LGDP).

A major drawback in measuring savings and investment in India is the difficulty involved in direct estimation of household consumption and investment expenditures. The household sector is treated as a residual in the national accounts where household savings in physical assets is identical to household investment. Thus, for our estimation purposes, to avoid double counting, household savings in physical assets component is eliminated from gross domestic savings. In addition, in our estimations, household savings equals savings in financial assets only.

The author would also like to point out that initially all variables were divided by the labour force and then converted to Naperian logs to put the variables in per worker terms, consistent with the growth models. However, the data for the labour force, taken from the Indian Planning Commission are only available for the census years of 1951, 1961, 1971, 1981, 1991 and 2001. The values for other years were estimated using simple interpolations. An earlier paper was presented at the Reserve Bank of India and this was criticized on the ground of unreliable labour force data.[11]

Further to this, the author decided not to use per capita data or per worker data for estimation purposes because of the large variation between the labour force and the population. This is due to (i) the huge demographic change in India which has led to a significant changing participation rate; and (ii) the cohort labour force which includes part-time labour, child labour and the existence of underemployment.

Lastly, it is important to note that the Indian savings and investment data is not without issues and it be said that the data does suffer from some errors.[12] However, the Central Statistical Organisation who is responsible for the preparation of the savings/investment data has followed a uniform methodology in preparing the data throughout the period of this study, thus allowing econometric analysis of the data.

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11 This being the earlier study by the Verma and Wilson (2005).

12 For details, see National Accounts Statistics of India (2006).

CHAPTER FOUR

UNIT ROOT TESTS AND STRUCTURAL BREAKS*

4.1 Introduction

The previous chapter discusses the apparent important issues of trends and breaks in the measures of savings, investment, foreign capital inflows and GDP in India. Therefore, it becomes important to determine whether or not the variables contain a trend and whether that trend is deterministic or stochastic. This is known as the unit root test which is also a preliminary step in testing for cointegration and causality. Unit root tests are conducted to verify the stationarity properties (absence of trend and long-run mean reversion) of the time series data so as to avoid spurious regressions. A series is said to be (weakly or covariance) stationary if the mean and autocovariances of the series do not depend on time. If an economic time series is characterised by non-stationarities, then the classical *t*-test and *F*-test are inappropriate because the limiting distributions of the asymptotic variances of the parameter estimates are infinite (Fuller 1985). This often leads to spurious results in conventional regression analysis.[1]

Traditionally, the Augmented Dickey-Fuller (Dickey and Fuller (1979, 1981) and the Phillip-Perron (1988) tests have been widely used to test for stationary. However, Perron (1989) argues that most economic time series are characterised by stochastic rather than deterministic nonstationarity. Perron shows that many apparent non-stationary macroeconomic variables are indeed stationary if one allows for structural changes in the intercept or trends. Structural change can complicate the tests for trends; a policy regime change can result in a structural break that makes an otherwise

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[1] According to Granger and Newbold (1974), a spurious regression has a high R^2 and *t*-statistics that appear to be significant, but the results are without any economic meaning.

* A modified version of this chapter has been published by the author in the *Journal of Quantitative Methods for Economics and Business Administration* 3: 63-79 (with J. Glynn and N. Perera).

stationary series appear to be non-stationary (Enders 1995, p.211). Also, when there are structural breaks, the traditional Augmented Dickey-Fuller and the Phillip-Perron test statistics are biased toward the non-rejection of a unit root.

As mentioned in chapter three of this study, during the period from 1950 and 2005, the Indian economy has gone through a number of structural changes such as regime shifts, numerous wars, droughts, the green revolution and financial reforms leading to the deregulation in 1991. In other words, India has experienced a number of structural breaks in the macroeconomic variables over the past five decades. In the context of India, there are limited studies that have considered the issue of breaks in the data. For example Wallack (2003), Sinha and Tejani (2004) and Balakrishina and Paramsewaran (2007) determine a single break date in GDP. While Sahoo *et al*. (2001) determine break dates for gross domestic savings and GDP but again, they only consider one structural break. As the literature review in chapter two reveals, none of the India studies, or for that matter any studies examine the relationships of savings, investment, foreign capital inflows and growth within the cointegration and error correction framework that accommodate two structural breaks.

Applying traditional unit root tests alone is insufficient and problematic as significant structural breaks in the time series data are very likely. Therefore, the aim of this chapter is firstly to test for unit roots using traditional unit root tests; and secondly, to test for unit root in the presence of any potential structural breaks for the variables of gross domestic savings, gross domestic investment, foreign capital inflows and GDP for India. The structure for the rest of chapter is as follows: Section 4.2 discusses the traditional unit roots tests, which do not take into account structural breaks and presents empirical results of the Augmented Dickey-Fuller and Phillip-Perron tests. Section 4.3 explains the unit root tests that take into account one structural break. Empirical results of Perron's (1997) Innovational Outlier Model and the Additive Outlier Models are examined. Section 4.4 discusses and applies the new Lee and Strazicich (2003), Minimum Lagrange Multiplier Unit Root Test which endogenously determines two structural breaks. Finally, section 4.5 provides some concluding remarks.

4.2 Stationarity and Unit Root Tests

A time series is said to be stationary if its mean, variance and auto covariance are independent of time. Variables whose means and variances change over time are known as non-stationary or unit root variables. Any series that is not stationary is said to be non-stationary. A series is said to be integrated of order *d*, denoted by I(*d*), if it has to be differenced *d* times before it becomes stationary. If a series, by itself, is stationary in levels without having to be first differenced, then it is said to be I(0). The main thrust of the unit root literature concentrates on whether time series is I(0) or I(1). This can be tested by the Augmented Dickey-Fuller (ADF) model, which is primarily concerned with the estimate of α. In the following equation, we test the null hypothesis of $\alpha = 0$:

$$\Delta y_t = u + \beta t + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-1} + \varepsilon_t \tag{4.1}$$

where Δ denotes the first difference, y_t is the time series being tested, *t* is the time trend variable, and *k* is the number of lags which are added to the model to ensure that the residuals, ε_t are white noise.[2] The ADF test statistic tests for the null hypothesis of a unit root ($\rho = 0$) against the alternative of a stationary ($\rho < 0$ and $u_1 = 0$) or trend stationary ($\rho < 0$ and $u_1 \neq 0$) process.

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[2] This means ε_t has zero mean and constant variance that is uncorrelated with ε_s for $t \neq s$.

Phillips-Perron (PP) introduces a nonparametric method of controlling for serial correlation in the error term using the following specification, which is estimated, by using the ordinary least squares (OLS) method:

$$\Delta y_t = \alpha + \rho y_{t-1} + u_t \tag{4.2}$$

The unit root test results of the ADF and PP tests, with constant and trend, are shown in Table 4.1. The null hypothesis of a unit root is rejected if the value of the test statistic for α (in absolute value) is greater than the critical value. The results in Table 4.1 shows that both the ADF and the PP tests do not reject the null hypothesis of a unit root for gross domestic savings (LGDS), foreign capital inflows (LFCI) and gross domestic product (LGDP) but do so for gross domestic investment (LGDI).[3]

Table 4.1: Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) Unit Root Test Results

Description	Variable	ADF Test Statistics	Result	PP Test Statistics	Result
Gross Domestic Savings	LGDS	-3.3442	Unit Root	-3.3636	Unit root
Gross Domestic Investment	LGDI	-5.7698	Stationary	-3.9452	Stationary
Foreign Capital Inflows	LFCI	-2.1952	Unit root	-1.9663	Unit root
Gross Domestic Product	LGDP	-0.4190	Unit root	-0.1634	Unit root

Critical value at the five percent level is - 3.4953.

In general, the ADF and PP tests have very low power against I(0) alternatives that are close to being I(1). That is, unit root tests cannot distinguish highly persistent stationary processes from non-stationary processes very well. Also, the power of the unit root tests

[3] The explanation of the data used is given in chapter three.

diminish as deterministic terms (i.e. the constant and trend) are added to the test regressions. Including too many of these deterministic regressors results in lost power, whereas not including enough of them biases the test in favour of the unit root null.

4.3 Unit Root Tests in the Presence of a Structural Break

Testing for both unit root and structural changes in time series are essential for analysing time series data. The presence or absence of unit roots helps to identify some features of the underlying data generating process of a series. In the absence of a unit root, the series fluctuates around a constant long-run mean and implies that the series has a finite variance which does not depend on time. On the other hand, non-stationary series have no tendency to return to long-run deterministic path and the variance of the series is time dependent. Non-stationary series suffer permanent effects from random shocks and thus the series follow a random walk.

4.3.1 Single Structural Break

The debate on unit root hypothesis underwent renewed interest after important findings by Nelson and Plosser (1982). The traditional view of the unit root hypothesis was that the current shocks only have a temporary effect and the long-run movement in the series is unaltered by such shocks. The most important implication under the unit root hypothesis sparked by Nelson and Plosser (1982) is that the random shocks have a permanent effect on the system; that is the fluctuations are not transitory. Using annual data for 14 US macroeconomic variables over the period 1909 to 1970, Nelson and Plosser did not reject the unit root hypothesis with the standard ADF test for 13 of them including Gross National Product (GNP). They conclude that these series behave more like a random walk than like transitory deviations from steadily growing trend. Subsequent empirical findings of Stulz and Wasserfallen (1985) and Wasserfallen (1986) supported the unit root hypothesis in the sense that most of the US macroeconomic variables are not stationary in levels.

Perron (1989) continued the debate by arguing that most variables are indeed stationary; "Our conclusion is that most macro-economic time series are not characterised by the presence of the unit root and that fluctuations are indeed transitory" (Perron 1989, p.1362). Furthermore, Perron argues that in the presence of a structural break, the standard ADF tests are biased towards the non-rejection of the null hypothesis.

To test for a unit root, Perron (1989) bases his estimation on the following three equations. The equations take into account the existence of three kinds of structural breaks: a 'crash' model (4.3) which allows for a break in the level (or intercept) of series; a 'changing growth' model (4.4), which allows for a break in the slope (or the rate of growth); and lastly one that allows both effects to occur simultaneously, i.e. one time change in both the level and the slope of the series (4.5).

$$x_t = \alpha_0 + \alpha_1 DU_t + d(DTB)_t + \beta t + \rho x_{t-1} + \sum_{i=1}^{p} \phi_i \Delta x_{t-1} + e_t \tag{4.3}$$

$$x_t = \alpha_0 + \gamma DT_t{}^* + \beta t + \rho x_{t-1} + \sum_{i=1}^{p} \phi_i \Delta x_{t-1} + e_t \tag{4.4}$$

$$x_t = \alpha_0 + \alpha_1 DU_t + d(DTB)_t + \gamma DT_t + \beta t + \rho x_{t-1} + \sum_{i=1}^{p} \phi_i \Delta x_{t-1} + e_t \tag{4.5}$$

The intercept dummy DU_t represents a change in the level; $DU_t = 1$ if $(t > Tb)$ and zero otherwise; the slope dummy DT_t (also DT_t*) represents a change in the slope of the trend function; $DT* = t\text{-}TB$ (or $DT_t* = t$ if $t > TB$) and zero otherwise; the crash dummy $(DTB) = 1$ if $t = TB + 1$, and zero otherwise. Each of the three models has a unit root with breaks under the null hypothesis, as the dummy variables are incorporated in the regression under the null. The alternative hypothesis is a broken trend stationary process.

Perron (1989) using the Nelson and Plosser (1982) data set, allows for a known single break date methodology to test for the presence of unit root. He chooses the stock market crash of 1929 as a break point that permanently changed the level of series. Perron's result challenged most of Nelson and Plosser's conclusions as he rejects the unit root null for 11 series that Nelson and Plosser find to be non-stationary. The results confirmed the view that the ADF tests are biased towards the non-rejection of the unit root when a structural break is taken into account. He proposes that such a series are better described as stationary around a trend with a structural break in 1929. Perron also applies the same test using quarterly post-war real GNP series for the US economy from 1947:1 to 1986:III. He includes a one-time change in the slope of the deterministic trend in 1973 due to the oil price shock. The quarterly GNP series is also found to be stationary.

This result once again confirms the view that where there is a structural break, the ADF tests are biased towards the non-rejection of the unit root. In Perron's (1989) procedure, dating of the potential break is assumed to be known *a priori* in accordance with the underlying asymptotic distribution theory. Perron uses a modified Dickey-Fuller unit root test that includes dummy variables to account for one known structural break. The break point of the trend function is fixed (exogenous) and chosen independently of the data. Perron's (1989) unit root tests allow for a break under both the null and alternative hypothesis.

However, Perron's known assumption of the break date is criticized by many, most notably by Christiano (1992) as "data mining". Christiano argues that the data based procedures are typically used to determine the most likely location of the break and this approach invalidates the distribution theory underlying conventional testing. Since then, the most important contributions in this direction are those of Banerjee, Lumsdaine and Stock (1992), Zivot and Andrews (1992), Perron and Vogelsang (1992) Perron (1994, 1997), Vogelsang and Perron (1998), Lumsdaine and Papell (1998), and Clemente, Montañés and Reyes (1998). These studies have shown any bias in the usual unit root tests can be reduced by endogenously determining the time of the structural break(s).

Banerjee *et al.* (1992) note that Perron's model has four important implications. First, given the stationary/trend shift model is correct, then previous studies which explore conventional ADF tests are biased towards non-rejection. Secondly, it provides a useful description of the model with slowly changing trend component of the variable (output). Thirdly, if the series is stationary with a breaking trend but treated as integrated of order one, it then results in incorrect inferences. Lastly, empirical studies which employ the unit root hypothesis and cointegration procedures will be brought into question, again, if the time series variables are most likely to be characterised by stationary with a break trend rather than non-stationary.

Zivot and Andrews (1992) argue that Perron (1989) over estimates the evidence against the unit root hypothesis when the time of a structural break is unknown. Thus, Zivot and Andrews (1992) propose a variation of Perron's (1989) original test in which the time of the break is endogenously estimated, rather than assumed as exogenous.[4] They also consider structural breaks of three alternative forms: a change in the intercept (4.6); a change in trend (4.7); or a change in both the intercept and trend (4.8) as follows:

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[4] See equations 4.3-4.5.

$$y_t = \hat{\mu}^A + \hat{\theta}^A DU_t(\hat{T}_b) + \hat{\beta}^A t + \hat{\alpha}^A y_{t-1} + \sum_{j=1}^{k} \hat{c}_j^A \Delta y_{t-j} + \hat{e}_t \tag{4.6}$$

$$y_t = \hat{\mu}^B + \hat{\beta}^B t + \hat{\gamma}^B DT_t^*(\hat{T}_b) + \hat{\alpha}^B y_{t-1} + \sum_{j=i}^{k} \hat{c}_j^B \Delta y_{t-j} + \hat{e}_t \tag{4.7}$$

$$y_t = \hat{\mu}^C + \hat{\theta}^C DU_t(\hat{T}_b) + \hat{\beta}^C t + \hat{\gamma}^C DT_t^*(\hat{T}_b) + \hat{\alpha}^C y_{t-1} + \sum_{j=1}^{k} \hat{c}_j^C \Delta y_{t-j} + \hat{e}_t \tag{4.8}$$

The null hypothesis in the Zivot and Andrews method is that the variable under investigation contains a unit root with a drift, while the alternative hypothesis is that the series is a trend stationary process with a one-time break occurring at an unknown point in time. By determining the structural break endogenously, Zivot and Andrews argue that the results of the unit root hypothesis previously suggested by conventional tests such as the ADF test may be changed. Zivot and Andrews (1992) endogenous structural break test is a sequential test which utilizes the full sample and uses a different dummy variable for each possible break date. The break date is selected where the *t*-statistic from the ADF test of unit root is at a minimum. Consequently a break date will be chosen where the evidence is least favourable for the unit root null.

Banerjee *et al.* (1992) and Zivot and Andrews (1992) provide evidence that confirms the Nelson and Plosser's findings, in the sense that the results are mostly in favour of the integrated model. Banerjee *et al.* (1992) analyse data on post-war real output for Canada, France, Germany, Italy, Japan, UK and US. Only in Japan's case is the unit root hypothesis rejected in favour of the trend shift hypothesis. Zivot and Andrews (1992) who test for a single endogenous break date find less evidence against the unit root hypothesis than Perron (1989) does using the Nelson and Plosser (1982) data. Zivot and Andrews reject the unit root at the five percent significance level for only three out of 13 variables using the Nelson and Plosser data. However, the results for nominal GNP, real GNP and industrial production are consistent with Perron's as these variables are rejected even after the break was endogenously determined. A summary of the unit root tests using the Nelson and Plosser data set (1982) is given below in Table 4.2.[5]

Table 4.2: Unit Root Tests with the Nelson and Plosser's Data (1982) Set

Empirical Studies by:	Model	Unit Root	Stationary
Nelson and Plosser (1982)	ADF test with no break	13	1
Perron (1989)**	Exogenous with one break	3	11
Zivot and Andrews (1992)*	Endogenous with one break	10	3
Lumsdaine and Papell (1997)*	Endogenous with two breaks	8	5
Lee and Strazicich (2003)**	Endogenous with two breaks	10	4

* Assume no break(s) under the null hypothesis of unit root.

** Assume break(s) under both the null and the alternative hypothesis.

The work was continued by Perron and Vogelsang (1992) and Perron (1997) who propose a class of test statistics that allows for two different forms of a structural break. These are the Additive Outlier (AO) and Innovational Outlier (IO) models. The AO model allows for a sudden change in mean (crash model) while the IO model allows for gradual changes. Perron and Vogelsang (1992, p.303) argue that these tests are based on the minimal value of t statistics on the sum of the autoregressive coefficients over all possible breakpoints in the appropriate auto regression. While Perron (1997; p. 356), argues that "...if one can still reject the unit root hypothesis under such a scenario it must be the case it would be rejected under a under a less stringent assumption". Perron and

[5] The Lumsdaine and Papell (1997) and Lee and Strazicich (2003) studies are considered in Section 4.4.

Vogelsang (1992) apply these two models for non-trending data, while Perron (1997) modifies them for use with trending data.

4.3.2 Innovational Outlier (IO) Model and Additive Outlier (AO) Model

Perron (1997) re-examines his 1989 findings, with an unknown break point. He presents a statistical procedure used to test for the unit root allowing for the presence of the structural change in the trend function occurring at most once. The IO specification uses a dummy variable to model the gradual changes. Three parameterizations of the structural break models can be considered as follows:

The IO1 model allows for a one time change in the intercept of the trend function, such that:

$$\text{IO1: } x_t = \mu + \theta DU_t + \beta t + \delta D(T_b)_t + \alpha x_{t-1} + \sum_{i=1}^{K} c_i \Delta x_{t-i} + e_t \quad (4.9)$$

The IO2 is the most inclusive model, allowing for changes in both the intercept and the slope of the trend function: It is performed using the t-statistic for the null hypothesis, α=1:

$$\text{IO2: } x_t = \mu + \theta D_t t + \beta t + \gamma DT_t + \delta D(T_b)_t + \alpha x_{t-1} + \sum_{i=1}^{K} c_i \Delta x_{t-i} + e_t \quad (4.10)$$

where T_b denotes the unknown time of break, $DU_t = 1$ if $t > T_b$ and zero otherwise, $DT_t = t$ if $t > T_b$ and zero otherwise, $D(T_b) = 1$ 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 $\alpha = 1$ is greater than the corresponding critical value. Perron (1997) suggests two methods for determining the time of the break, T_b. In the first approach, equations (4.9) or (4.10) are sequentially estimated assuming different T_b with T_b chosen to minimize the *t*-ratio for $\alpha = 1$. The second approach is where, 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* depends upon whether the *t*-ratio on the coefficient associated with the last lag in the estimated auto regression is significant. The optimum lag (*k**) is selected such that the coefficient on the last lag in an auto regression of order *k** is significant and that the last coefficient in an auto regression of order greater than *k** is insignificant, up to a maximum order *k* (Perron, 1997).[6]

The third model is the Additive Outlier (AO) model. In contrast to the gradual change in the IO model, the AO model assumes structural changes take place instantaneously; that is it allows for a sudden and rapid change in the trend function. When considering the AO model for testing a unit root, a two-step procedure is used. First the series is detrended using the following regression:

$$y_t = \mu + \beta_t + \gamma DT_t^* + \tilde{y}_t \tag{4.11}$$

where $\tilde{y}_t$ is the detrended series and $DT_t^* = 1(t - T_b)$ if $t > T_b$ and zero otherwise. This assumes that a structural break only impacts on the slope coefficient. Thus, the test is then performed using the *t*-statistic for $\alpha = 1$ in the regression:

$$\tilde{y}_t = \alpha \tilde{y}_{t-1} + \sum_{i=1}^{\kappa} c_i \Delta y_{t-i} + e_t \tag{4.12}$$

6 Usually $k = 8$.

Similar to the IO methodology, these equations are estimated sequentially for all possible values of T_b (T_b = k + 2,..,T-1) where T is the total number of observations so as to minimize the t-statistic for $\alpha = 1$. The null hypothesis is rejected if the t-statistic for $\alpha = 1$ is larger in absolute value than the corresponding critical value. The break date is assumed to be unknown and endogenously determined by the data. Again, the lag length is data-determined using the general to specific method. An alternative method (used in this study) which is more widely used, is to select T_b as the value over all possible break dates that minimizes the value of the t-statistic on $\gamma = 0$ (Harris and Sollis 2003).

4.3.3 Empirical Results for the Innovational Outlier and Additive Outlier Models

The IO and the AO models are estimated to examine the four variables of LGDS, LGDI, LFCI and LGDP in India for stationarity. The least restrictive model of IO2 is firstly estimated and if the $t_{\hat{y}}$ is significant at the five percent level or less, the results are reported. If $t_{\hat{y}}$ is not significant, the results of IO1 is reported as is the case for LFCI (Table 4.3). The AO model is also estimated to determine the sudden effect of the unknown structural break. The results for both IO and AO, shown in Tables 4.3 and 4.4 are consistent with the ADF and PP tests whereby the unit root null cannot be rejected for LGDS and LFCI but is rejected for LGDI. The conventional results using the ADF and PP tests indicate that LGDP contains a unit root; however, both the IO and AO models indicate that LGDP is stationary at the five percent significance level. Therefore, in this analysis, both LGDI and LGDP are stationary with a break.

Table 4.3: Innovational Outlier Model for Determining the Break Date in Intercept (IO1) or Both Intercept and Slope (IO2)

Description	Series	*k*	Model	T_b	$t_{\hat{\gamma}} / t_{\hat{\theta}}$	$t_{\hat{\alpha}}$	Result
Gross Domestic Savings	LGDS	5	IO2	1965	-3.20	-5.29	Unit Root
Gross Domestic Investment	LGDI	1	IO2	1965	-5.35	-8.26	Stationary with break
Foreign Capital Inflows	LFCI	0	IO1	1967	-3.46	-3.44	Unit Root
Gross Domestic Product	LGDP	0	IO2	1978	6.34	-6.19	Stationary with break*

Note: Critical values at the 1%, 5% and 10% are -5.92, -5.23, and -4.92 respectively for IO1; and 6.32, -5.59 and -5.29 respectively for IO2. In the Innovational Outlier model, changes are assumed to take place gradually The IO1 model allows for a break in the intercept, while the IO2 model allows for a break in both the intercept and slope. *Tb* is selected as a value that minimizes the absolute value on the t-statistic on the parameter associated with a change in slope in IO2 model or change in the intercept in IO1 model. The max *k*=8.

* The unit root null cannot be rejected at the 1% level.

The break date of 1978 for GDP growth from the IO2 model and 1984 from the AO model are consistent with other studies such as Sahoo *et al*. (2001) and Wallack (2003), who find a significant break in the GDP series in 1980; Sinha and Tejani (2004) who find a significant break date of 1980/81; and Balakrishina and Paramsewaran (2007) who confirm the break date of 1978/1979 in GDP growth. The break for gross domestic savings in 1965 is also in line with Sahoo *et al*. (2001). The break dates for all the variables in the IO model of 1965, 1967 and 1978 correspond with major events that took place in India over the last 55 years. These include the wars with China (1962) and Pakistan (1965); severe droughts in the years 1965-1967; and the Green revolution of 1967-1978.

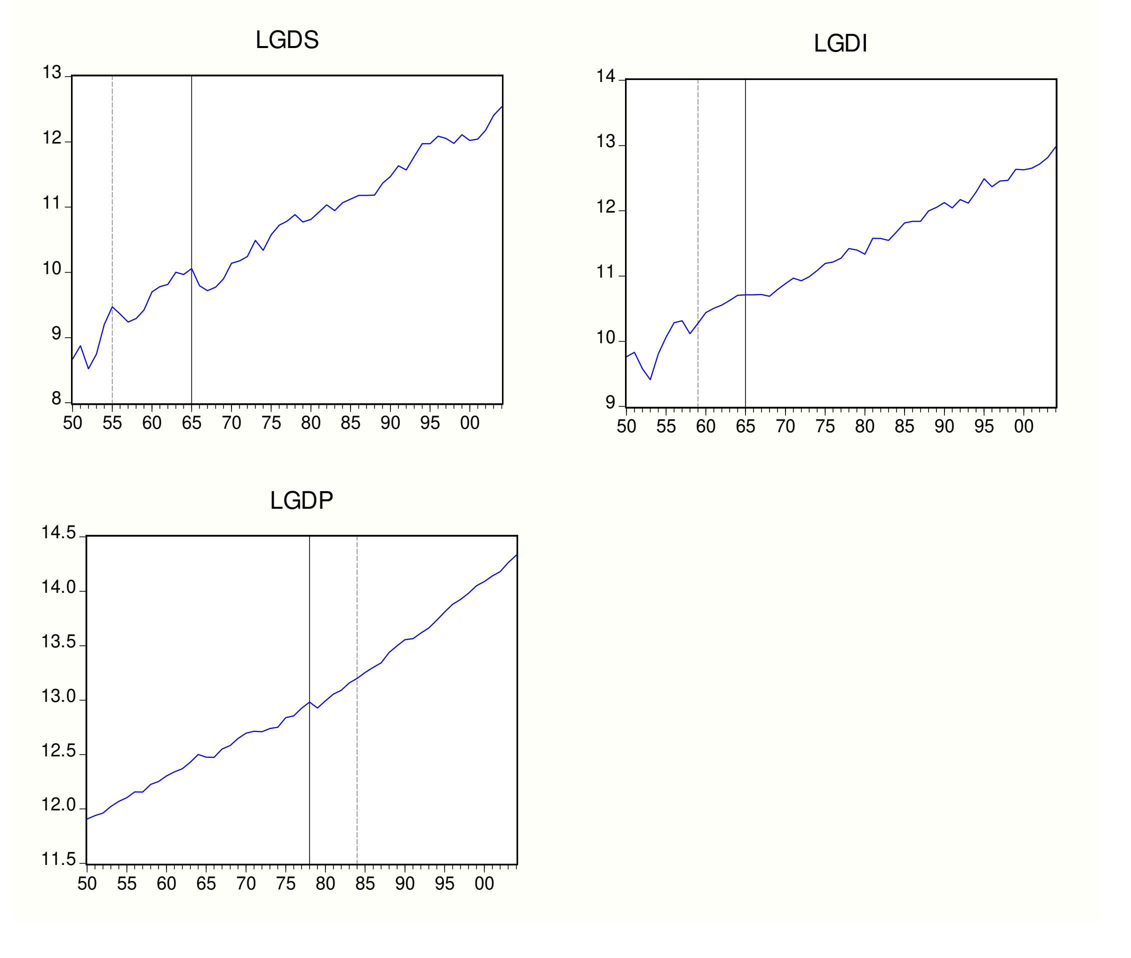
Table 4.4: Additive Outlier Model (AO) for Determining the Break Date

Description	Series	*k*	T_b	$\hat{\gamma}$	$t_{\hat{\gamma}}$	$t_{\hat{\alpha}}$	Result
Gross Domestic Savings	LGDS	5	1955	-0.08	-2.65	-4.29	Unit Root
Gross Domestic Investment	LGDI	1	1959	-0.03	-2.67	-6.64	Stationary with a break
Foreign Capital Inflows	LFCI	0	1979	0.05	3.78	-2.47	Unit Root
Gross Domestic Product	LGDP	0	1984	0.02	22.66	-5.13	Stationary with a break*

Note: Critical values at the 1%, 5% and 10% are -5.45, -4.83 and -4.48 respectively. In the Additive Outlier model, changes are assumed to take place rapidly, allowing for a break in the slope. *Tb* is selected as a value that minimizes the absolute value on the t-statistic on the parameter associated with a change in slope. The max *k* =8.

* The unit root null cannot be rejected at the 1% level.

Figure 4.1: Plot of the Series and the Estimated Timing of Structural Breaks by the Innovational Outlier (IO) and Additive Outlier (AO) Models.



The solid line indicates breaks by the IO model and the dotted line indicates breaks by the AO model.

Applying the procedure for testing the unit root hypothesis which allows for the possible presence of the structural break has at least two advantages. Firstly, as mentioned earlier, it prevents yielding a test result which is biased towards non-rejection of the unit root null as suspected by Perron (1989). Secondly, since this procedure can identify when the possible presence of structural break occurs, it provides valuable information for analysing whether structural break on a certain variable is associated with a particular government policy, economic crises, regime shifts, wars or other factors.

However, two important issues need to be raised. Firstly, the power of these tests has been questioned by Perron himself and many others. The issue has been raised by many as to the trade-off between the power of the test and the amount of information incorporated with respect to the choice of break point (Perron 1997, p.378). That is, assuming an unknown break point will be less powerful that if the break point is already known. Secondly, these tests only capture the single most significant break in each variable, raising the question; what if there is more than one break in each variable? The discussion now turns to this topic on more than one break in a time series.

4.4 Unit Root Tests in the Presence of Two Structural Breaks

Several studies[7] including Lumsdaine and Papell (1997) argue that only considering one endogenous break is insufficient and leads to a loss of information when actually more than one break exists. Lumsdaine and Papell introduce a procedure to capture two structural breaks and argue that unit roots tests that account for two breaks are more powerful than those that allow for a single break. Their test is an extension to the Zivot and Andrews (1992) model, allowing for two breaks under the alternative hypothesis of the unit root. Lumsdaine and Papell (1997) re-examine the Nelson and Plosser (1982) data finding more evidence against unit root than Zivot and Andrews but less than Perron (1989)[8]. Using finite-sample critical values, they reject the unit root null for five series at the five percent significance level, the three series found by Zivot and Andrews plus employment and per-capita real GNP.

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[7] Ben-David, Lumsdaine and Papell (2003) argue that failure to allow for multiple breaks can cause the non-rejection of the unit root null by these tests which incorporate only one break. Maddala and Kim (2003) believe that allowing the possibility of two endogenous break points show more evidence against the unit root hypothesis.

[8] See Table 4.2.

Others who have considered two breaks are Clemente *et al*. (1998) who base their approach on Perron and Vogelsang (1992); and Papell and Prodan (2004) who propose a test based on restricted structural change, which explicitly allows for two offsetting structural changes. Ohara (1999) utilizes an approach based on sequential *t*-tests of Zivot and Andrews to examine the case on *m* breaks with unknown break dates. He provides evidence that unit root tests with multiple trend breaks are necessary for both asymptotic theory and empirical applications.

All the endogenous break tests, discussed above, which allow for the possibility of one or more breaks: Zivot and Andrews (1992), Banerjee *et al*. (1992), Perron (1997) and Lumsdaine and Papell (1997) do not allow for break(s) under the null hypothesis of unit root and thus derive their critical values accordingly.[9] This may potentially bias these tests. Nunes, Newbold and Kuan (1997) show that this assumption leads to size distortions in the presence of a unit root with a break; and Perron (2005) suggests that there may be some loss of power. Furthermore, Lee and Strazicich (2003) demonstrate that when utilizing these endogenous break unit root tests, researchers might conclude that the time series is trend stationary when in fact the series is non-stationary with breaks. In this regard 'spurious rejections' may occur. Therefore, as pointed out by Lee and Strazicich (2003), a careful interpretation of results in empirical work is required. As such Lee and Strazicich (2004) propose a Lagrange Multiplier (LM) unit root test as an alternative to the Zivot and Andrews test, while Lee and Strazicich (2003) suggest a two-break LM unit root test as a substitute for the Lumsdaine and Papell (LP) test.

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[9] This hypothesis differs from Perron's (1989) exogenous break unit root tests, which allows for the possibility of a break under both the null and alternative hypothesis.

Lee and Strazicich (2003) also apply their two-break minimum LM unit root test to Nelson and Plosser's (1982) data and compare it with the two-break LP test.[10] They find stronger rejections of the null using the LP test than the LM test. At the five percent significance level, they reject the null for six series with the LP test and four series with the LM test. Only the unit root null of industrial production and the unemployment rate are rejected by both the LP and LM tests. Furthermore, Lee and Strazicich (2003) point out that the null is rejected at the five percent significance level for real GNP, nominal GNP, per-capita real GNP and employment using the LP test, but the null for these variables is only rejected at the higher significance level with the LM test.

The minimum LM unit root two break test proposed by Lee and Strazicich (2003) has many advantages as follows:

- Endogenously determines two structural breaks from the data.
- Breaks are allowed under both the null and the alternative hypothesis.
- Corresponds to Perron's (1989) exogenous structural break with changes in the level and both level and trend (Models A and C).
- Avoids the problems of bias and spurious rejections with the traditional ADF tests.
- Lee and Strazicich (2003) show that the two-break LM unit root test statistic which is estimated by the regression according to the LM principle will not spuriously reject the null hypothesis.
- In contrast to the ADF test, the LM unit root test has the advantage that it is unaffected by breaks under the null (Lee and Strazicich, 2001).

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[10] See Table 4.2.

4.4.1 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:

$$y_t = \delta' Z_t + X_{t,} \qquad X_t = \beta X_{t-1} + \varepsilon_t \tag{4.13}$$

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, $Z_t = \left[1, t, D_{1t,} D_{2t,} T_{1t,} T_{2t}\right]$, 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 $T_{B,}$ while *T* is the corresponding trend shift variable. Lee and Strazicich (2003) use the following regression to obtain the LM unit root test statistic:

$$\Delta y_t = \delta' \Delta Z_t + \phi \bar{S}_{t-1} + \mu_t \tag{4.14}$$

where $\bar{S}_t = y_t - \hat{\psi}_x - Z_t \hat{\delta}_{t,}\ t = 2,...,T, \hat{\delta}$ 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: $\bar{\tau} = t -$ statistic testing the null hypothesis $\phi = 0$. The critical values for the two break case are tabulated in Lee and Strazicich (2003).

4.4.2 Empirical Results Based on Lee and Strazicich Two Break Model

The two break LM unit root test is utilized to once again examine the series for savings (LGDS), investment (LGDI), foreign inflows (LFCI) and GDP growth (LGDP) in India from 1950-2005. We consider model C, which allows for two changes in the level and trend.[11] Results of the two-break model LM unit root test are shown in Table 4.5. The results indicate a rejection of the unit root null for LGDI and LGDP but not for LGDS. The two structural breaks in the level (B_{jt}) and/or trend (D_{jt}) for Model C are significant for LGDS, LGDI and LGDP.[12] For LFCI, neither of the breaks are significant (denoted by N), suggesting that the traditional ADF and the PP tests are more appropriate in this case. Both the ADF and PP tests (Table 4.1) indicate that LFCI contains a unit root, I(1) process.

The break dates of savings (LGDS) in 1965 and investment (LGDI) in 1967 are consistent with the main trends and breaks discussed in chapter three; while the break date for LGDP in 1964 is line with Hatekar and Dongre (2005). More importantly, structural breaks in the mid-sixties coincide with the change of government, wars in 1962 and 1965; droughts in the years 1965-1967, which resulted in large imports of food and a massive balance of payments crisis. Further to this, Balakrishina and Paramsewaran (2007) point out that

> "keeping with conventional wisdom among researchers of the Indian economy that shifts in the Indian growth data such as the 'green revolution' and 'industrial stagnation' since the mid-1960s' represent trend breaks" (p.2918).

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[11] Justification of using only Model C is based on chapter three observations with the graphs showing that all the variables have a trend.

[12] *t* values are significant at the 1 percent level.

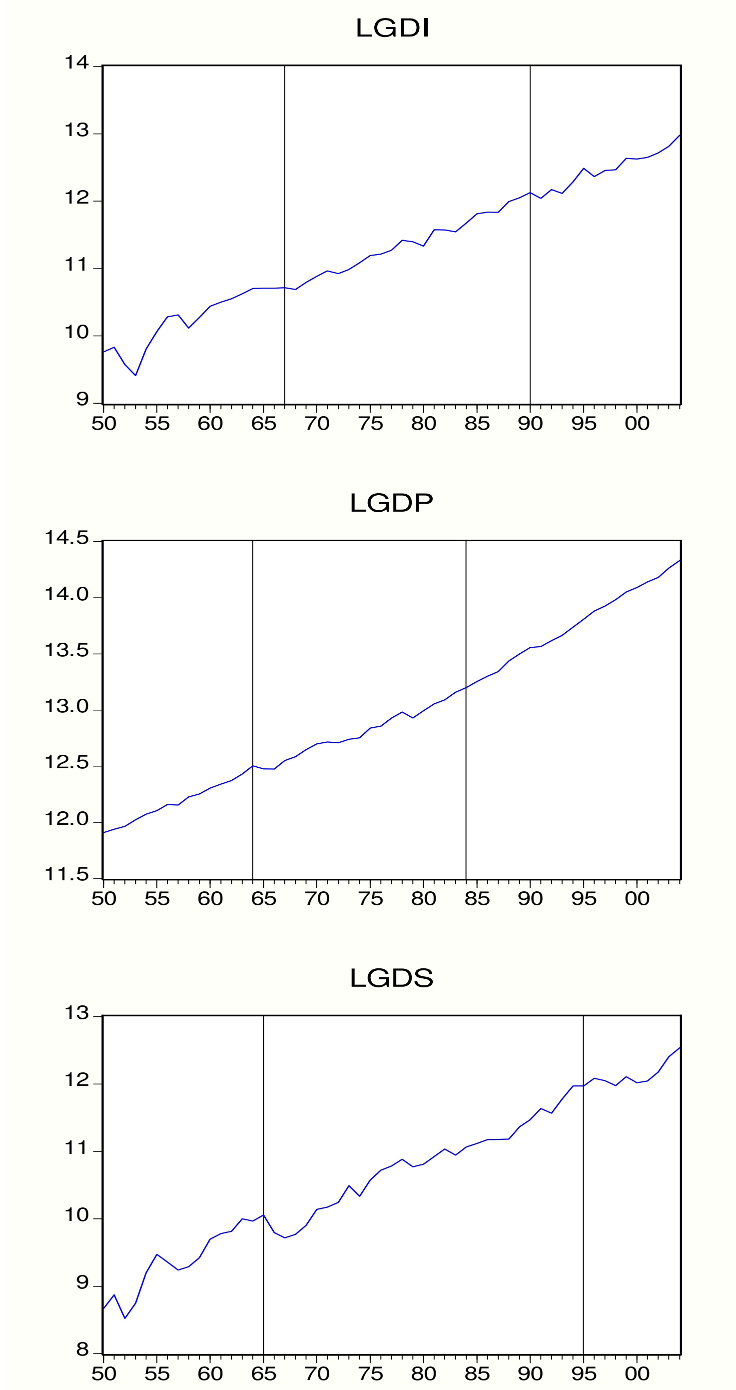
However, with the two-break model, as shown in Table 4.5, the second break date occurs in 1984 for LGDP, 1990 for LGDI and 1995 for LGDS respectively. These break dates are associated with the economic reforms that took place during Rajiv Gandhi's tenure in the mid-1980s, which include the reforms in the money and treasury bills market and the balance of payment crisis in 1990 leading to the deregulation of the Indian economy in 1991.

Table 4.5: Two-Break Minimum LM Unit-Root Tests,
Model C: Break in both Intercept and Slope

Description	Series	Lag $\hat{k}$	$\hat{T}_B$ T_{B1}, T_{B2}	Test Statistic	Result
Gross Domestic Savings	LGDS	5	1965, 1995	-5.5981	Unit Root with two breaks
Gross Domestic Investment	LGDI	6	1967, 1990	-6.7132	Stationary with two breaks
Foreign Capital Inflows	LFCI	3	1961N, 1982N	-5.1295	Unit root
Gross Domestic Product	LGDP	3	1964, 1984	-7.3791	Stationary with two breaks

Critical values taken from Lee and Strazicich (2004) were derived in sample size of T=100. The critical values depend somewhat on the location of the break, $(\lambda = T_B / T)$. The critical values at the five percent significance level for LGDS and LGDI is λ =(0.2,0.8)= -5.71 and LGDP is λ = (0.2,0.6)= -5.74. N = not significant. A maximum of 8 lags was specified in GAUSS.

Figure 4.2: Plot of the Series and the Estimated Timing of Structural Breaks by Lee and Strazicich Model (2003)



Note: The time of the structural break based on the Lee and Strazicich two break model (Model C).

A summary of the unit root tests employed in this chapter using different methodologies is shown below in Table 4.6. The overwhelmingly difference between the unit root tests is evident in the variable, LGDP. Using the traditional tests of determining stationary, both the ADF and PP tests show that LGDP contains a unit root; while the more recent techniques which take into account structural breaks indicate that LGDP is stationary with either one or two breaks at the five percent level of significance. This is line with the earlier statement of Enders (1995) that structural change can complicate the tests for trends; a policy regime change can result in a structural break that makes an otherwise stationary series appear to be non-stationary; and is also consistent with Perron's (1989) findings that a failure to allow for an existing break leads to a bias, that reduces the ability to reject a false unit root null hypothesis.

Table 4.6: Summary of Unit Root Tests Conducted Using Different Methodologies

Variables	ADF Test	PP Test	Perron (97) IO Model*	Perron (97) AO Model*	Lee and Stratizich (2003) **
LGDS	Unit root	Unit root	Unit root	Unit root	Unit root with two breaks
LGDI	Stationary	Stationary	Stationary with one break	Stationary with one break	Stationary with two breaks
LFCI	Unit root	Unit root	Unit root	Unit root	Unit root
LGDP	Unit root	Unit root	Stationary with one break	Stationary with one break	Stationary with two breaks

Note: The results for the above table are at the five percent significance level.

* Assume no break under the null hypothesis of unit root. In the Innovational Outlier model (IO model), changes are assumed to take place gradually, allowing for a break in both the intercept and slope. In the Additive Outlier model (AO model), changes are assumed to take place rapidly, allowing for a break in the slope.

** Assume breaks under both the null and the alternative hypothesis.

4.5 Conclusion

Originally, the Augmented Dickey-Fuller and the Phillip-Perron tests were widely used to test for stationary. However, Perron (1989) shows that failure to allow for an existing break leads to a bias that reduces the ability to reject a false unit root null hypothesis. To overcome this, Perron proposes allowing for a one known or exogenous structural break in the Augmented Dickey-Fuller tests. Following this, many testing methods emerged where the break point is assumed to be unknown including Banerjee *et al*. (1992), Zivot and Andrews (1992) and Perron (1997). Lumsdaine and Papell (1997) extend the Zivot Andrews (1992) model to two structural breaks with unknown break points. However, these endogenous tests are criticized for their treatment of breaks under the null hypothesis. Given the breaks are absent under the null hypothesis of unit root, there may be tendency for these tests to suggest evidence of stationary with breaks (Lee and Strazicich 2003). The Minimum Lagrange Multiplier unit root test with two structural breaks proposed by Lee and Strazicich (2003) overcomes this problem as this allows for breaks in both the null and alternative hypothesis. This test is also the only test which is consistent with Perron's (1989) original study.

As a significant contribution to the study, this chapter analyses the development of testing for structural change, originally proposed by Perron (1989). The main purpose of the chapter is to conduct unit root tests in the presence of structural change at the unknown time of the break(s). The study uses annual time series data from 1950 to 2005 to determine the most important years when structural breaks occurred for the four variables of gross domestic savings, gross domestic investment, foreign capital inflows and GDP growth for India. Firstly, Perron's (1997) Innovational and Additive Outlier models are used to determine the single most important structural break. The empirical evidence based on this model shows that gross domestic investment is stationary with a break while gross domestic savings and foreign capital inflows contain a unit root. This is consistent with the results obtained by the traditional unit root tests (ADF and PP) without a break. LGDP is found to be stationary with a break at a five percent level in the Perron's (97) model but non-stationary using the both the ADF and PP tests.

Following these tests, the minimum LM unit root test proposed by Lee and Strazicich (2003) is employed to specify a model to accommodate for the potential existence of two significant structural breaks in the data. Advantages of the two-break Lee and Strazicich (2003) procedure are that the break points are determined endogenously from the data; the test is not subject to spurious rejections in the presence of unit root with break(s); and as Lee and Strazicich (2003) demonstrate that a two break minimum LM test has greater or comparable power to the Lumsdaine and Papell test when the alternative hypothesis is true and spurious results are absent. Lee and Strazicich (2003) results are consistent with the Perron's (1997) results with savings, investment and GDP with two breaks.

However, the Perron (1997) and the Lee and Strazicich (2003) models are unable to identify multiple structural breaks. It could be argued that the procedure which would allow for multiple structural breaks would be more appropriate here. One avenue of inquiry would be to apply unit root tests with more than two breaks. Banerjee *et al*. (1998), Ohara (1999) and Bai and Perron (2003), have all developed unit root tests along these lines. However, if multiple breaks were to be detected, the data would need to be of a longer term and it is generally believed that two breaks would be sufficient to reject the null of unit root. Further to this, the greater the number of breaks that are added to the model, the closer are macroeconomic time series to random walks and the less relevant are unit roots with structural breaks (Mehl 2000, p.376). Moreover, as Ben-David and Papell (1997) note, tests that allow for multiple structural breaks, such as Bai and Perron (2003), are restricted to stationary and non-trending data, which is not the case of the variables under investigation. In respect to structural break dates, these methods are statistically very important in unit root testing. Keeping in mind, that these tests indicate the most significant one or two breaks, it is interesting to note here, that only one break was detected after India's deregulation in 1991. The inference that can be made from the above results is that the major changes in the country occurred during the 1960s and 1980s with the Green revolution starting in 1967; along with the wars with China (1962) and Pakistan (1965); the severe droughts (1965-1967); balance of payments crisis (1966); the economic reforms that took place under Rajiv Gandhi's tenure in the mid-1980s; and balance of payments crisis of 1990 before the formal deregulation of the Indian economy in 1991. In addition, the annual data might not be long enough for the post deregulation period to pick the major significant structural breaks or the tests may not pick up the late (end of sample) changes.

The other key result from the unit roots tests indicate that the variables under investigation are of mixed order of integration; a mix of I(0) and I(1) process. Once the stationary/non-stationary properties of the variables are finalised, the next step of determining the long-run relationship between the variables is able to be conducted. Therefore, in the next chapter we turn to the discussion on the cointegration analysis that is appropriate for variables of mixed order of integration, which also take into account the two structural breaks, determined by the Lee and Strazicich (2003) procedure.

CHAPTER FIVE

COINTEGRATION ANALYSIS: AGGREGATE ANALYSIS OF SAVINGS, INVESTMENT, FOREIGN CAPITAL INFLOWS AND GDP GROWTH *

5.1 Introduction

Savings, investment and growth have been central to the development theories because of their close association. Growth models predict that increased total saving (from domestic or foreign sources) will lead to higher investment and hence higher growth. However, in an open economy with access to foreign capital, domestic saving and investment can diverge without necessarily impeding growth. Unless there are barriers to international capital mobility, funds should flow to investment projects with the highest expected rates of return.

Even though these empirical relationships are well established in the theoretical models of growth, there is still little agreement among economists about the direction of these relationships (as witnessed in the literature review of chapter two). Not only is it difficult to sort out the exact interrelationships, the facts are also consistent with different theories and models. As mentioned in the previous chapters, the relationships between savings, investment and growth have been extensively researched in India. However, chapter two indicates that the Indian studies have many major shortcomings which this chapter tries to overcome. Initially, the Indian studies only examined the relationships between the three variables of savings, investment and growth by commonly testing for the short-run bivariate Granger causality. The standard Granger

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* A modified version of this chapter has been published in the *South Asia Economic Journal* 8(1): 87-98.

causality tests do not contain the error-correction term and thus are criticized as they do not check the cointegrating properties of the concerned variables.[2]

Recently, limited studies have attempted to examine the long-term relationship through cointegration techniques. However, once again these studies only consider the relationship between the two variables; such as savings and growth without taking into account the role played by investment; or by studying the relationship between investment and growth without taking into account the role played by domestic or foreign savings; or by examining the relationship between savings and investment only, ignoring their relationship to growth. Given the important relationship between the three variables in the theoretical models of growth, examining the relationship between only two variables cannot be justified.

Thirdly, all Indian studies with the exception of Saggar (2003)[3] ignore the effect of foreign inflows to growth. But Saggar in his estimations, only examines foreign savings and real growth using bivariate VARs, which are unable to model interactions with other macroeconomic variables. However, many Indian studies do examine the short-run effect of foreign direct investment (FDI) on domestic savings and growth. But there was an upsurge in FDI only after the liberalization of the economy in 1991. As explained in chapter three, India received substantial amount of inflows since independence. These were in terms of large foreign aid in the late 1950s and 1960s, commercial borrowing in the 1970s and high capital resource from non-resident Indians in the 1980s. Therefore, the role of foreign capital inflows to the growth process and its relationship with savings and investment is important in an economy such as India. By

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2 If the variables are cointegrated then the standard causality techniques lead to misleading conclusions as these tests will miss some of the "forecastibility" which becomes available through the error-correction term.

3 This is to the best of my knowledge.

only examining FDI, these studies ignore the long-term impact of foreign inflows on savings, investment and growth.

Fourth, given the importance of the relationship of savings and investment to growth in the popular growth models, many studies surveyed in the literature do not relate or refer their estimation results to the short-run dynamics of the neoclassical Solow-Swan model or long-term (permanent) effect of the endogenous AK model.

Lastly, as mentioned in the previous chapter, almost all the studies use the Augmented Dickey Fuller and/or Phillip-Perron tests to examine stationarity of the variables. These tests have been criticized on the grounds of power and size distortion. As early as 1989, Perron points out that unit root tests which do not take into account for breaks in the variables will lead to misleading results.

As a major contribution to this study, this chapter fills the above gaps by examining the interrelationships among the variables of domestic savings, domestic investment, foreign capital inflows and growth in India from 1950 to 2005, modeled in Appendix A. As per Bahamini-Oskooee and Alse (1994), advanced econometric techniques of cointegration and error-correction modelling are applied to combine the short-term information with the long-run, taking care of the important issue of structural breaks. The short-run estimates allow us to test the Solow growth model and the long-term estimates to test for the AK model of growth. Further to this, several different hypotheses can also be tested, as detailed in chapter one.[4]

No study to the best of my knowledge examines the role played by the three important determinants of savings, investment and foreign capital inflows in the growth process along with two endogenously determined structural breaks. This study goes

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4 Such as the Carroll-Weil hypothesis, F-H hypothesis, substitution between foreign capital inflows and domestic savings, the complementarity between domestic investment and foreign inflows.

further by examining the interdependencies between savings, investment and foreign capital inflows, GDP growth and two structural breaks in both the short and long-run for the Indian economy over the last 55 years.

As mentioned in chapter three, the variables in the Indian economy have trends and have been subjected to a number of structural changes, regime shifts and wars between 1950 and 2005. Therefore, in chapter four, the time series data is analysed, firstly by applying the Perron (1997) innovational outlier and additive outlier models and then by applying the Lee and Strazicich (2003) procedure. The empirical results based on these models indicate that the variables under consideration are of a mixed order of I(0) and I(1). Furthermore, the Lee and Strazicich (2003) procedure which endogenously determines two structural breaks finds that gross domestic savings, gross domestic investment and gross domestic product have two significant breaks, while with foreign capital inflows, none of the break dates are significant. The structural break dates coincide with wars, balance of payments crisis and the green revolution of the 1960s; economic reforms that took place in the mid-1980s; balance of payments crisis of 1990 and finally the deregulation in 1991.

An important contribution made by this chapter is to test for the interrelationships between gross domestic product (LGDP), gross domestic savings (LGDS), gross domestic investment (LGDI), foreign capital inflows (LFCI) and the two relevant structural break dates, estimated by the Lee and Strazicich (2003) procedure. The long-run relationship among the four variables (LGDS, LGDI, LFCI and LGDP) and the endogenously determined structural breaks are examined by using the bounds testing approach to cointegration.[5] The Autoregressive Distributed Lag (ARDL) approach is

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[5] With the exception of the author of this study, no known Indian study has used this method in looking at the relationship to GDP growth.

then used to determine the long-run and short-run coefficients via the important error correction mechanism. The importance of cointegration analysis is that it not only tests for the long-run relationship among the variables, but also by using an error correction term allows for the dynamic behaviour of the process of adjustments from short-run disequilibria to long-run equilibrium.

This chapter is divided into five sections. Along with the outlining the advantages, section 5.2 presents a brief analytical review of the ARDL model. Section 5.3 describes the specification of this model while the empirical results based on the ARDL are presented in Section 5.4. Finally, section 5.5 presents some concluding remarks.

5.2 The Autoregressive Distributed Lag (ARDL) Cointegration Approach

The cointegration concept is associated with the long-run equilibrium relationship between two or more variables. Commonly used methods for conducting cointegration tests include the residual based Engle-Granger (1987) test and the maximum likelihood based Johansen (1991; 1995) and Johansen and Juselius (1990). Others such as Gregory and Hansen (1996), Saikkonen and Lütkepohl (2000), Carrion-i-Silvestre and Sanso (2006) and Westerlund and Edgerton (2007) test for cointegration taking into account one structural break. Due to the low power and other problems associated with these tests, the ARDL bounds test approach to cointegration has become popular in recent years.[6]

The ARDL modelling approach developed by Pesaran and Shin (1998), Pesaran and Smith (1998) and Pesaran, Shin and Smith (1996, 2001) have numerous

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[6] There are numerous cointegration studies employing the ARDL model instead of the traditional maximum likelihood test based on Johansen (1988) and Johansen and Juselius (1990). Some of these studies include Atkins and Coe (2002), Bahmani-Oskooee and Nasir (2004), Ghatak and Siddik (2001), Narayan (2005) and Morely (2006), Kollias, Mylonidis and Paleologou (2008).

advantages. The main advantage of this approach lies in the fact that it can be applied irrespective of whether the regressors are I(0) or I(1) (Pesaran and Pesaran, 1997, p.302-303). Other advantages of the ARDL method over other cointegration techniques are outlined below:

- Other cointegration techniques require all variables to be integrated of order one, "which introduce a further degree of uncertainty into the analysis of levels relationships" (Pesaran *et al*. 2001, p.289).
- ARDL avoids the pre-testing problems associated with the standard cointegration techniques. The pre-testing procedure in the unit root cointegration literature is problematic, as the power of unit root tests are known to be typically low, and there is a switch in the distribution function of the test statistics as one or more roots of the x_t process approaches unity (Pesaran 1997, p.184). Generally speaking, if the researcher is not completely sure of the exact unit root properties of the data, then the ARDL is the appropriate model for empirical testing.
- Further advantage of the ARDL is that it is a more statistically significant approach for determining cointegrating relationships for a small number of observations, while the Johansen cointegration technique requires large observations to be valid. The ARDL model is more robust and performs well for small number of observations (such as this study) than other cointegration techniques. The current study though having relatively small number of observations (55), has a large sample size (1950-2005).
- By using the F-test, the ARDL cointegration method is able to distinguish which series is the dependent variable when cointegration exists (Narayan and Narayan 2003, p.11).

- A dynamic error-correction model can be derived from ARDL through a simple linear transformation (Banerjee, Dolado, Galbraith and Hendry 1993, p.51). The error correction integrates the short-run dynamics with the long-run equilibrium without losing long-run information. This is important for this study as this allows us to test the short-run transitory affect of savings and investment in the growth process, consistent of the Solow model; and the long-run permanent affect of savings and investment on growth, in line with the endogenous AK model of growth.
- Furthermore, many of the Monte Carlo results strongly indicate that the ARDL method is preferable to other methods of estimating the long-run coefficients in light of the sensitivity of the diagnostic test of the specification of the error correction model to the alternative estimation methods (Gerrard and Godfrey, 1998).
- Another difficulty with the Johansen cointegration technique (which the ARDL method avoids) concerns the large number of choices which need to be made. They choices include the treatment of deterministic elements, number of endogenous and exogenous variables to be included (if any), the order of VAR and the optimal number of lags to be specified. The empirical results are very sensitive to the method and various alternative choices available in the estimation procedure (Pesaran and Smith, 1998).

In chapter five, the unit root results show that the variables under consideration in this study are a mix of stationary and non-stationary, that is the variables consist of a mix of I(0) and I(1) series with structural breaks. This rules out the Johansen (1991; 1995) and Johansen and Juselius (1990), Gregory and Hansen (1996), Saikkonen and Lutkephol

(2000), Carrion-i-Silvestre and Sanso (2006) and Westerlund and Edgerton (2007) procedures. Moreover, as can be seen in chapter four, a slight change in specification or assumption can affect the result of the unit root test and as a consequence, a non-stationary time series may be found to be stationary and vice-versa. Even if the stationary of time series can be ascertained by the unit root tests, there still remains some risk of misspecification. For these reasons and the advantages outlined above, the ARDL modelling approach of cointegration is employed in this study to examine the relationship among the variables of LGDS, LGDI, LFCI, LGDP and the two relevant structural breaks. According to Pesaran and Pesaran (1997) and Pesaran *et al*. (2001) the augmented ARDL ($p, q_1, q_2, ..., q_k$) is given by the following equation:

$$\alpha(L, p) y_t = a_0 + \sum_{i=1}^{k} \beta_i (L, q_i) x_{it} + \lambda' w_t + \varepsilon_t \tag{5.1}$$

where $\alpha(L, p) = 1 - \alpha_1 L - \alpha_2 L^2 - ... - \alpha_p L^p$ and (5.2)

$$\beta_i(L, q_i) = \beta_{i0} + \beta_{i1} L + \beta_{i2} L^2 + ... + \beta_{iq_i} L^{q_i} \qquad i = 1,2,..k \tag{5.3}$$

Where y_t is the dependent variable, a_0 is the constant term, L is the lag operator such that $Ly_t = y_t - 1$; and w_t is a $s \times 1$ vector of deterministic variables employed such as intercept term, time trends, dummy variables and other exogenous variables with fixed lags. The x_{it} in equation (5.1) is the *i* independent variable where *i* = 1, 2..,*k*. In the long-run, we have $y_t = y_{t-1} = ... = y_{t-p}$; $x_{it} = x_{i,t-1} = x_{i,t-q}$ where $x_{i,t-q}$ denotes the q^{th} lag of the i^{th} variable.

The long-run equation with respect to a constant term can be written as follows:

$$y = a_o + \sum_{i=1}^{k} \beta_i x_i + \lambda' w_t + v_t \qquad \alpha = \frac{\alpha_o}{\alpha(1, p)} \tag{5.4}$$

The long-run coefficient for a response of y_t to a unit change in x_{it} are estimated by:

$$\phi_i = \frac{\hat{\beta}_i(1,\hat{q}_i)}{\alpha(1,\hat{p})} = \frac{\hat{\beta}_{i0} + \hat{\beta}_{i1} + ... + \hat{\beta}_{i\hat{q}}}{1 - \hat{\alpha}_1 - \hat{\alpha}_2 ... - \hat{\alpha}_{\hat{p}}} \qquad i = 1, 2, \ldots k \qquad (5.5)$$

Here $\hat{p}$ and $\hat{q}_i, i = 1,2,...,k$ are the selected (estimated) values of p and q_i , i = 1, 2,…*k*.

Similarly, the long-run coefficients are estimated by:

$$\pi = \frac{\hat{\lambda}(\hat{p},\hat{q}_1,\hat{q}_2,...,\hat{q}_k)}{1 - \hat{\alpha}_1 - \hat{\alpha}_2 - ... - \hat{\alpha}_{\hat{p}}} \qquad (5.6)$$

where $\hat{\lambda}(\hat{p},\hat{q}_1,\hat{q}_2,...,\hat{q}_k)$ denotes the ordinary least squares estimate of λ in equation (5.1) for the selected ARDL model. The error correction representation of the ARDL $(\hat{p},\hat{q}_1,\hat{q}_2,...,\hat{q}_k)$ model can be obtained by writing equation 5.1 in terms of lagged levels and the first difference of $y_t, x_{1t}, x_{2t},...,x_{kt}$ and w_t :

$$\Delta y_t = \Delta a_0 - \alpha(1,\hat{p})EC_{t-1} + \sum_{i=1}^{k} \beta_{i0}\Delta x_{it} + \lambda'\Delta w_t - \sum_{j=1}^{\hat{p}-1} \alpha^* \Delta y_{t-j} - \sum_{i=1}^{k}\sum_{j=1}^{\hat{q}_i-1} \beta_{ij} * \Delta x_{i,t-j} + \varepsilon_t \qquad (5.7)$$

Here, EC_t is the error correction term defined as follows:

$$EC_t = y_t - \hat{a} - \sum_{i=1}^{k} \hat{\beta}_i x_{it} - \lambda' w_t \qquad (5.8)$$

and Δ is the first difference operator; $\alpha * \lambda' and\ \beta_{ij} *$ are the coefficients relating to the short-run dynamics of the model's convergence to equilibrium while $\alpha(1,\hat{p})$ measures the speed of adjustment.

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.

5.3 Model Specification

To capture the autonomous time related changes, the trend variable is included in the equations. This is confirmed by the graphs in chapter three (indicating that the variables have trends) and is also consistent with the Lee and Strazicich's (2003), Model C used to identify breaks (in chapter four). Therefore, following Pesaran *et al*. (2001), the ARDL model to be estimated is a general error correction model with unrestricted intercept and unrestricted trend.[7]

The approach of the chapter is firstly, to investigate evidence of a long-run relationship by using the bounds testing approach; and secondly to estimate the long-run and short-run elasticities by using the ARDL model suggested by Pesaran *et al*. (2001). Without having any prior knowledge about the direction of the long-run relationship among the variables, the following unrestricted error correction regressions are individually estimated, taking each of the variables in turn as a dependent variable:

$$\Delta LGDP = \alpha_O + \sum_{j=1}^{n} b_j \Delta LGDP_{t-j} + \sum_{j=0}^{n} c_j \Delta LGDS_{t-j} + \sum_{j=0}^{n} d_j \Delta LGDI_{t-j} + \sum_{j=0}^{n} e_j \Delta LFCI_{t-j} + \delta_1 LGDP_{t-1} + \delta_2 LGDS_{t-1} + \delta_3 LGDI_{t-1} + \delta_4 LFCI_{t-1} + \delta_5 D64 + \delta_6 D84 + \varepsilon_{1t} \quad (5.9a)$$

$$\Delta LGDS = \alpha_O + \sum_{j=1}^{n} b_j \Delta LGDS_{t-j} + \sum_{j=0}^{n} c_j \Delta LGDI_{t-j} + \sum_{j=0}^{n} d_j \Delta LFCI_{t-j} + \sum_{j=0}^{n} e_j \Delta LGDP_{t-j} + \delta_1 LGDS_{t-1} + \delta_2 LGDI_{t-1} + \delta_3 LFCI_{t-1} + \delta_4 LGDP_{t-1} + \delta_5 D65 + \delta_6 D95 + \varepsilon_{1t} \quad (5.9b)$$

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[7] $\Delta y_t = c_0 + c_1 t + \pi_{yy} y_{t-1} + \pi_{yx.x} x_{t-1} + \sum_{i=1}^{p-1} \Psi_i' \Delta z_{t-1} + w' \Delta X_t + u_t$ where $c_0 \neq 0$ and $c_1 \neq 0$. The F-statistic tests for the null hypotheses as $H_0^{\pi_{yy}} : \pi_{yy} = 0$, $H_0^{\pi_{yx.x}} : \pi_{yx.x} = 0'$, and alternative hypotheses as $H_1^{\pi_{yy}} : \pi_{yy} \neq 0$, $H_1^{\pi_{yx.x}} : \pi_{yx.x} \neq 0'$.

$$\Delta LGDI = \alpha_O + \sum_{j=1}^{n} b_j \Delta LGDI_{t-j} + \sum_{j=0}^{n} c_j \Delta LGDS_{t-j} + \sum_{j=0}^{n} d_j \Delta LFCI_{t-j} + \sum_{j=0}^{n} e_j \Delta LGDP_{t-j} + \delta_1 LGDI_{t-1} + \delta_2 LGDS_{t-1} + \delta_3 LFCI_{t-1} + \delta_4 LGDP_{t-1} + \delta_5 D67 + \delta_6 D90 + \varepsilon_{1t} \quad (5.9c)$$

$$\Delta LFCI = \alpha_O + \sum_{j=1}^{n} b_j \Delta LFCI_{t-j} + \sum_{j=0}^{n} c_j \Delta LGDS_{t-j} + \sum_{j=0}^{n} d_j \Delta LGDI_{t-j} + \sum_{j=0}^{n} e_j \Delta LGDP_{t-j} + \delta_1 LFCI_{t-1} + \delta_2 LGDS_{t-1} + \delta_3 LGDI_{t-1} + \delta_4 LGDP_{t-1} + \varepsilon_{1t} \quad (5.9d)$$

These equations incorporate two dummy variables, denoted by *D* to capture the detected structural change effects found in chapter four using the Lee and Strazicich (2003) procedure for LGDP, LGDS and LGDI. Information on structural breaks in the time series is crucial in correctly specifying the model. The F test is used to determine whether a long-run relationship exists among the variables through testing the significance of the lagged level of the variables. When there is evidence of a long-run relationship, the F test indicates which variable should be normalised.

The parameters δ_i where *i* = 1, 2, 3, 4, 5, 6 are the corresponding long-run multipliers, while the parameters b_j, c_j, d_j, e_j are the short-run dynamic coefficients of the underlying ARDL model. In equation 5.9a, where LGDP is the dependent variable, the null hypothesis of no cointegration amongst the variables is $H_0 : \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$ is tested against the alternative $H_1 : \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq \delta_6 \neq 0$. This is denoted as $F(LGDP / LGDS, LGDI, LFCI, D1, D2)$. Similarly, the null hypothesis of non-existence of a long-run relationship in equation 5.9b, 5.9c, 5.9d where LGDS, LGDI and LFCI are the dependent variable is denoted by: $F(LGDS / LGDI, LFCI, LGDP, D1, D2)$, $F(LGDI / LGDS, LFCI, LGDP, D1, D2)$ and

$F(LFCI / LGDS, LGDI, LGDP)$ respectively.[8] The asymptotic distributions of the F-statistics are non-standard under the null hypothesis and 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 is 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. Finally, the result is inconclusive if the computed F-statistic falls within the lower and upper bound critical values. In this case, following Kremers, Ericsson and Dolado (1992), the error-correction term will be a useful way of establishing a long-run relationship.

5.4 Empirical Results based on the ARDL model

Since we have fifty-five annual observations, the maximum lag of two was chosen. The results reported in Table 5.1 show inconclusive outcomes for all the four dependent variables of LGDP, LGDS, LGDI and LFCI as the computed F-statistics are greater than the lower bound critical values but less than the upper bound critical values. In this case, as mentioned earlier, the error-correction term will be a useful way of establishing cointegration (Bannerjee, Dolado and Mestre, 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

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[8] The structural break dates for LFCI were not significant and thus not included in this equation, i.e. δ_5 and δ_6 net to zero.

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.

Table 5.1: F-Statistics for Testing the Existence of a Long-Run Relationship among the Variables:
LGDS, LGDI, LFCI, LGDP and the Respective Structural Break Dates.

Equation	The calculated F-statistic
$F(LGDP / LGDS, LGDI, LFCI, D1, D2)$	4.2189
$F(LGDS / LGDI, LFCI, LGDP, D1, D2)$	4.1449
$F(LGDI / LGDS, LFCI, LGDP, D1, D2)$	4.0996
$F(LFCI / LGDS, LGDI, LGDP)$	4.1140

The relevant critical value bounds are obtained from Table CI (v) Case V: unrestricted intercept and unrestricted trend (Pesaran *et al*. 2001). The critical values for the five regressors are 3.12 (lower bound) and 4.25 (upper bound) at the five percent significance level. This is the case for LGDS, LGDI and LGDP. For LFCI, we have only three regressors and the relevant critical value bounds are 4.01(lower bound) and 5.07 (upper bound) at the five percent significance level.

The next step is to estimate the long-run and short-run coefficients of the ARDL model by normalising on each of the four variables of LGDP, LGDS, LGDI and LFCI in turn. The ARDL method estimates $(\rho+1)^k$ number of regressors in (5.7) in order to obtain the optimal lag of each variable, where ρ the maximum number of lag to be used and k is the number of variables in the equation. As we have fifty-five annual observations, this study uses the Akaike Information Criteria (AIC) method with the maximum (ρ) lag of two.[9]

9 With the sample size of 55 years, the choice of a long lag length can lead to over-parameterisation.

Chapter four determines a number of significant structural breaks in the Indian economy over the last five decades. Based upon these results and as the literature has not yet provided a test for cointegration with endogenously determines multiple structural breaks,[10] the two relevant structural breaks will be accounted for by the inclusion of break point dummy variables in the ARDL model. In equation 5.9a to 5.9c, two dummy variables are included. The two dummy variables take the value of 0 until the break year and then 1 afterwards. The break years for LGDP are 1964 and 1984; for LGDS, 1965 and 1995; and for LGDI, 1967 and 1990.[11] The empirical results of the long-run and short-run coefficients on gross domestic product, savings, investment and foreign capital inflows for India are obtained by normalizing on LGDP, LGDS, LGDI and LFCI. These are presented in Tables 5.2-5.5.

5.4.1 Gross Domestic Product

With gross domestic product (LGDP) as the dependent variable, this allows us to test two important hypotheses, that savings promote economic growth and investment is the driver of economic growth in the long-run. To test the long-term effect of savings and investment on growth in the endogenous AK model and the short-term transitory effect of the Solow-Swan model, we normalise on LGDP to determine the role of savings, capital formation and foreign inflows in promoting economic growth. The conditional error correction has the AIC lag specification (1, 0, 1, 0) where the numbers represent the lags of the variables listed in order in 5.9a. Long and short-run coefficient estimates

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10 Methods such as Gregory and Hansen (1996), Carrion-i-Silvestre and Sanso (2006) and Westerlund and Edgerton (2007) test for cointegration allowing for a possibility of a structural break. However, it takes into account only one structural break, and the literature regarding cointegration tests with multiple structural breaks thus far has been scant.

11 According to Harvey *et al.* (2001), choosing the break date at one observation later such as *Tb*+1 rather than the suggested *Tb* will overcome an asymptotic size distortion

are reported in Table 5.2. The results indicate that only foreign capital inflows have a long and short-run positive impact on growth in India; not domestic savings nor domestic investment. A one percent increase in foreign capital inflows will have a significant positive impact on GDP growth by 0.14 percent in the long-run and a smaller increase of 0.03 percent in the short-run, both significant at the one percent level.

The result in Table 5.2 also indicates that gross domestic investment has a negative impact on GDP growth, but this significant at only at the ten percent.[12] A one percent increase in domestic investment will result in a decrease in GDP growth by 0.45 percent, contradicting the mainstream view that investment is crucial in explaining growth.

The trend and the structural dummy variable for 1964 are also significant, confirming the analysis in chapters three and four. The structural dummy variable of 1964 has a negative sign indicating that the structural change has a negative long and short-run impact on GDP. The structural change that took place in 1964 coincides with the change in government, wars with China and Pakistan in the early 1960s and as expected, these events have a negative impact on the performance of GDP growth. The dummy variable of 1964 in the short-run shows that there is a slight reduction of 0.03 in ΔGDP in the period 1964 to 1984, significant at the five percent significance level.

The error correction model of the selected ADRL is (1, 0, 1, 0) as shown in Table 5.2 is significant at the one percent level with the expected negative sign. The ecm(-1) represents the speed of adjustment of ΔGDP to its long-run equilibrium following a

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12 This is consistent with the Ganger-causality tests by Sandilands and Chandra (2003) who find that the growth of government investment has a negative and significant impact on economic growth.

shock. The ecm(-1) of -0.22 suggests that that a deviation from the long-run equilibrium level of GDP growth in one year is corrected by about 22 percent in the next year. Moreover, a significant error correction confirms the existence of a stable long-run relationship between the significant regressors and the dependent variable, LGDP.

Table 5.2: Estimated Long-Run Coefficients and Short-Run Error Correction Model (ECM)
Dependent Variable: LGDP

The long-run coefficients estimates based on ARDL (1, 0, 1, 0) selected lags based on AIC			ECM-ARDL: dependent variable: Δ LGDP based on ARDL (1, 0, 1, 0) selected lags based on AIC		
Regressor	Coefficient	T-Ratio	Regressor	Coefficient	T-Ratio
LGDS	-0.0258	-0.1912	$\Delta LGDS_t$	-0.0057	-0.1916
LGDI	-0.4537	-1.8730*	$\Delta LGDI_t$	0.0192	0.4226
LFCI	0.1437	3.0788***	$\Delta LFCI_t$	0.0315	2.5987***
Constant	15.3968	7.6037***	Constant	3.3831	3.2782***
Trend	0.0650	4.9301***	Trend	0.1427	3.2466***
D1964	-0.1588	-2.2689**	Δ D1964	-0.0349	-2.0686**
D1984	0.0257	0.35056	Δ D1984	0.0057	0.35085
			ecm(-1)	-0.2197	-2.9099***

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

An important result that emerges from this estimation is that neither domestic saving nor domestic investment has a significant positive impact on growth in either the long and short-run in the Indian economy. This finding does not support policies designed to increase domestic savings and investment in order to promote economic growth in India. There is no evidence of the popular long-term permanent endogenous explanation of economic growth or Solow's short-run dynamic effect of savings and investment on growth for India. This is further fuelled by the result of a negative impact of gross domestic investment on economic growth in the long-run, providing no support for the AK model that investment is the driver of long-run economic growth. These findings are in line with Sahoo *et al*. (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".[13]

But these results refute the claims made by Saggar (2003) that "total investment rate does Granger cause real GDP growth rate"[14] and Athukorala and Sen (2002) who find that a one percent increase in investment rate leads to a 0.24 percent increase in GDP growth, significant at the one percent level.[15] However, this important result is firstly, in line with the trends in chapter three which indicates that the growth rates of domestic savings and investment as a percentage of GDP has declined over the growth decades (Figure 3.13). Secondly, this result is consistent with the observations in Figure 3.1 which shows that the long-run growth in real GDP and foreign capital inflows is very different to the aggregate measures of savings and investment in India over the period of study.

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13 Sahoo *et al*. (2001) examine the causal nexus between savings and economic growth in India including one break in savings and gross domestic product. But they fail to take into account the effect of investment or foreign capital inflows. Sandilands and Chandra (2003) when examining the relationship of investment to growth fail to take into account the effect of domestic or foreign capital inflows as well as any structural break.

14 Saggar's (2003) results are only based on short-run Granger F-statistic on bivariate VARs between real GDP growth and total investment, without taking into account the effect of savings or foreign capital inflows or any structural breaks.

15 Athukorala and Sen (2002) use OLS to test the Scott's (1989) model for GDP and the rate of aggregate investment which include two exogenous dummy variables in 1965 and 1979. However they ignore the effects of savings (domestic and foreign).

5.4.2 Gross Domestic Savings

Long and short-run coefficient estimates when gross domestic savings (LGDS)[16] is the dependent variable are reported in Table 5.3. With the dependent variable of LGDS, the Carroll-Weil hypothesis and the traditional hypothesis that foreign inflows are a substitute for domestic savings is tested.[17] The lags of the variables are given by AIC as ARDL (1, 1, 2, 0). Table 5.3 indicates that none of the three variables of investment, foreign inflows or GDP growth has a significant long-run impact on gross domestic savings.

However, in the short-run, the results indicate that investment positively affects savings. A one percent increase in investment will lead to an increase in savings by 0.48 percent, significant at the five percent level. On other hand, an increase in one period lagged foreign capital inflows by one percent will lead to a slight fall in savings of 0.18, significant at the one percent level. This indicates higher levels of foreign capital inflows are associated with lower gross domestic savings and is consistent with the traditional hypothesis that foreign inflows is a substitute for domestic savings.

Neither of the dummy variables is significant which implies either the effects of the structural changes are common across the variables (so that they tend to net out in the simultaneous specification) or the two variables are not enough to approximate the range of detected changes shown in the previous chapter.

The error-correction term, ecm(-1) represents the speed of adjustment to restore equilibrium in the dynamic model following a disturbance, has a negative sign and

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[16] Household savings in physical assets is identical to household investment. Thus, for our estimation purposes, to avoid double counting, household savings in physical assets component is eliminated from total gross domestic savings.

[17] The relationship between foreign capital inflows and domestic savings has long been thought of to be strong and negative.

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 -0.40 for savings suggests that deviation from the long-term domestic savings path in this period is corrected by 40 percent over the following year.

The above result does not provide support for the Carroll-Weil hypothesis found in a number of studies (in the literature review chapter). This could be due to a number of factors. Firstly, this study takes all the important variables into account. Secondly, this study explicitly distinguishes between the long-run and short-run relationship; and lastly this study takes into account two endogenously detected structural breaks.

Table 5.3: Estimated Long-Run Coefficients and Short-Run Error Correction Model (ECM)
Dependent Variable: LGDS

The long-run coefficients estimates based on ARDL (1, 1, 2, 0) selected lags based on AIC			ECM-ARDL: dependent variable: Δ LGDS based on ARDL (1, 1, 2, 0) selected lags based on AIC		
Regressor	**Coefficient**	**T-Ratio**	**Regressor**	**Coefficient**	**T-Ratio**
LGDI	0.1527	0.2331	Δ LGDI$_t$	0.4792	0.2475**
LFCI	0.0189	0.1217	Δ LFCI$_t$	0.0050	0.0595
			Δ LFCI$_{t-1}$	-0.1812	-2.5936***
LGDP	0.7483	0.4813	Δ LGDP$_t$	0.3009	0.5223
Constant	-1.639	-0.0868	Constant	-0.6590	-0.0877
Trend	0.0373	0.4852	Trend	0.0138	0.4649
D1965	-0.2308	-1.1043	Δ D1965	-0.0928	-1.0772
D1995	-0.3415	-1.0783	Δ D1995	-0.1373	-1.3979
			ecm(-1)	-0.4021	-2.6240***

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

Next we turn our attention to gross domestic investment (LGDI) and foreign capital inflows (LFCI) as the dependent variables. Theoretical models argue that a degree of complementarity or substitution exists between foreign capital inflows (especially FDI) and domestic investment. The assumption is that that the total stock of knowledge in the recipient economy depends on domestic and foreign owned physical stocks (Dunning, 1981). Also, foreign capital inflows are expected to affect the economy's growth positively, and this increase in growth results via investment.

5.4.3 Gross Domestic Investment

With gross domestic investment (LGDI) being the dependent variable, it allows us to test the above complementarity or substitution hypothesis between LGDI and LFCI and the two growth models. Lastly, we are able to test the Feldstein and Horioka (1980) hypothesis of international capital mobility which implies that there should be no relation between domestic savings and domestic investment.

The results reported in Table 5.4 indicate that two of the three regressors have significant long-run and short-run impacts on investment; namely domestic savings and foreign capital inflows. A one percent increase in domestic savings will lead to a 0.37 percent increase in domestic investment, significant at the one percent level. This finding supports the endogenous AK growth model, that savings determine investment in the long-run and is also consistent with the trends in chapter three (which show that domestic investment has been predominately financed by domestic savings). The positive relationship between savings and investment is specified in equations (3) and (10), $s = \dot{b} = y - e^{\int_0^t \theta(r(s)-\rho)ds}$ and $\dot{k} = \phi\left[\int_t^\infty (y')e^{-\rho(s-t)}ds - 1\right]$.[18]

This existence of a long-run relation between these two ratios could imply greater macroeconomic stability in these two economies as domestic investment is not dependent on foreign savings and therefore, the influence of external forces on these two economies is smaller relative to those that rely on foreign savings to finance their investment.

This existence of a long-run relation between domestic savings and domestic investment is also consistent with the Feldstein and Horioka (1980) hypothesis where a high correlation between saving and investment is often taken as evidence of capital immobility. The coefficient of 0.37 suggests that there has been a substantial degree of capital movement in India, in the overall period of study, 1950-2005. However, unlike the long-run findings, savings is not affecting investment in the short-run. The absence of short-run causality running from savings to investment implies a high degree of short-run international capital mobility. This is to be expected as the reforms in the India economy (discussed in chapter three) started to take place in mid-1980s leading to formal deregulation of the Indian economy in 1991, therefore leading to a higher degree of openness in the short-run.

The results also indicate that a one percent increase in foreign capital inflows lead to a 0.12 percent increase in gross domestic investment, significant at the one percent level. This long-run result is consistent with the short-run findings where once again foreign capital inflows have a positive impact on gross domestic investment in the short-run. A one percent increase in foreign capital inflows will lead to 0.15 percent

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18 These equations are part of the model given in Appendix A.

increase in gross domestic investment in the short-run at the one percent level of significance. These short and long-run findings support the complementarity hypothesis between foreign capital inflows and domestic investment in India.

Table 5.4: Estimated Long-Run Coefficients and Short-Run Error Correction Model (ECM)
Dependent Variable: LGDI

The long-run coefficients estimates based on ARDL (2, 1, 0, 2) selected lags based on AIC			ECM-ARDL: dependent variable: Δ LGDI based on ARDL (2, 1, 0, 2) selected lags based on AIC		
Regressor	**Coefficient**	**T-Ratio**	**Regressor**	**Coefficient**	**T-Ratio**
			$\Delta LGDI_{t-1}$	0.2639	2.2291**
LGDS	0.3681	4.1640***	$\Delta LGDS_{t}$	0.1418	1.5828
LFCI	0.1234	5.2514***	$\Delta LFCI_{t}$	0.1506	3.7969***
LGDP	-0.0083	-0.0347	$\Delta LGDP_{t}$	0.3806	0.9582
			$\Delta LGDP_{t-1}$	0.8015	1.9476*
Constant	5.4869	1.7042*	Constant	6.6949	1.5330
Trend	0.0280	2.0133**	Trend	0.0341	1.7567*
D1967	-0.0094	-2.0708**	Δ D1967	-0.1158	-0.2059
D1990	-0.1460	-3.3074***	Δ D1990	-0.1782	-3.2699***
			ecm(-1)	-1.2202	-7.1542***

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

The trend and both the structural dummy variables of 1967 and 1990 are also significant at the five and one percent levels respectively. This indicates that the structural change has a long-run negative impact on investment. The structural break dates of 1967 and 1990 coincide with severe droughts in the years 1965-1967, the balance of the payment crisis in 1966 and then again in 1990 at the onset of financial reforms. The dummy variable of 1990 in the short-term shows that there is a reduction of 0.18 in ΔLGDI in the reform period of 1990 to 2005, significant at the one percent level.

Another interesting result from Table 5.4 in short-run is that a one-period lag GDP growth will increase domestic investment by 0.80 percent, significant at the ten percent level. Even though this is only significant at the ten percent level, this does contradict the mainstream view that investment is important in the growth process for India.

Apart from these relationships, the error correction mechanism for gross domestic investment with a value of -1.22 is of the correct sign and significant at the one percent level. This large elastic magnitude indicates considerable overshooting behaviour for domestic investment in the short-run equilibrating process.

5.4.4 Foreign Capital Inflows

Lastly, equation 5.9d which represents a conditional error correction version of the ARDL model for foreign capital inflows (LFCI) is estimated. The important relationships of foreign capital inflows to domestic investment and gross domestic product are tested here. The AIC lag specification is ARDL (1, 0, 1, 2) and the long and the short-run coefficient estimates are reported in Table 5.5. The results show that among the variables, gross domestic investment and GDP growth have positive long-run impacts on foreign capital inflows. A one percent increase in investment and GDP leads to an increase in foreign capital inflows by large 4.0 and 4.2 percents respectively, significant at the one percent level. This result points to a feedback effects between foreign capital inflows and growth in the long-run. Relationship (4), $c+\dot{b}+\dot{b}_f = w^n + rb + rb_f$ details this feedback effect between the two.

However, the impact of growth in attracting foreign capital inflows is much stronger than that of foreign capital inflows in inducing economic growth in the long-run. As expected, the long and short-run feedback also exists between domestic investment and foreign capital inflows in India; the impact of domestic investment in attracting foreign capital inflows in the long-run is more than thirty times larger than that of foreign capital inflows in inducing domestic investment. The feedback effect between the two can be explained in 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 is resulting in larger inflows of foreign capital.

Similar results are found in the short-run with both gross domestic investment and one period lagged GDP growth, both significantly affecting foreign capital inflows, but this time GDP has a negative effect on foreign inflows. An increase in domestic investment and one period lagged LGDP by one percent will lead to an increase by 0.66 (much lower than the long-run results) and a decrease by 2.83 percent respectively in foreign capital inflows, significant at the five and one percent level.

The ecm(-1) suggests that that following a shock, about 40 percent of the adjustment back to equilibrium is completed after a year. Moreover, a significant error correction term confirms the existence of a stable long-run relationship between the significant regressors and the dependent variable, LFCI.

Table 5.5: Estimated Long-Run Coefficients and Short-Run Error Correction Model (ECM)

Dependent Variable: LFCI

The long-run coefficients estimates based on ARDL (1, 0, 1, 2) selected lags based on AIC			ECM-ARDL: dependent variable: Δ LFCI based on ARDL (1, 0, 1, 2) selected lags based on AIC		
Regressor	**Coefficient**	**T-Ratio**	**Regressor**	**Coefficient**	**T-Ratio**
LGDS	0.0982	0.1843	Δ LGDS $_t$	0.0386	0.1855
LGDI	4.0302	4.5186***	Δ LGDI $_t$	0.6555	1.9689**
LGDP	4.1824	4.4019***	Δ LGDP $_t$	1.4604	1.4274
			Δ LGDP $_{t-1}$	-2.8279	-2.6625***
Constant	-80.9225	-5.6490***	Constant	-31.8104	-5.2309***
Trend	-0.3411	-4.9103***	Trend	-0.1341	-5.3102***
			ecm(-1)	-0.3931	-5.0667***

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

To ascertain the appropriateness of the ARDL model, diagnostic and stability tests are conducted. Key regression statistics of the ARDL are also employed for sections 5.4.1 to 5.4.4. These are provided in Appendix B. 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 four 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 four models are statistically significant at the one percent level. Lastly, the Durbin-Watson statistic for all the models are over two (LGDP, LGDS and LGDI) or close to two (LFCI).

Finally, the stability of the regression coefficients is evaluated using the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMQ). According to Bahmani-Oskooee (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. It is clear from Appendix B that the plots of both the CUSUM and CUSUMQ for all the four variables are within the boundaries.

5.5 Summary

The main purpose of the chapter is to examine the long and short-run interrelationships among gross domestic product, gross domestic savings, gross domestic investment and foreign capital inflows for the period 1950-2005, taking into account the two relevant endogenously determined structural breaks. The short-run estimates allow us to test for the dynamics of the Solow growth model and the long-term estimates to test for the AK model of growth, that savings and investment have a permanent effect on growth. Further to this, by normalising in turn each variable as the dependent variable, allows the testing of several different hypotheses.

As a significant contribution to this study, the bounds testing approach to cointegration is used to test for the long-run relationship among the variables. Taking each variable in turn as the dependent variable, the F-test indicates inconclusive results in all the four cases. However, the long-run and short-run coefficients using the ARDL estimator brings out seven conclusions.

Firstly and most importantly, the results indicate that neither domestic savings nor investment have any positive impact on GDP growth in India. This result is robust in both the short-run and the long-run, providing no evidence for either the short-run dynamic affect of savings and investment on growth (the Solow model) or the permanent long-run affect of savings and investment on growth (the AK model of growth) in India.

Secondly, a foreign capital inflow affects economic growth in both the short and long-runs. There is a feedback effect between foreign capital inflows and GDP growth in the long-run; with the effect from GDP to foreign capital inflows much larger than that from foreign capital inflows to GDP. 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.

Thirdly, foreign capital inflows may have stimulated economic growth but they are found to be negatively related to domestic savings in the short-run, indicating a substitution between the two. An increase (decrease) in domestic savings requires less (more) reliance on savings from the rest of the world. It could be argued here that foreign savings has pushed out the domestic effort to save.

Fourth, the results support the view that savings drive investment in the long-run. Whilst savings affecting investment is expected, there is the serious missing link between investment and GDP growth. This missing link also importantly qualifies the endogenous growth explanation. An existence of a long-run relationship between domestic savings and domestic investment is also consistent with the Feldstein and Horioka hypothesis, but the result suggests evidence of perfect capital mobility in the short-run.

Fifth, feedback exists between domestic investment and foreign capital inflows in both the long-run and short-run. The impact of domestic investment in attracting foreign capital inflows is much stronger than in reverse, supporting the complementarity hypothesis. The link of foreign capital inflows supplementing domestic investment indicates that the productive capacity of the economy will increase and thus there will be an increase in national income. This increase in national income will increase savings. But, once again there is a missing link for productive investment to growth in the Indian economy.

Consistent with the fifth conclusion, short-run results indicate that gross domestic investment effects gross domestic savings. A one percent increase in gross domestic investment will increase gross domestic savings by 0.48 percent in the short-run, significant at the five percent level.

Finally, the structural dummy variable analysis for both GDP growth and gross domestic investment are significant. They indicate firstly, the short-run change in GDP decreases by 0.03 in 1964, significant at the five percent level; and secondly, a reduction of 0.18 in the period of financial reforms, 1990 to 2005 for gross domestic investment, significant at the one percent level.

Applying the error correction version of the ARDL model shows that the error correction coefficients have an expected and highly significant sign. The error corrections are of the correct sign with relatively faster adjustment to equilibrium for investment. The estimated model passes a battery of diagnostic tests as well as the CUSUM and CUSUMQ graphs indicating that the model is stable during the sample period.

The analysis of Indian savings and investment with endogenously determined structural breaks does not support the commonly accepted models of economic growth. There is no evidence for India which supports the short-run dynamics of savings and investment of the Solow growth model or the long-run permanent affect of endogenous

AK model of growth. Accordingly, the policy prescriptions to promote economic growth are not straightforward in India. However, there is support for the open economy model as empirical estimates provide support in that foreign capital inflows affects economic growth, both in the short and long-run.

Perhaps, the lack of detected connections between GDP and gross domestic savings and investment is due to the analysis of broad aggregate measures. Therefore, in order to shed further light on these possible interdependencies, the next chapter will consider disaggregated gross domestic savings and investment into household, private corporate and public sectors.

CHAPTER SIX

DISAGGREGATE ANALYSIS: SAVINGS, INVESTMENT, FOREIGN CAPITAL INFLOWS AND GDP GROWTH

6.1 Introduction

This chapter disaggregates gross domestic saving and gross domestic investment into three components of household, private corporate and public sectors in its estimations. The importance of the three sectors of gross domestic saving and gross domestic investment is highlighted in chapter three and the important interrelationships between these sectors will provide valuable insights for policy makers. Therefore, this chapter extends the previous analysis in chapter five and considers the long-run and short-run relationship between household, private corporate and public sector savings and investment, foreign capital inflows and economic growth for India over the period 1950-2005. This chapter uses the ARDL procedure to test for both the long-run and short-run effects between the eight variables, along with any endogenously detected structural breaks. To the best of the author's knowledge, there is no known study that has examined the interrelationships between the sectoral savings and investment, foreign capital inflows and real GDP with endogenous structural breaks for India. This chapter (and chapter five) are therefore major contributions.

6.2 Background

The literature review in chapter two surveys the major empirical studies on savings, investment and foreign inflows in promoting economic growth in India. It appears that there is no comprehensive study available on the analysis of the interdependences between savings and investment for the household, private corporate and public sectors and GDP growth. This chapter therefore intends to fill this gap by exploring these interdependencies for India from 1950 to 2005 with an emphasis on any potential structural breaks.

Chapter three discusses the significant changes in patterns of the three sectors of savings and investment; household, private corporate and public. The changes in the sectors are quite visible in their respective shares to the total domestic savings and investments, with the household sector dominating. The trends in chapter three show that household savings has increased from 65 per cent to over 85 per cent of India's gross domestic savings during the decades from 1950 to 2005. Further to this, the importance of the household sector is highlighted by the recent comments of Mohan (2008) and Reserve Bank of India (2007) in its annual policy statement for 2007/08. Mohan (2008) in his paper remarks that "A remarkable feature of the Indian macroeconomic story since independence has been the continuous rise in household savings over the decades" and Reserve Bank of India (2007) states that "the household savings is the lion's share of total savings".

Whilst household investment is relatively less important, it contributes a stable and sizeable 40 to 50 per cent of total gross domestic investment over the same period. Therefore, 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 3.7 also shows the relative sizes of the other sectors in gross domestic savings are varying over time with evidence of crowding out between private and public savings. The variation in the relative sectoral investment shares is even higher according to Figure 3.11 and the contribution of public investment is declining since the late 1980s. There is also a reversal in the shifts for household and private corporate investment in the mid 1990s. The data shown in Figures 3.7 and 3.11 and Tables 3.1 and 3.5 describe a dynamic process involving changing relative shares and trends across sectors over a fifty-five year period.

Overall, with these changes in the savings and investment patterns of the three sectors from 1950 to 2005, Palakkeel (2007) rightly concludes that this "makes the position of household more crucial" and "The huge share, which households' hold in the total national savings, shows that any changes in the households' assets portfolio can exert considerable impact upon the savings and investment patterns in the Indian economy".

As a major contribution to this study, this chapter undertakes a comprehensive analysis in terms of sectoral savings, sectoral investment, foreign capital inflows and growth in the Indian economy. The open economy model derived in Verma and Wilson (2004) will be estimated.[1] This model explains the interdependencies between sectoral savings and investment along with foreign capital inflows and growth. As explained earlier, the relevant variables are all real variables in 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). We follow the same procedure as before, where firstly, the variables will be tested for nonstationarity under structural change in section 6.3. This is in line with the discussions on considerable breaks and trends identified in chapters three and four. Secondly, the long-run relationship among the eight variables and the potential structural break dates is examined by using the bounds testing approach to cointegration in section 6.4. The ARDL approach is then used to determine

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[1] The model, given in Appendix D, is a modified version of the original model in Verma and Wilson (2004).

the long-run and short-run coefficients via the important error correction mechanism. Finally, section 6.5 summarises the key findings to conclude the chapter.

6.3 Lee and Strazicich (2003) 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. This is done for the variables of the three sectors of savings and investment, LHHS, LPRS, LPUS, LHHI, LPRI and LPUI. Throughout, model C is considered, which allows for two changes in the level and trend.[2] If both the breaks are significant, the results are reported in Table 6.1 as is the case for LPRI. LPRI is found to be stationary with two significant breaks in level (B_{jt}) and/or trend (D_{jt}).[3] 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.[4] 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 and LPRS 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 is non-stationary. LGDP and LFCI results (from chapter four) indicate that LGDP is stationary with two breaks in 1964 and 1984; and LFCI contains is non-stationary with no breaks.

The breaks in the investment variables of LPRI (1962 and 1980), LPUI (1977) and LHHI (1991) are consistent with the observations in chapter three, where these breaks

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2 The graphs in chapter three show considerable trends for the variables and allow us to be consistent with the estimations in chapter four.

3 *t* values are significant at least 5 percent.

4 Lee and Strazicich (2004) one break model is explained in Appendix C.

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 also consistent with the observations and discussions in chapter three where LPUS reaches negative figures in 1999 before rebounding back in 2003.

Table 6.1: 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

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 (λ = (0.2,0.8)= -5.71; 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.

Along with the structural break dates, the results in Table 6.1 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.[5]

6.4 Autoregressive Distributed Lag (ARDL)

The approach is firstly to investigate evidence of a long-term relationship by using the bounds testing approach to cointegration; and secondly to estimate the long-run and short-run elasticities by the ARDL model suggested by Pesaran *et al*. (2001). The results reported in Table 6.2 shows that the null hypothesis of no cointegration among the variables is rejected when LHHS, LPRS, LPUS, LHHI, and LPRI are the respective dependent variables. The calculated F-statistic for these variables is greater than the upper bound critical value at the five percent significance level. This result suggests that there exists a long-run relationship between LHHS and the variables of LPRS, LPUS, LHHI, LPRI, LPUI, LFCI and LGDP, where its right hand side variables of LPRS, LPUS, LHHI, LPRI, LPUI, LFCI and LGDP can be treated as the 'long-run forcing variables' for the explanation of LHHS. Similarly, a long-run relationship exists between LPRS and the right hand side variables and these right hand side variables can be treated as the 'long-run forcing variables' for the explanation of LPRS. This is also true for the LPUS, LHHI and LPRI which also include one or two structural dummy variables.

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[5] The advantages of the ARDL modelling are explained in chapter five.

Table 6.2: F-Statistics for Testing the Existence of a Long-Run Relationship among the Variables

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

With respect to LGDP as per the aggregate results in chapter five, the results are inconclusive as the computed F-statistic (3.07) falls within the lower and upper bound critical values (2.43-3.56) at the five percent significance level. The results in Table 6.2 also indicate inconclusive results when LPUI and LFCI are the dependent variables at the ten percent level, as the F-statistics fall between the lower and the upper bound critical values. Under these inconclusive cases, following Kremers *et al*. (1992), Bannerjee *et al*. (1998) and Bahmani *et al.* (2004), the error correction term will be a useful way of establishing a long-run relationship. Therefore, subsequent estimations of the short and long-run parameters will yield further information on the significance of these variables.

The results in Table 6.2 shows the importance of disaggregating the savings and investment variables into the three sectors of household, public and private corporate. These F-statistics of the bounds testing approach to cointegration clearly show the existence of a long-run relationship among the variables. This is in contrast with the estimations in chapter five were the aggregate variables of domestic saving and domestic investment show inconclusive outcomes in terms of cointegration.

Given that the test results suggest that a long-run cointegrating relationship exists between the variables, both the long and short-run coefficients are now estimated. To be consistent with the estimations done in chapter five for the aggregate variables and with a data set of fifty-five annual observations, this study uses the AIC method with the maximum (ρ) lag of two.

6.4.1. Gross Domestic Product

Firstly, we normalise on LGDP to determine if any role is played by the three sectors of gross domestic savings and gross domestic investment; and foreign inflows in promoting economic growth in India. The AIC lag specification for LGDP is ARDL (1, 1, 0, 0, 1, 0, 1, 0) where the numbers represent the lags of the variables. Long and short-run coefficient estimates are reported in Table 6.3. As per the results in the previous chapter, Table 6.3 indicates 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 intercept and trend are also significant in both the long and short-run, at the one percent level.

The aggregate estimations in chapter five show that in India, the gross domestic savings and gross domestic investment are not affecting GDP growth in either the long or the short-run. These results are reinforced here with 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.

This important conclusion of the absence of any significant long-run relationships between the savings and investment variables and real GDP is consistent with the data reported in Figure 3.1, which shows that GDP has been growing very differently to savings and investment in India. This implies an imprecise relationship from capital formation (LHHI and LPRI) to output (LGDP) via the production function, $y = f_h\left(k^n{}_h\right) + f_p\left(k_p, k_g, n_p, A\right)$.[6] 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

6 These relationships are explained in Appendix D.

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.

Table 6.3: Estimated Long-Run Coefficients and Short-Run Error Correction Model (ECM)

Dependent Variable: LGDP

The long-run coefficients estimates based on ARDL (1, 1, 0, 0, 1, 0, 1, 0) selected lags based on AIC			ECM-ARDL: dependent variable: Δ LGDP based on ARDL (1, 1, 0, 0, 1, 0, 1, 0) selected lags based on AIC		
Regressor	**Coefficient**	**T-Ratio**	**Regressor**	**Coefficient**	**T-Ratio**
LHHS	0.0110	0.2972	$\Delta LHHS_t$	0.0246	1.0827
LPRS	0.0605	1.4704	$\Delta LPRS_t$	0.0325	1.2552
LPUS	-0.0009	-0.2868	$\Delta LPUS_t$	-0.0005	-0.2810
LHHI	0.0187	0.3693	$\Delta LHHI_t$	0.0517	1.6288
LPRI	-0.0024	-0.1293	$\Delta LPRI_t$	-0.0013	-0.1295
LPUI	-0.1218	-1.8365*	$\Delta LPUI_t$	0.0389	0.9875
LFCI	0.0730	3.1374***	$\Delta LFCI_t$	0.0393	3.2687***
Constant	11.6460	13.3733***	Constant	6.2606	4.3315***
Trend	0.0398	6.4239***	Trend	0.0214	4.3130***
D1964	-0.0596	-1.8189*	D1964	-0.0320	-1.8878*
DU1984	0.02517	0.0252	DU1984	0.0135	0.8540
			ecm(-1)	-0.5374	-4.0519***

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

6.4.2 Savings

This section, with each of the three sectors of savings being the dependent variable, allows us to test three key relationships. Firstly, the relationship between sectoral savings and sectoral investment is examined. Only Sinha (2002), Seshaiah and Sriyval (2005) and Verma (2007) examine the relationship between savings and investment in India; but these three studies only consider the measures in aggregate levels. To best of the author's knowledge, no known studies have examined the relationship between sectoral savings and sectoral investment. Secondly, the relationship between the three sectors of savings is tested. The two Indian studies of Athukorala and Sen (2002) and Saggar (2003) examine the relationship between private and public sectors but these studies combine the household sector and the private corporate sectors together. Athukorala and Sen find that pubic sector savings is a substitute for private corporate savings, where a one percentage point increase in public savings is associated with an 0.53 percentage point reduction in the private savings rate. This is consistent with the long-run result of Saggar who finds that public savings crowds out private savings. Lastly, we test for one of the main conclusions to come out of the literature review in chapter two, the existence of the Carroll-Weil hypothesis (1994). To test these three key relationships for India, we normalise in turn on each of the sectoral savings of household (LHHS), private (LPRS) and public (LPUS) sectors.

Tables 6.4 and 6.5 show 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. Further to this, an increase in LGDP by one percent leads to an increase in LHHS by 1.37 in the short-run, significant at the ten percent level. These values support the Carroll-Weil hypothesis where growth is affecting savings and not vice-versa. This result is different to that found in the previous chapter where LGDP was found not to affect gross domestic savings, however is consistent with the long-run supply side intertemporal optimization specified in equation (3) $s_h = \dot{b}_p + \dot{b}_g = \alpha y_h - e^{\int_0^t \theta(r(s)-\rho)ds}$.[7]

The importance of the disaggregated sectors of savings is shown here once again as no evidence is found of the Carroll-Weil hypothesis in the aggregated chapter five when LGDS is the dependent variable. However, with the disaggregation of LGDS into household, public and private sectors in this chapter, evidence of the Carroll-Weil hypothesis is prominent.

6.4.2.1 Household Savings

When household savings (LHHS)[8] is the dependent variable, the results in Table 6.4 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. Relationship $\dot{k}_g = (\tau_h + \tau_p) + (\dot{b}_g - rb_g)$ details this expected strong and direct effect between public investment, $\dot{k}_g$ and household savings, $\dot{b}_g$.

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[7] Relationships are modelled in Appendix D.

[8] Household savings is equal to savings in financial assets only as explained in the data section in chapter three.

Table 6.4: Estimated Long-Run Coefficients and Short-Run Error Correction Model (ECM)

Dependent Variable: LHHS

The long-run coefficients estimates based on ARDL (2, 0, 0, 1, 2, 0, 1, 1) selected lags based on AIC			**ECM-ARDL: dependent variable: Δ LHHS based on ARDL (2, 0, 0, 1, 2, 0, 1, 1) selected lags based on AIC**		
Regressor	**Coefficient**	**T-Ratio**	**Regressor**	**Coefficient**	**T-Ratio**
			Δ LHHS $_{t-1}$	-0.3334	-2.7810***
LPRS	0.2797	1.025	Δ LPRS $_t$	0.15918	1.0380
LPUS	-0.0045	-0.2658	Δ LPUS $_t$	-0.0026	-0.2620
LHHI	-1.6209	-2.9596***	Δ LHHI $_t$	-0.5362	-3.5441***
LPRI	-1.0881	-2.8078***	Δ LPRI $_t$	-0.3107	-3.2889***
			Δ LPRI $_{t-1}$	0.1846	3.5614***
LPUI	0.8618	3.1009***	Δ LPUI $_t$	0.4905	2.7141***
LFCI	-0.1999	-1.2850	Δ LFCI $_t$	0.0574	0.5191
LGDP	5.0423	2.7579***	ΔLGDP $_t$	1.3727	1.8330*
Constant	-37.1245	-2.2588**	Constant	-21.128	-2.8350***
Trend	-0.0179	-0.3786	Trend	-0.0102	-0.3864
			ecm(-1)	-0.5691	-4.7870***

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

The short-run coefficients have a similar story to tell as the long-run. Public investment (LPUI) positively affects household savings (LHHS), while household (LHHI) and private investment (LPRI) negatively affects household savings (LHHS). However, the lagged variable of private investment (LPRI $_{t-1}$) affects household savings (LHHS) positively. This result is in sharp contrast to the aggregate results in chapter five where the results showed that gross domestic investment (LGDI) has no long or short-run impact on gross domestic savings (LGDS). This once again highlights the importance of the disaggregated sectors of investment to the savings variable.

The ecm(-1) represents the speed of adjustment to restore equilibrium in the dynamic model following a disturbance. The error correction coefficient shows how slowly/quickly the variable returns 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 -0.57 suggesting that deviation from the long-term household savings path is corrected by 57 percent in the following year, meaning that the adjustment takes place relatively quickly.

6.4.2.2 Private Savings

With private savings (LPRS) being the dependent variable, the AIC lag specification for PRS is ARDL (1, 2, 2, 2, 0, 0, 2, 1). The empirical results in Table 6.5 show 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.

There is no evidence of public savings (LPUS) crowding-out private savings (LPRS) in the long-run, found by Athukorala and Sen (2002) and Saggar (2003). This could be due to the fact that we have split the sectors into the three sectors which includes the household sector. In fact, the results indicate that public savings (LPUS) and household savings (LHHS) have small positive impacts on private savings (LPRS) in the both the short and long-run, though the long-run effect of LHHS (0.33) on LPRS is significant at only the ten percent level. This supports the conventional view that, since business firms are owned by households, the overall level of private savings is still basically determined by household saving behaviour (Modigilani 1970).

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 is consistent with equations (7) and (8) in the model where borrowing from overseas via equation (8), $\dot{b}_f = -\beta y_p + y_h - \dot{b}_p - rb_g + rb_f$ will add to private corporate savings.

After estimating the long-term coefficients, we obtain the error correction representation of the ARDL model. Table 6.5 reports the short-run coefficient estimates obtained from the error correction version of the ARDL model. The short-run results tell a similar story to the long-run results. The short-run estimates point to all the three forms of investment weakly affecting LPRS, with one period lagged LHHI and LPRI affecting LPRS with positive elasticties of 0.17 and 0.10; and LPUI with a negative elasticity of -0.27, but these are only significant at the ten percent level.

The empirical estimations also indicate that one period lagged LHHS affects LPRS by an elasticity of 0.15. As per the long-run results LPUS affects LPRS with a smaller elasticity of 0.02. A consistent story from the aggregate results comes through here with one period lag of foreign inflows (LFCI) affecting LPRS negatively. A one percent increase in LFCI affects LPRS negatively by -0.29 percent, significant at the one percent level.[9] This indicates substitution between private savings and foreign inflows in the short-run for India.

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

9 In the aggregate results, a one percent increase in one period lagged LFCI negatively affects LGDS by 0.18 percent, significant at the one percent level.

statistically significant at the one percent level. This ensures that the series is non-explosive and that a long-term equilibrium is attainable. 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.

Table 6.5: Estimated Long-Run Coefficients and Short-Run Error Correction Model (ECM)

Dependent Variable: LPRS

The long-run coefficients estimates based on ARDL (1,2,2,2,0,0,2,1) selected lags based on AIC			**ECM–ARDL: dependent variable: Δ LPRS based on ARDL (1,2,2,2,0,0,2,1) selected lags based on AIC**		
Regressor	**Coefficient**	**T-Ratio**	**Regressor**	**Coefficient**	**T-Ratio**
LHHS	0.3300	1.8539*	Δ LHHS $_t$	0.0445	0.5225
			Δ LHHS $_{t-1}$	0.1478	2.0244**
LPUS	0.0374	2.2717**	Δ LPUS $_t$	0.0171	2.1954**
			Δ LPUS $_{t-1}$	-0.0179	-1.7684*
LHHI	-0.0489	-0.2324	Δ LHHI $_t$	-0.1127	-1.1519
			Δ LHHI $_{t-1}$	0.1651	1.7638*
LPRI	0.1912	1.9682**	Δ LPRI $_t$	0.1024	1.8804*
LPUI	-0.4455	-1.9815**	Δ LPUI $_t$	-0.2686	-1.9035*
LFCI	0.2064	2.2885**	Δ LFCI $_t$	-0.0524	-0.7872
			Δ LFCI $_{t-1}$	-0.2887	-5.2617***
LGDP	2.8440	3.2628***	Δ LGDP $_t$	0.5818	1.1714
Constant	-27.5708	-2.6785***	Constant	-14.765	-2.6147***
Trend	-0.0847	-2.2420**	Trend	-0.04538	-2.3105**
			ecm(-1)	-0.5355	-6.1568***

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

6.4.2.3 Public Savings

To measure the long-run relationship between public savings and the rest of the variables, we normalise on the dependent variable, public savings (LPUS). The estimation is based on the ARDL model selected by the AIC method. The long and short-run coefficients are reported in Table 6.6. 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. Equations (4) and (5) in Appendix D indicate the 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 ΔLPUS 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 ΔLPUS 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.

Table 6.6: Estimated Long-Run Coefficients and Short-Run Error Correction Model (ECM)

Dependent Variable: LPUS

The long-run coefficients estimates based on ARDL (1, 0, 0, 2, 0, 0, 0, 0)selected lags based on AIC			ECM–ARDL: dependent variable: Δ LPUS based on ARDL (1, 0, 0, 2, 0, 0, 0, 0) selected lags based on AIC		
Regressor	**Coefficient**	**T-Ratio**	**Regressor**	**Coefficient**	**T-Ratio**
LHHS	-3.4460	-1.5130	Δ LHHS $_t$	-2.003	-1.5993
LPRS	2.5897	1.0002	Δ LPRS $_t$	1.5055	1.0311
LHHI	6.0935	1.3530	Δ LHHI $_t$	0.5663	0.3413
			Δ LHHI $_{t-1}$	-4.2941	-2.6209***
LPRI	-0.1707	-0.1534	Δ LPRI $_t$	-0.0992	-0.1538
LPUI	8.4609	1.9686**	Δ LPUI $_t$	4.9185	2.3675**
LFCI	-1.4520	-1.1186	Δ LFCI $_t$	-0.8441	-1.1565
LGDP	10.0595	0.7585	Δ LGDP $_t$	5.8478	0.8054
Constant	-218.4253	-1.2392	Constant	-126.9752	-1.4582
Trend	-0.94158	-1.3845	Trend	-0.5474	-1.7310*
D1997	-8.0680	-3.6836***	Δ D1997	-4.6907	-3.2962***
			ecm(-1)	0.5813	-3.7843***

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

6.4.3 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. The long and short-run elasticties allow determining the important interrelationships between the three sectors of the investment as explained in chapter three. The few studies that examine the relationship between private and public sector investment in India find mixed results. Serven (1996) finds that in India, government investment in non-infrastructure projects crowds-out private investment in the long-run; Athukorala and Sen (2002) state that pubic investment has a strong complementary relationship with corporate private investment; Mitra (2006) concludes that short-run crowding-out exists between the two; and lastly Soumya and Murthy (2006) finds a significant crowding-in effect between private and public sector investment. However, once again these studies do not explicitly split investment into the household sector; they combine the household sector and the private corporate sectors together. Given the importance of the household sector, this study fills the above gap by examining the relationship between household, private and public sector investments which brings out two important conclusions.[10]

Firstly, the results indicate that there is a long-term inverse relationship between household investment (LHHI) and private investment (LPRI). Tables 6.7 and 6.8 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 6.8 and 6.9 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

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[10] No known study to the best of my knowledge, has examined the three sectors of investment.

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.

6.4.3.1 Household Investment

The results in Table 6.7 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 result is different with the result found in the previous chapter where GDP growth is found not to affect gross domestic investment (LGDI) in the long-run.[11] This positive LHHI elasticity of 2.19 indicates a large accelerator effect from growth to household investment and is specified in the household investment relationship of (15), $\dot{k}_h = \varphi\left[\int_t^{\infty} \alpha y'_{h,k_p} e^{-\rho(s-t)} ds - 1\right]$. 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.

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[11] However, the short-run aggregate results in chapter five does indicate that one-period lagged LGDP has a positive impact on gross domestic investment (LGDI) with an elasticity of 0.80, significant at the ten percent level.

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 via equation (13), $\dot{k}_p = \phi\left[\int_t^{\infty}\left(\beta y'_{p,k_p} - y'_{h,k_p}\right)e^{-\rho(s-t)}ds - 1\right]$ which increases household income, y_h and LHHI in equation (15), $\dot{k}_h = \varphi\left[\int_t^{\infty}\alpha y'_{h,k_p}e^{-\rho(s-t)}ds - 1\right]$. 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 ΔLHHI 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.

Table 6.7: Estimated Long-Run Coefficients and Short-Run Error Correction Model (ECM)

Dependent Variable: LHHI

The long-run coefficients estimates based on ARDL (1, 2, 0, 0, 2, 0, 0, 1) selected lags based on AIC			ECM–ARDL: dependent variable: Δ LHHI based on ARDL (1, 2, 0, 0, 2, 0, 0, 1) selected lags based on AIC		
Regressor	**Coefficient**	**T-Ratio**	**Regressor**	**Coefficient**	**T-Ratio**
LHHS	0.0400	0.2975	Δ LHHS $_t$	-0.3412	-2.6196***
			Δ LHHS $_{t-1}$	-0.2999	-2.8471***
LPRS	0.0302	0.2224	Δ LPRS $_t$	0.0303	0.2213
LPUS	0.0017	0.1990	Δ LPUS $_t$	0.0017	0.1986
LPRI	-0.4514	-4.6004***	Δ LPRI $_t$	-0.2499	-3.0284***
			Δ LPRI $_{t-1}$	0.1409	2.9708***
LPUI	-0.2065	-0.9632	Δ LPUI $_t$	-0.2076	-0.9762
LFCI	0.0259	0.3639	Δ LFCI $_t$	0.0260	0.3617
LGDP	2.1910	3.6328***	Δ LGDP $_t$	0.8110	1.1950
Constant	-12.4631	-1.8158*	Constant	-12.5239	-1.8175*
Trend	0.0030	0.1293	Trend	0.0030	0.1291
D1991	-0.2700	-2.2159**	D1991	0.2713	-2.2703**
			ecm(-1)	-1.005	-6.8497***

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

6.4.3.2 Private Investment

We normalise on private investment (LPRI), the other significant long-run cointegrating relationship. The AIC lag specification for LPRI is ARDL (1, 2, 2, 0, 1, 2, 0, 0) where the numbers represent the lags of the variables. Long and short-run coefficient estimates are reported in Table 6.8. The empirical results 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; and secondly, is consistent with the findings of the aggregate estimations in chapter five where gross savings (LGDS) has a lower long-run elasticity of a 0.37 with respect to gross investment (LGDI).

Unlike the long-run elasticties, the short-run estimates indicate that the household savings (LHHS) and one period lagged LHHS negatively affect private investment (LPRI). Once again, 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)[12] 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.

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[12] The effect of LHHS on LHHI is shown in section 6.4.3.1.

The other important result in the short-run is that of a one period of lagged pubic 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 dummy variable of 1980 shows that there is a slight reduction of about 0.27 percent in both the long and short-run in the period 1980 to 2005, significant at the ten percent level. 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. The error corrections for household investment (LHHI) and private investment (LPRI) are consistent with the error correction of gross domestic investment (LGDI) in chapter five indicating overshooting behaviour for investment in the short-run equilibrating process in the Indian economy.

Table 6.8: Estimated Long-Run Coefficients and Short-Run Error Correction Model (ECM)

Dependent Variable: LPRI

The long-run coefficients estimates based on ARDL (1, 2, 2, 0, 1, 2, 0, 0) selected lags based on AIC			ECM–ARDL: dependent variable: Δ LPRI based on ARDL (1, 2, 2, 0, 1, 2, 0, 0) selected lags based on AIC		
Regressor	**Coefficient**	**T-Ratio**	**Regressor**	**Coefficient**	**T-Ratio**
LHHS	0.5539	2.3111**	Δ LHHS $_t$	-0.4607	-2.1855**
			Δ LHHS $_{t-1}$	-0.9293	-6.1520***
LPRS	0.3997	1.3924	Δ LPRS $_t$	0.5108	1.8527
			Δ LPRS $_{t-1}$	0.5639	2.1748**
LPUS	0.0066	0.4601	Δ LPUS $_t$	0.0069	0.4579
LHHI	-0.9661	-3.5221***	Δ LHHI $_t$	-0.5052	-1.9270*
LPUI	-0.3565	-0.7922	Δ LPUI $_t$	0.5340	1.4270
			Δ LPUI $_{t-1}$	0.8940	2.9372***
LFCI	0.0402	0.3209	Δ LFCI $_t$	0.0421	0.3214
LGDP	1.1935	1.0228	Δ LGDP $_t$	1.2506	1.0219
Constant	-2.0894	-0.1659	Constant	-2.1893	-0.1655
Trend	.0008	0.0191	Trend	0.0009	0.0191
D1962	0.2793	1.4585	D1962	0.2927	1.5389
DU1980	0.2693	1.7462*	DU1980	0.2822	1.7472*
			ecm(-1)	-1.0478	-10.0469***

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

6.4.3.3 Public Investment

With public investment (LPUI) as the dependent variable, the AIC lag specification is ARDL (2, 0, 0, 1, 1, 0, 0, 2) where the numbers represent the lags of the variables. 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. Relationship (4), $\dot{k}_g = \left(\tau_h + \tau_p\right) + \left(\dot{b}_g - rb_g\right)$ details this expected strong and direct effect between public investment, $\dot{k}_g$ and household savings, $\dot{b}_g$. 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, once again contradicting the view that investment promotes economic growth. This result is much stronger than the one found in the aggregated chapter five.[13]

One important difference between the aggregate results in chapter five and the disaggregate results here, is absence of any impact of foreign capital inflows to either household, private or pubic sector investment in both the short and long-run.

The dummy variable of 1977 shows that there is a slight reduction of 0.15 in ΔPUI in the period 1977 to 2005, significant at the five percent level. The short-run

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[13] The aggregate result shows that the short-run result of one-period lagged LGDP will increase LGDI by 0.80 percent, significant at only the ten percent level.

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.

Table 6.9: Estimated Long-Run Coefficients and Short-Run Error Correction Model (ECM)

Dependent Variable: LPUI

The long-run coefficients estimates based on ARDL (2, 0, 0, 1, 1, 0, 0, 2)selected lags based on AIC			ECM–ARDL: dependent variable: Δ LPUI based on ARDL (2, 0, 0, 1, 1, 0, 0, 2) selected lags based on AIC		
Regressor	**Coefficient**	**T-Ratio**	**Regressor**	**Coefficient**	**T-Ratio**
			Δ LPUI $_{t-1}$	-0.3540	-2.7206
LHHS	0.9484	2.3853**	Δ LHHS $_t$	0.2745	4.7721***
LPRS	-0.3119	0.33722	Δ LPRS $_t$	-0.0903	-1.0368
LPUS	-.0183	-0.6599	Δ LPUS $_t$	0.0098	1.4348
LHHI	0.1226	0.36685	Δ LHHI $_t$	-0.0724	-0.8327
LPRI	0.3274	1.9677**	Δ LPRI $_t$	0.0948	3.0103***
LFCI	0-.3031	-0.9384	Δ LFCI $_t$	-0.0877	-1.3882
LGDP	-1.4502	-0.7781	Δ LGDP $_t$	0.3104	0.5892
			Δ LGDP $_{t-1}$	1.4363	2.6815***
Constant	20.008	0.9786	Constant	5.7911	0.7799
Trend	0.0531	0.7695	Trend	0.0154	0.6311
D1977	0-.5031	-1.3700	D1977	-0.1456	-2.2220**
			ecm(-1)	-0.2894	-2.4086**

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

6.4.4 Foreign Capital Inflows

To examine the long-run relationship between foreign capital inflows (LFCI) and the rest of the variables, we normalise on the dependent variable, LFCI. The results in Table 6.10 are similar to the aggregate results in chapter five, where 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. As per the aggregate findings, these results once again point 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. However, unlike the findings in the aggregate chapter, no long-run feedback exists between any sectors of investment and foreign inflows.

The short-run elasticties tell a similar story to the long-run where investment (private) and GDP growth have an affect on foreign capital inflows, but once again this is only significant at the ten percent level. However, consistent with the aggregate results in chapter five, an increase in one period lagged LGDP by one percent will lead to a decrease in LFCI by 2.34 percent, significant at the ten percent level.[14]

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

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14 The aggregate results in chapter five shows that an increase in one period lagged LGDP by one percent will lead to a decrease in LFCI by 2.83 percent, significant at the one percent level.

long-run equilibrium level of foreign capital inflows in one year is corrected by about 44 per cent in the next year. Finally, a significant error correction confirms the existence of a stable long-run relationship between the significant regressors and the dependent variable, LFCI.

Table 6.10: Estimated Long-Run Coefficients and Short-Run Error Correction Model (ECM)
Dependent Variable: LFCI

The long-run coefficients estimates based on ARDL (1, 1, 0, 0, 1, 2, 1, 2)selected lags based on AIC			ECM-ARDL: dependent variable: Δ LFCI based on ARDL (1, 1, 0, 0, 1, 2, 1, 2) selected lags based on AIC		
Regressor	**Coefficient**	**T-Ratio**	**Regressor**	**Coefficient**	**T-Ratio**
LHHS	0.6006	1.1235	Δ LHHS $_t$	0.0496	0.2278
LPRS	-0.3757	-0.7614	Δ LPRS $_t$	-0.1644	-0.7919
LPUS	0.0187	0.5805	Δ LPUS $_t$	0.0082	0.5811
LHHI	0.9599	1.5044	Δ LHHI $_t$	-0.0431	-0.1878
LPRI	0.8239	2.2943**	Δ LPRI $_t$	0.1580	1.9056*
LPUI	0.4907	0.6606	Δ LPRI $_{t-1}$	0.1137	-1.4557
LGDP	5.3663	1.8456*	Δ LPUI $_t$	-0.1674	-0.4675
Constant	-76.0347	-2.4762**	Δ LGDP $_t$	2.1050	1.8587*
Trend	-0.3183	-3.1941***	Δ LGDP $_{t-1}$	-2.3405	-1.7875*
			Constant	-33.2621	-2.3259**
			Trend	-0.1393	-3.1869***
			ecm(-1)	-0.4375	-4.5445***

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

To ascertain the appropriateness of the ARDL model, the diagnostic and stability tests are conducted along with some key regression statistics of the ARDL are employed for sections 6.4.1 to 6.4.4 which are provided in Appendix E. 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.

Finally, the stability of the regression coefficients is evaluated using the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMQ). According to Bahmani-Osokee (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. It is clear from Appendix E that the plots of both the CUSUM and CUSUMQ for all the eight variables are within the boundaries.

6.5 Conclusion

This chapter, as a major contribution to this study extends the previous analysis to explore important relationships in sectoral savings and investment, foreign capital inflows and GDP growth for India, taking particular care to identify their complex interrelationships. This chapter 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. This chapter makes three important contributions in this field. The first contribution of this chapter is to test sectoral savings and sectoral investment 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 elasticties 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 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.[15]

Firstly, the results are consistent with the gross results in chapter five, indicating 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

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15 A summary of the long-run results are given in Table 6.11.

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 it 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 pubic 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 the both the long and short-runs. As per the aggregate findings, 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. However, unlike the findings in the aggregate chapter five, no long-run feedback effect between any sectors of investment and foreign capital inflows exists. Only private sector investment is found to affect foreign capital inflows.

Lastly, unlike to aggregate results, the estimates in this chapter show that 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 6.11: Long-Run Coefficients for the Disaggregate Analysis

Long-Run Elasticities
1950 to 2005: Unrestricted Intercepts and Unrestricted Trends

Dependent Variable [1]	Explanatory Variables [2]										
	LHHS	**LPRS**	**LPUS**	**LHHI**	**LPRI**	**LPUI**	**LFCI**	**LGDP**	**Trend**	**Dummy 1**	**Dummy 2**
LGDP						-0.1218*	0.0730****		0.0398***	-0.0596*	
LHHS				-1.6209***	-1.0881***	0.8618***		5.0423***			
LPRS	0.3300*		0.0374**		0.1912**	-0.4455**	0.2064**	2.8440***	-0.0847**		
LPUS						8.4609**				-8.0680***	
LHHI					-0.4514***			2.1910***		-0.2700**	
LPRI	0.5539**			-0.9661***							0.2693*
LPUI	0.9484**				0.3274**						
LFCI					0.8239**			5.3663*	-0.3183***		

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.

CHAPTER 7

CONCLUSION AND POLICY IMPLICATIONS

7.1 Introduction

The main purpose of this study was to examine the short-run and long-run interrelationships between savings, investment, foreign capital inflows and economic growth, taking into account structural breaks for India from 1950 to 2005. The study firstly, tests for the short-run dynamics of savings and investment on growth in India in line with the Solow-Swan model; and secondly, tests for the long-term (permanent) effect of savings and investment on growth, consistent with the AK model of growth. This is further extended to examine the interrelationships between sectoral savings and investment and their role in the growth process, again in both the short and long-run. The chapter outlines the major findings of the study in section 7.2; whilst section 7.3 discuses policy implications. Finally this chapter concludes with a discussion on future areas of work.

7.2 Summary of the Study

Chapter two surveys the relevant literature between the relationships of savings, investment, foreign capital inflows and GDP growth, paying attention to the Solow-Swan and the endogenous AK models of growth. The literature on savings and growth indicates that the two variables are strongly positively correlated across countries. However, the evidence from the literature review, concerning the temporal precedence between saving and growth in countries is mixed. There are studies which indicate that a higher savings is associated with higher growth; while many other studies find evidence of the Carroll-Weil hypothesis, that savings do not cause growth, but economic growth causes savings. The consensus that emerges from the Indian studies tends to support the Carroll-Weil hypothesis.

The survey of the literature between investment and growth is also mixed. There is no definite consensus of the growth theories of Romer, Lucas and Barro that capital accumulation is the driver of long-run economic growth. The evidence for India is on the same lines. Some Indian studies find that investment is the key to growth; while others find that it is growth that drives investment. The Feldstein-Horioka (1980) hypothesis emphasises the empirical association between savings an investment, however again no consensus explanation from the empirical literature has emerged about the link between the two or its direction. It appears that foreign capital inflows have stimulated economic growth on one hand and have substituted for domestic savings on the other. Evidence of bi-directional causality between foreign direct investment and economic growth is found for India. Lastly, the survey on sectoral savings and investment finds that there are no comprehensive studies, which disaggregate savings and investment into the three sectors of household, private corporate and public.

Given the important relationships between the variables, chapter three discusses the trends, breaks and patterns of each of the variables of savings, investment, foreign capital inflows and GDP growth in turn, to give an overall view of the Indian economy for the last 55 years. In terms of GDP growth, two phases are identified, with a break around 1980. Overall, the trends of the Indian economy show a constant increase in real GDP over each decade, except of the fall in the 1970s; and an overall increase in gross domestic savings and investment rates through the post-independence period from 1950-2005. Foreign capital inflows have been low throughout the period, though they increased substantially after the deregulation of the economy in 1991. This review indicates that growth rates of saving and investment have been considerably lower but less variable than the growth rates in foreign capital inflows and GDP and the growth differential has widened in the later decades.

The chapter also discusses the dynamic process involving changing relative shares and trends across sectors over a fifty-five year period. This shows significant changes in the savings and investment patterns of the three sectors, household, private corporate and public, over the past five decades in the Indian economy, with the household sector being the most dominant.

Consistent with the important issues of trends and breaks in the measures of savings, investment, foreign capital inflows and GDP identified in chapter three, chapter four conducts unit root tests to verify the stationarity properties of the time series data so as to avoid spurious regression findings. The literature review in chapter two indicates that almost all of the empirical research has used conventional econometric testing procedures. The discussion on trends and patterns in chapter three highlighted that the Indian economy has faced significant structural breaks such as wars, green revolution, major droughts and economic reforms leading to deregulation in 1991. As per Perron (1989), applying the conventional econometric tests which fail to take into account an existing break will lead to a bias that reduces the power to reject a false unit root hypothesis.

Chapter four makes a significant contribution to the study by analysing the recent development of unit root hypotheses in the presence of structural change at the unknown time of the break. Methodologies such as Perron's (1997) Innovational Outlier (IO) model and the Additive Outlier (AO) models; along with the new Lee and Strazicich (2003), Minimum Lagrange Multiplier Unit Root Tests are conducted. The IO and AO techniques endogenously determine the single most important structural break in each series. In order to assure robustness of the findings, both the IO (assumes gradual changes) and AO (sudden changes occur) models are applied. However, to be consistent with Perron's (1989) original model, we also apply the Lee and Strazicich (2003) Minimum Lagrange Multiplier Unit Root Tests which endogenously determines two structural breaks. From the observations and discussions in chapter three, Model C which assumes changes in both the intercept and slope is applied. All the unit root tests indicate that the variables under investigation are of mixed order of integration, I(0) and I(1) process. Regarding the endogenously determined time of the structural breaks, the results are consistent with the trends and breaks discussed in chapter three and coincide with the Green revolution (starting in 1967); wars with China (1962) and Pakistan (1965); the severe droughts (1965-1967); balance of payments crisis (1966); the economic reforms that took place under Rajiv Gandhi's tenure (in the mid-1980s); the balance of payments crisis (1990) and formal deregulation of the Indian economy (1991).

Chapter five, consistent with the growth models, examines the short and the long-run interrelationships between gross domestic product, gross domestic savings, gross domestic investment and foreign capital inflows in India for the period 1950-2005, taking into account the trends and endogenous breaks identified in the previous two chapters. The long-run relationship among the variables, presented as an endogenous growth model (Appendix A) is tested using the bounds testing approach to cointegration. Once the long-run relationship is established, the ARDL approach is then used to determine the long-run and short-run coefficients via the important error correction mechanism.

This chapter as a major contribution tests for the short-run and the long-run relationships between the variables, consistent with the growth theories of Solow and the AK growth model. Empirical estimations are conducted which allow testing for the short-run (transitory) dynamics of savings and investment on growth in India in line with the Solow-Swan model; and the long-term (permanent) effect of savings and investment on growth, consistent with the endogenous AK model of growth.

Firstly and most importantly, the results indicate that neither domestic savings nor investment have any positive impacts on GDP growth in India. This result is robust in both 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 permanent long-run effect of savings and investment on growth (the AK model of growth) in India.

Secondly, it is found that only foreign capital inflows affect growth in the both the short and long-run. In fact, there is feedback effect between foreign capital inflows and GDP growth. Thirdly, even though foreign capital inflows have stimulated economic growth, they are found to be negatively related to domestic savings indicating the presence of substitution between the two. Fourth, the results indicate that gross savings are driving gross investment in the long-run (consistent with the AK model of growth), but there is the missing link between investment and GDP growth. The result is also in line with the Feldstein and Horioka proposition.

Fifth, feedback effects exists between gross domestic investment and foreign capital inflows in both the long-run and short-run, with the impact of domestic investment in attracting foreign capital inflows much stronger than that of foreign capital inflows in inducing domestic investment. Finally, the dummy variables representing the two endogenous breaks for gross domestic product and gross domestic investment were also significant. Applying the error correction version of the ARDL model shows that the error correction coefficient, which determines the speed of adjustment, has an expected and highly significant sign. The estimated model passes a battery of diagnostic tests as well as the CUSUM and CUSUMQ graphs indicating that the models are stable during the sample period.

Chapter six, as another major contribution to the study, extends the previous aggregate analysis to test for the short and long-run relationships between sectoral savings and investment, foreign capital inflows and GDP growth, taking into account potential structural breaks for India from 1950 to 2005. Gross domestic savings and investment are disaggregated into household, private corporate and public sectors. A modified model (provided in appendix D), first presented in Verma and Wilson (2004) is estimated. The relationships between household, private corporate and public sector savings and investment, foreign capital inflows and GDP bring out important conclusions.

Firstly, the Lee and Strazicich (2003) one or two break minimum LM unit root tests and the ADF test indicate that the variables are of mixed order of I(0) and I(1). Moreover, the endogenously determined structural breaks indicate that changes in the variables took place at different time periods, with significant breaks for household, private and public investment; public savings and GDP.

Secondly, these endogenously determined structural breaks were taken into account when testing for a long-run relationship using the bounds testing approach to cointegration. The F-statistics indicate the existence of a long-run relationship with the three measures of savings; and household and private investment as the dependent variables. With GDP growth, public investment and foreign capital inflows as the dependent variables, the significant values of F-statistic show inconclusive result.

The long and short-run estimates of the ARDL are consistent with the gross results reported in chapter five, indicating that foreign capital inflow is the only variable that affects growth, in both the long and short-run in India. The results are robust in that neither of the three savings nor three investment measures have a positive impact on GDP growth, in either the short or the long-run. These results do not support policies designed to increase sectoral 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.[1] The chapter finds no evidence of the popular endogenous explanation that investment is the driver of long-run economic growth in India.

Secondly, evidence is found that growth is affecting savings and not vice-versa (Carroll-Weil hypothesis). GDP growth has a large elastic effect on household and private savings in the long-run. Thirdly, GDP is also found to have a large elastic effect on household investment, indicating a strong accelerator effect of GDP on household sector investment.

Fourthly, significant interrelationships are found between the three sectors of savings and investment. Household saving has a positive affect on private sector investment in the long-run; and pubic sector investment in both the long and short-run. The results also indicate that private sector savings positively affects private sector investment with a one period lag in the short-run. While these relationships from savings to investment are consistent with the growth models, there is a serious missing link from investment to economic growth. Overall, the relationships between sectoral savings and investment can be summarised as firstly that household savings and public

[1] This is only significant at the ten percent level.

investment crowd-in each other in both the long-run and short-run. Secondly, crowding-out exists in the short-run between household sector savings and investment and between household savings and private investment.

Significant relationships exist between sectoral investments and to a lesser extent sector savings. There is crowding-out between household investment and private investment in the long-run. While in the short-run, there is significant crowding-in effect between private and public investment. With regards to sectoral savings, there is evidence that pubic sector savings and household savings lead to a small increase in private sector savings.

Sixth, only public sector investment and GDP growth affect foreign capital inflows in the both the long and short-run. The evidence indicates feedback exists between foreign capital inflows and GDP growth in both the long and short-run.[2]

Lastly, the estimates in chapter six show that foreign capital inflows have a positive influence on private sector savings in the long-run. This can be explained in terms of the borrowing from overseas leading to an increase in private corporate savings.

The short-run adjustments to long-run equilibrium show that real GDP, household, private and public sector savings and investment and foreign capital inflows, all exhibit stable equilibrating behaviour. The estimated model passes a battery of diagnostic tests as well as the CUSUM and CUSUMQ graphs indicating that the models are stable during the sample period.

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[2] Though only significant at the ten percent level, the impact of growth in attracting foreign capital inflows is much stronger than that the reverse.

7.3 Policy Implications

This study finds that any policies that encourage saving and investment are not likely to contribute to economic growth in India. Even though foreign capital inflows have a positive effect on GDP, it is fairly small. It is GDP growth that has large elastic positive affects on household and private savings; and household investment in the long-run. The first supports the Carroll-Weil hypothesis whilst the second represents an accelerator effect. This result disputes the claims that savings and investment are crucial in increasing economic growth. This is problematic for Indian policy makers as there is very limited evidence of the popular growth models explanation of economic growth for India. There is evidence that savings drive investment in the long-run, consistent with the growth models. However, there is the serious missing link between investment and GDP growth, which importantly qualifies the endogenous growth explanation.

The empirical results in chapter six can be viewed as though savings and investment are derivative rather than the initiating factors of economic growth. To this effect, policymakers should formulate and implement policies that promote economic growth because these strategies will lead to higher savings and investment. The evidence in this study suggests that policies which promote growth of real GDP will lead to more rapid growth of household and private savings; and household investment. The lack of empirical validation of the commonly accepted growth theories is problematic for policy formulation in India. Even though savings have no statistically significant effect on growth, it should still be encouraged for its desirable level effects. The results show that private savings have positive effects on private investment. But since investment mechanism through which savings affect economic growth does not seem to function in the Indian economy, savings promoting policies aimed at encouraging private investment activities are likely to be ineffective in achieving an enhanced economic performance. This study 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. Development policies here should focus on technological progress, human capital and trade policy.

Even though the elasticties are small, foreign capital inflow seems to be driving GDP growth, which in turn induces higher savings, investment and more foreign inflows. Therefore, Indian policy makers in order the facilitate more foreign capital inflows into the county need to set the macroeconomic environment in line with low inflation and a reduction in the budget deficits to enhance more inflows in India.

However, though foreign capital inflows appear to have stimulated economic growth, it seems that this has been at the expense of the domestic savings. There is a substitution effect between the two; an increase (decrease) in domestic savings requires less (more) reliance on savings from the rest of the world. One explanation is that the external flows as result of making resources easily available permit a relaxation in the savings effort. This encourages an increase in consumption and therefore, external flows may impede public and private savings. Thus, the policymakers need to pay further attention to this.

7.4 Suggestions for Future Research

Although the interpretation of these finding are powerful, more work can be done in this area. Firstly, this study indicates that savings do not affect growth in the long or the short-run, but this does not mean the savings have no effect on growth whatsoever. There may be other channels through which savings affects growth. More research is needed to identify other mechanisms that savings operate to generate higher economic growth. For instance, higher savings may contribute to creating a sustainable current account deficit which in turn may be valuable to the growth process in India. Whilst this thesis is the first to disaggregate savings and investment, there is a need to analyze the savings-GDP relationship using Indian states data.

Secondly, there is a need to investigate the effect of financial reforms and the eventual liberalization of the Indian economy in 1991. There are questions like whether the financial reforms of the late 1980 and early 1990s result in higher savings, investment and foreign capital inflows and hence higher economic growth? Comparisons between the roles savings and investment in promoting economic growth before and after the reforms could also be made. Has the link between these variables and economic growth become stronger in the aftermath of reforms? However, there is insufficient data for the post reform period to conduct this comparison.

Thirdly, the results indicate the foreign capital inflows affect growth in both the long and the short-run. Therefore, there is a need to examine the impact on growth and savings of different components of foreign inflows. This will allow the Indian policy makers to enhance the macroeconomic environment to target the most beneficial inflows into India.

Finally, an important question arising from this study needs to be answered. If savings and investment are not the drivers of economic growth as predicted by the growth models, what is causing the Indian economy to keep growing?

APPENDIX A

AGGREGATED MODEL

In order to explore the possible relationships between savings, investment, foreign capital inflows and economic growth, a simple endogenous growth model is presented below.[1] This model is estimated in chapter five.[2]

The typical household pays itself a wage rate, w for the labour services, n and distributed earnings in the form of return to capital owned, rb to produce output via the production function, $y = f\left(k, n\right)$, where k represents the capital.[3]

The budget constraint for the representative household is given by:

$$c + \dot{b} = \left(w^{n} + rb\right) \qquad (1)$$

where the right hand side represents total income, which is spent on purchases of consumption goods, c, and shares, $\dot{b}$.[4]

The household selects the time path of consumption which maximises the household intertemporal utility, $U\left(c\right) = \int_{t_0}^{\infty} u\left[c\left(t\right)\right] e^{-\rho t} dt$, where $u\left(c\right)$ is a concave instantaneous utility function.[5] The utility maximising growth in consumption can be determined by substituting out the costate variable in the Hamiltonian maximisation:

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1 The model presented is an simple endogenous growth model, however the author is aware of the many extensions to this.

2 The model is not expressed in the traditional form of per worker terms because of the unavailability of data for India (as explained in chapter 3).

3 The production function is assumed to have properties: $k\left(0\right) = k_0$, $f_k' > 0$, $f_k'' < 0$, $\lim_{x \to 0^+} f_k' = \infty$ and $\lim_{x \to \infty} f'k = 0$ where $f_k' = \partial f / \partial k$, $f_k'' = \partial^2 f / \partial k^2$.

4 In order to keep the model tractable, it is assumed that the household does not borrow or lend overseas.

5 The utility function has the standard properties: $u\left(0\right) = 0$, $u\left(c\right) > 0$ and $u'\left(c\right) = \partial u\left(c\right) / \partial c < 0$.

$$H = u(c)e^{-\rho t} + \mu(\dot{b}) \tag{2}$$

to give the well known result for the utility maximising growth in consumption, $\dot{c} = \theta(r - \rho)$.[6] Integrating forward with respect to time gives the accumulated value of the utility maximising consumption, $c(t) = e^{\int_0^t \theta(r(s)-\rho)ds}$.[7] The optimal savings path, can be derived from this result by defining gross income as, $y = w^n + rb$. Substituting $\dot{c} = \theta(r - \rho)$ derives the time path of savings which maximise the intertemporal utility:

$$s = \dot{b} = y - e^{\int_0^t \theta(r(s)-\rho)ds} \tag{3}$$

Firms pay a wage rate, *w*, for the labour services, *n*, and distributed earnings in the form of return to capital owned, rb. The firm is also able to borrow capital from overseas, $\dot{b}_f$ and pays interest on the outstanding debt, rb_f.[8] They also purchase consumer goods, *c*, from themselves. Total cash inflows therefore comprise receipts, c and total borrowings, $\dot{b} + \dot{b}_f$. Cash outflows are, $w^n + rb + rb_f$, giving the firm's cash flow constraint:

$$c + \dot{b} + \dot{b}_f = w^n + rb + rb_f \tag{4}$$

The profit by the firm is given by:

$$\pi = -(\dot{b} + \dot{b}_f) = y - rb_f \tag{5}$$

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6 The elasticity of marginal utility with respect to consumption term is specified as, $-1/\theta = u''(c)/u'(c)$.

7 The initial value of consumption is standardised at unity, i.e. $c_0 = 1$

8 The domestic interest rate is assumed to be equal to the world interest rate, *r*. In order to ensure model stability it is necessary to constrain overseas borrowing to be less than capital formation, $(\dot{k})$ in net present value terms. That is:
$\int_t^\infty [\dot{b}_f(t)] e^{-\rho(s-t)} ds < \int_t^\infty [\dot{k}(t)] e^{-\rho(s-t)} ds.$

with the substitutions, $y = c + \pi$, Equation (5) can also be rearranged to determine the endogenous overseas borrowings in the form of foreign capital inflows:

$$\dot{b}_f = -y - \dot{b} + rb_f \tag{6}$$

The representative competitive firm accumulates capital to maximise the intertemporal net present value of profit: $\int_{t_0}^{\infty} \pi\left[k(t)\right] e^{-\rho t} dt$ where the constant discount rate, ρ is assumed to be the same. For the Hamiltonian, $H = \pi\left(k_p\right)e^{-\rho t} + \mu\left[\left(-\dot{b}_f\right)\right]e^{-\rho t}$, it is convenient to define the costate variable μ as the net present value of Tobin's q at the current time period, t, that is, $\mu = \xi q_p e^{-\rho t}$. The Hamiltonian for this frictional system becomes:[9]

$$H = s(k)e^{-\rho t} + \xi q\left[-\left(\dot{b} + \dot{b}_f\right)\right]e^{-\rho t} \tag{7}$$

and the costate equation $\dot{\xi} = -H_k$ gives the result: $\dot{q} = rq - \beta y_k' + y_k'$, where: $y_k' = \partial y / \partial k$ and $y_k' = \partial y / \partial k$ represent the marginal products of the firm's and household's capital. This solves for q, to give the well known result:

$$q(t) = \int_t^{\infty} (y') e^{-\rho(s-t)} ds \tag{8}$$

which clearly shows that Tobin's q is the sum of the weighted net present values of all future marginal products. Since q represents the marginal valuation of capital relative to its replacement cost when frictions are present, then values of $q > 1$ will encourage investment by firms according to the investment function:

---

[9] Capital formation in this system will involve costs of adjustment. We will not explicitly define these costs here and assume that investment $\dot{k}$ is net of these costs, which are used up in production (*vide*: Wilson and Chaudhri (2000)).

$$\dot{k} = \phi\left(q-1\right) \quad \text{with} \quad \phi' > 0 . \tag{9}$$

When $q = 1$, investment will be zero, $\dot{k} = 0$, and when $q < 1$, there will be disinvestment $\dot{k} < 0$. Using (7) to substitute for q in (8) gives the required result for capital formation as a function of the net present value of the marginal products of capital used in production:

$$\dot{k} = \phi\left[\int_t^{\infty} \left(y'\right) e^{-\rho(s-t)} ds - 1\right]. \tag{10}$$

APPENDIX B

STATISTICS OF THE ARDL MODELS

1. Gross Domestic Product (LGDP)

1.1 Key Regression Statistics:

$R^2 = 0.9988$

F (8, 44) = 4553.8 (0.000)

Durbin-Watson Statistic = 2.3074

1.2 Diagnostic Tests Results

LM Test Statistics	χ^2 Statistic	Probability
Serial Correlation [a] $\chi^2(1)$	2.2508	0.134
Functional Form [b] $\chi^2(1)$	0.69726	0.706
Normality [c] $\chi^2(2)$	11.3176	0.001
Heteroscedasticity [d] $\chi^2(1)$	1.7737	0.183

a Breusch-Godfrey LM test for serial correlation.

b Ramsey RESET test for omitted variables/functional form.

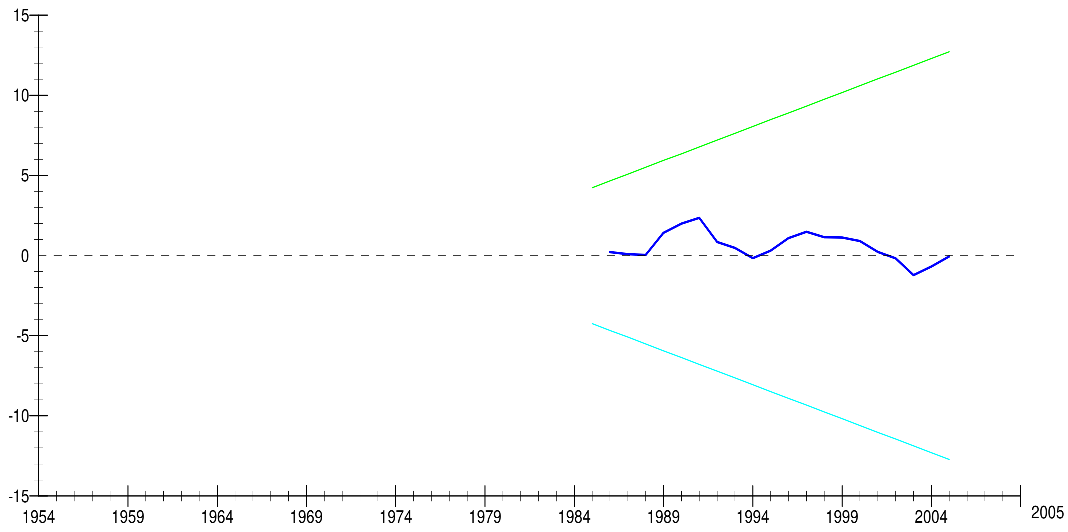
c Jarque-Bera normality test.

d White test for heteroscedasticity.

1.3 Plot of CUSUM and CUSUMSQ (Stability Test)

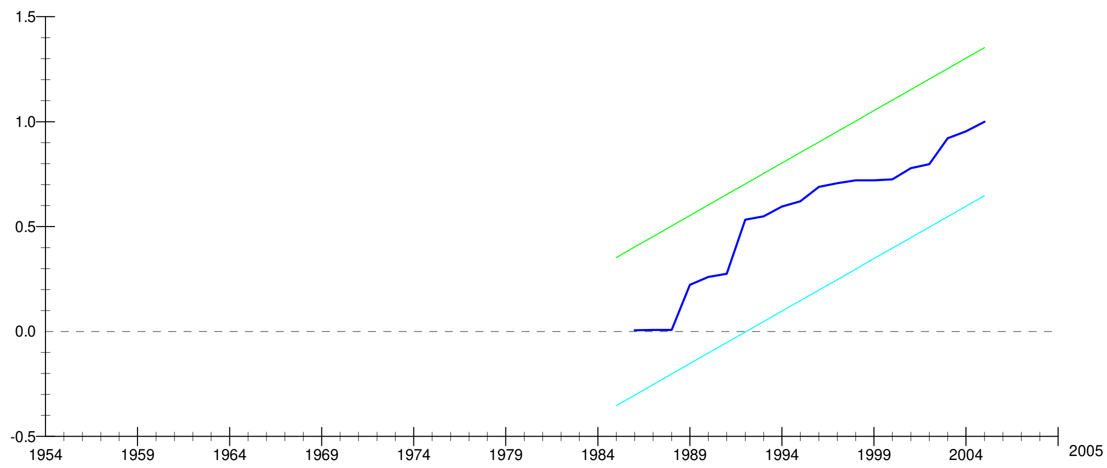
The CUSUM and CUSUMSQ plotted against the critical bound of the five percent significance level show that the model is stable over time.

Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

Plot of Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

2. Gross Domestic Savings (LGDS)

2.1 Key Regression Statistics:

R^2 = 0.9907

F (10, 42) = 445.3038 (0.000)

Durbin-Watson Statistic = 2.2368

2.2 Diagnostic Tests Results

LM Test Statistics	χ^2 Statistic	Probability
Serial Correlation [a] $\chi^2(1)$	4.6505	0.031
Functional Form [b] $\chi^2(1)$	3.8576	0.050
Normality [c] $\chi^2(2)$	0.3768	0.828
Heteroscedasticity [d] $\chi^2(1)$	2.1723	0.141

a Breusch-Godfrey LM test for serial correlation.

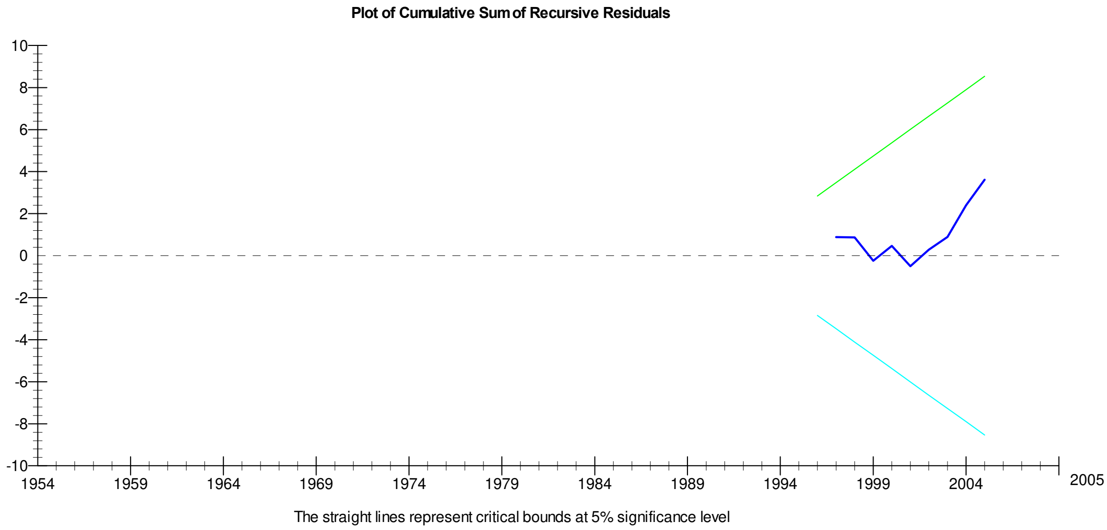
b Ramsey RESET test for omitted variables/functional form.

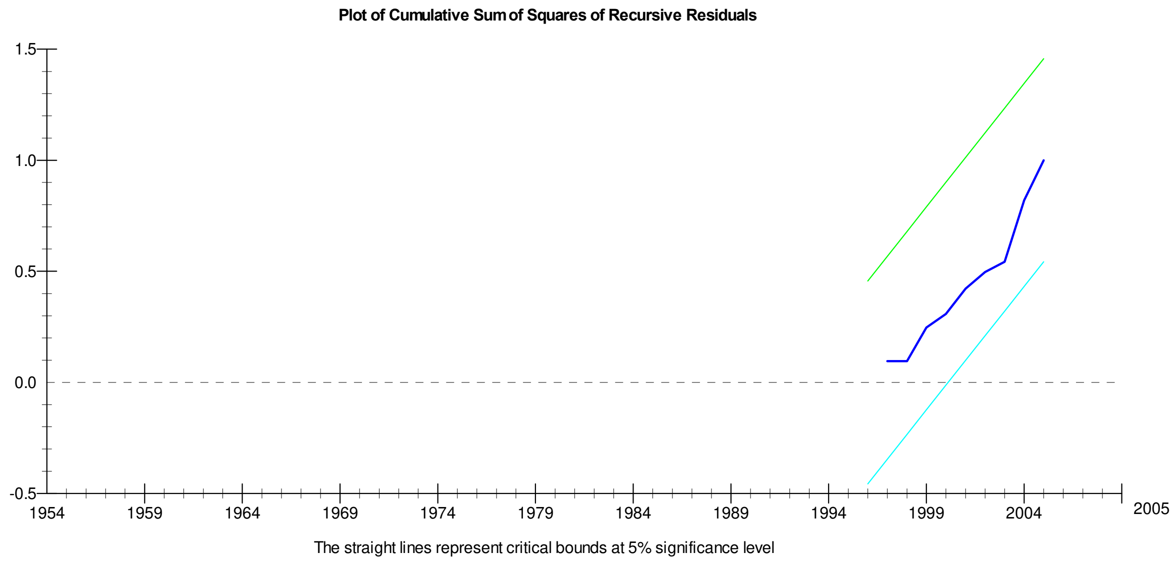
c Jarque-Bera normality test.

d White test for heteroscedasticity.

2.3 Plot of CUSUM and CUSUMSQ (Stability Test)

The CUSUM and CUSUMSQ plotted against the critical bound of the five percent significance level show that the model is stable over time.





3. Gross Domestic Investment (LGDI)

3.1 Key Regression Statistics:

R^2 = 0.9955

F (11, 41) = 831.0607 (0.000)

Durbin-Watson Statistic = 2.1591

3.2 Diagnostic Tests Results

LM Test Statistics	χ^2 Statistic	Probability
Serial Correlation [a] $\chi^2(1)$	1.2838	0.257
Functional Form [b] $\chi^2(1)$	16.1879	0.000
Normality [c] $\chi^2(2)$	0.1149	0.944
Heteroscedasticity [d] $\chi^2(1)$	0.3478	0.555

a Breusch-Godfrey LM test for serial correlation.

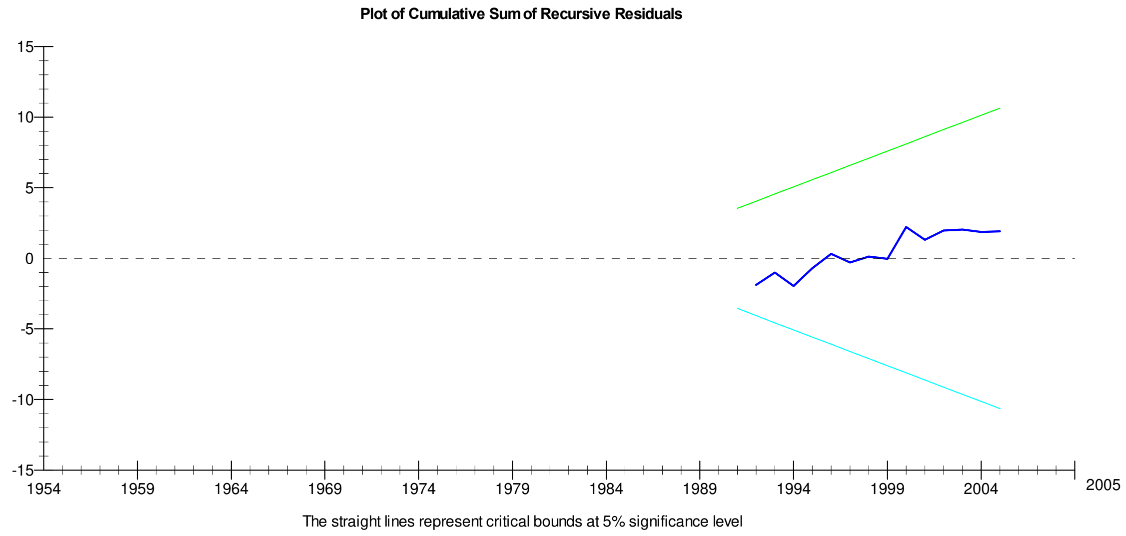
b Ramsey RESET test for omitted variables/functional form.

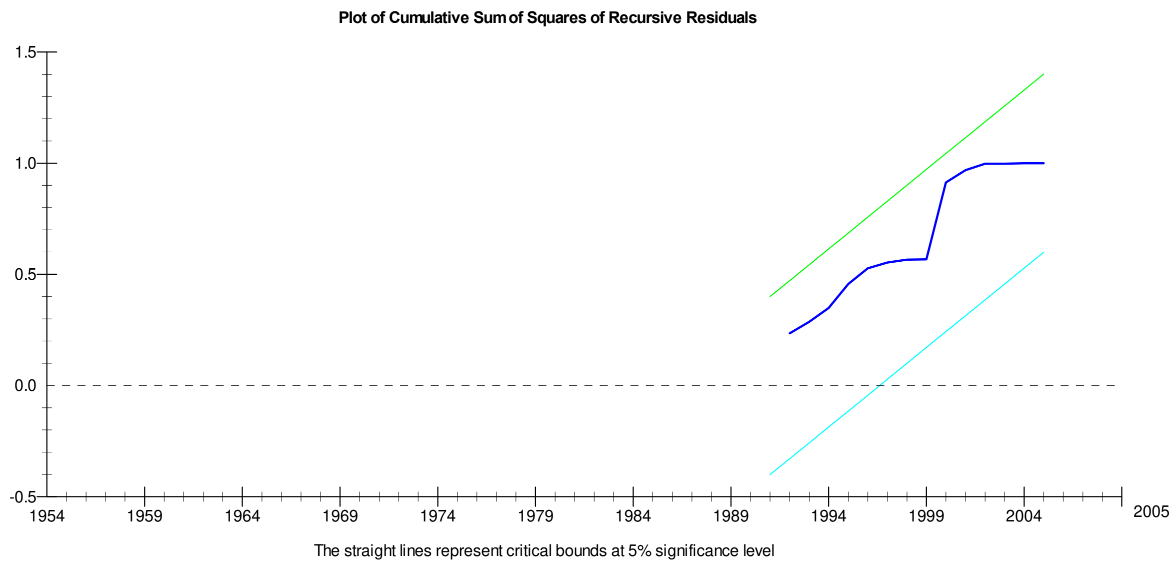
c Jarque-Bera normality test.

d White test for heteroscedasticity.

3.3 Plot of CUSUM and CUSUMSQ (Stability Test)

The CUSUM and CUSUMSQ plotted against the critical bound of the five percent significance level show that the model is stable over time.





4. Foreign capital Inflows (LFCI)

4.1 Key Regression Statistics:

$R^2 = 0.9819$

F (8, 44) = 297.5603 (0.000)

Durbin-Watson Statistic = 1.990

4.2 Diagnostic Tests Results

LM Test Statistics	χ^2 Statistic	Probability
Serial Correlation [a] $\chi^2(1)$	0.0706	0.790
Functional Form [b] $\chi^2(1)$	0.0099	0.921
Normality [c] $\chi^2(2)$	2.0513	0.359
Heteroscedasticity [d] $\chi^2(1)$	1.1453	0.285

a Breusch-Godfrey LM test for serial correlation.

b Ramsey RESET test for omitted variables/functional form.

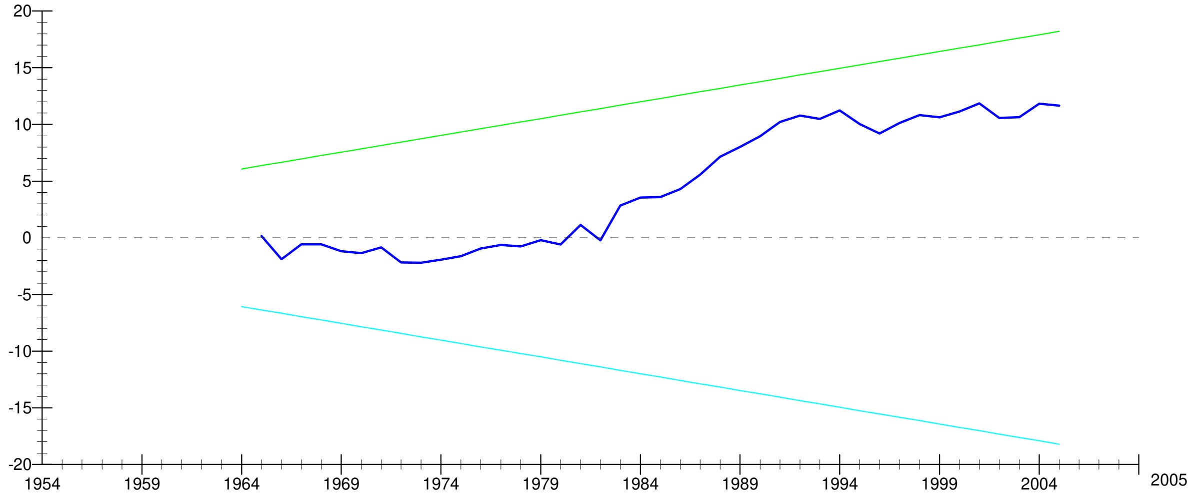
c Jarque-Bera normality test.

d White test for heteroscedasticity.

4.3 Plot of CUSUM and CUSUMSQ (Stability Test)

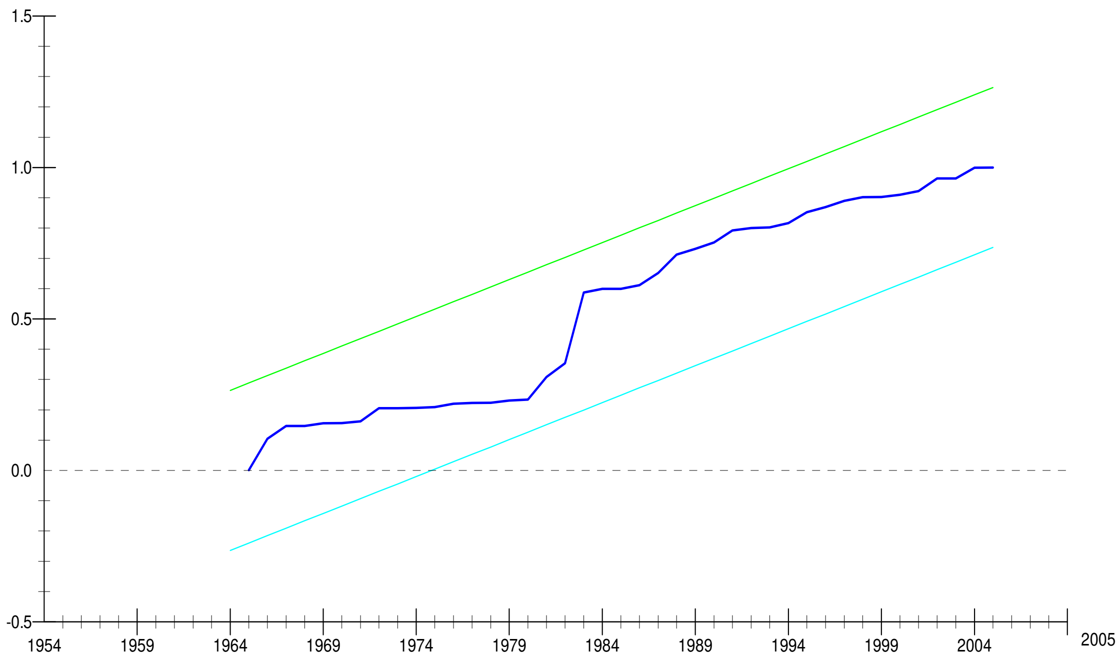
The CUSUM and CUSUMSQ plotted against the critical bound of the five percent significance level show that the model is stable over time.

Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

Plot of Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

APPENDIX C

LEE AND STRAZICICH (2004) MINIMUM LM UNIT ROOT TEST

The one break LM unit root test statistics according to the LM (score) principle, are obtained from the following regression:

$$\Delta y_t = \delta' \Delta Z_t + \phi \tilde{S}_{t-1} + u_t \qquad (1)$$

where $\tilde{S}_t = y_t - \tilde{\psi}_x - Z_t \tilde{\delta}$ (t = 2,…T) and Z_t is a vector of exogenous variables defined by the data generating process; $\tilde{\delta}$ is the vector of coefficients in the regression of Δy_t on ΔZ_t respectively with Δ the difference operator; and $\hat{\psi}_x = y_1 - Z_1 \tilde{\delta}$, with y_1 and Z_1 the first observations of y_t and Z_t respectively.

Equivalent to Perron's (1989) Model C, with allows for a shift in intercept and change in trend slope under the null hypothesis and is described as $Z_t = [1, t, D_t, DT_t]'$, where $DT_t = t - T_B$ for $t > T_B + 1$, and zero otherwise. It is important to note here that testing regression (1) involves using ΔZ_t instead of Z_t. ΔZ_t is described by $[1, B_t D_t]'$ where $B_t = \Delta D_t$ and $D_t = \Delta DT_t$. Thus, B_t and D_t correspond to a change in the intercept and trend under the alternative and to a one period jump and (permanent) change in drift under the null hypothesis, respectively.

The unit root null hypothesis is described in (1) by ϕ = 0 and the LM t-test is given by $\tilde{\tau}$; where $\tilde{\tau}$ = t-statistic for the null hypothesis ϕ =0.

The augmented terms $\Delta\widetilde{S}_{t-j}$, j = 1,...k, terms are included to correct for serial correlation. The value of k is determined by the general to specific search procedure.[1] To endogenously determine the location of the break (T_B), the LM unit root searches for all possible break points for the minimum (the most negative) unit root t -test statistic as follows:

$$Inf\ \widetilde{\tau}(\widetilde{\lambda}) = Inf_{\lambda}\widetilde{\tau}(\lambda)\text{; where } \lambda = T_B / T\ . \quad (2)$$

Critical Values of the One-Break Minimum LMτ Test - Model C

λ	1%	5%	10%
0.1	-5.11	-4.50	-4.21
0.2	-5.07	-4.47	-4.20
0.3	-5.15	-4.45	-4.18
0.4	-5.05	-4.50	-4.18
0.5	-5.11	-4.51	-4.17

Note: All critical values were derived in samples of size T = 100. Critical values in Model C (intercept and trend break) depend (somewhat) on the location of the break

(λ = TB/T) and are symmetric around λ and (1-λ).

[1] General to specific procedure begins with the maximum number of lagged first differenced terms max k =8 and then examine the last term to see if it is significantly different from zero. If insignificant, the maximum lagged term is dropped and then estimated at k =7 terms and so on, till the maximum is found or $k = 0$.

APPENDIX D
DISAGGREGATED MODEL

To explore the possible relationships between household, private, government and overseas savings and investment, it is necessary estimate a growth model which includes the overseas and government sectors. The generic growth model developed by Verma and Wilson (2004) is modified below. The key relationships, summarised in Table 1, are estimated in chapter six.

The private sector is disaggregated into two sectors, namely households and private corporate firms.[1] All variables are real and consistent with the growth models. A typical household supplies labour services, n for a wage rate, *w*, to produce household output via the production function, $f_h\left(k^n{}_h\right)$, where k_h represents the households capital. Households also arbitrage their supply of their labour, n_h to private corporate firms, which equilibrates the wage, *w*, across the two sectors. Households own the real capital used in production by private corporate firms, k_p, in the form of share purchases, $\dot{b}_p$, with real return, rb_p. The household pays net taxes to the government, τ_h and purchases government debt, $\dot{b}_g$, with return, rb_g. Consumption goods, *c*, are also purchased by households from private corporate firms.[2] Household investment, $\dot{k}_h$, returns rk_h, based on the assumption that the real returns, *r*, are arbitraged and therefore equal across sectors. The representative household's budget constraint is given by:

$$c+\dot{b}_p+\dot{b}_g=\left(w^{n_h}+rb_p+rb_g+\dot{k}_h\right)-\tau_h \qquad (1)$$

---

[1] With the exception of the studies by the author (with E. Wilson), all of the Indian studies combine the household sector and the private corporate sector together.

[2] Households may receive transfer payments from the government which are included in net taxes.

where the right hand side represents total household disposable income, which is spent on purchases of consumption goods, *c*, and shares, $\dot{b}_p$, from private firms, and government bonds, $\dot{b}_g$.[3]

The utility maximisation involves selecting the consumption path, $U(c)=\int_{t_0}^{\infty} u\left[c(t)\right]e^{-\rho t}dt$, where $u(c)$ is a concave felicity function. Substituting out the costate variable in the Hamiltonian maximisation gives:

$$H = u(c)e^{-\rho t} + \mu\left(\dot{b}_p + \dot{b}_g\right) \tag{2}$$

where: $\dot{b}_p + \dot{b}_g = w + rb_p + rb_g + \dot{k}_h - \tau_h - c$ to give $\dot{c} = \theta(r-\rho)$. As per Appendix A, integrating forward with respect to time gives the accumulated value of the utility maximising consumption, $c(t) = e^{\int_0^t \theta(r(s)-\rho)ds}$. The optimal household savings path, s_h, can be derived from this result by defining household gross (pre-tax) income as, $y_h = w^{n_h} + rb_p + rb_g + \dot{k}_h$. Assuming household taxes are a proportion of household income, $\tau_h = \alpha_h y_h$, substituting in (1) and collecting like terms gives, $s_h = \dot{b}_p + \dot{b}_g = \alpha y_h - c$, where $\alpha = 1-\alpha_h$. Substituting $\dot{c} = \theta(r-\rho)$ derives the time path of savings which maximise household intertemporal utility:

$$s_h = \dot{b}_p + \dot{b}_g = \alpha y_h - e^{\int_0^t \theta(r(s)-\rho)ds}. \tag{3}$$

The second component of savings in (3) is the bonds purchased by household from the government, $\dot{b}_g$. Assuming government debt is only held by households, the government budget constraint is given by:

---

[3] In order to keep the model tractable, it is assumed that households do not borrow or lend overseas.

$$\dot{k}_g = \left(\tau_h + \tau_p\right) + \left(\dot{b}_g - rb_g\right) \tag{4}$$

where receipts comprise taxation received from households and private corporate firms $\left(\tau_h + \tau_p\right)$ plus net borrowings from households $\left(\dot{b}_g - rb_g\right)$. Outlays are in the form of government purchases of capital goods from firms, expressed terms, $\dot{k}_g$.[4] Government budget (dis)savings are therefore defined as:

$$s_g = -\left(\dot{b}_g - rb_g\right) = \left(\tau_h + \tau_p\right) - \dot{k}_g \tag{5}$$

The other component of household savings in the form of shares, $\dot{b}_p$ in (3) involves the private corporate sector. The representative firm employs household labour, n_p and household owned capital, k_p, to competitively produce output according to the production function, $f_p\left(k_p, k_g, n_p, A\right)$.[5] This specification assumes that government capital, k_g promotes production and parameter *A* represents total factor productivity.

As mentioned earlier, the corporate firm pays households the wage rate, *w* for their labour services, n_p and distributed earnings in the form of the real return to capital owned, rb_p. The firm is able to borrow capital from overseas, $\dot{b}_f$ and pays interest on the outstanding debt, rb_f. The typical firm also pays, τ_p to the government, which purchases capital goods, $\dot{k}_g$ from firms. Households also purchase consumer goods, *c*, from the firms. Total cash inflows therefore comprise receipts, $c + \dot{k}_g$ from households

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4 Government expenditure will include consumption spending on goods and services, broadly defined to include public service wages. In order to keep the model simple, assume government spending is in the form of purchases of capital from private corporate firms.

5 The firm's production function is assumed to have the well behaved properties: $\forall x \in \left\{k_p, k_g, n_p, A\right\}$ $x(0) = x_0$, $f'_x > 0$, $f''_x < 0$, $\lim_{x \to 0^+} f'_x = \infty$ and $\lim_{x \to \infty} f'_x = 0$ where $f'_x = \partial f / \partial x$, $f''_x = \partial^2 f / \partial x^2$.

and the government, and borrowings, $\dot{b}_p + \dot{b}_f$ from households and overseas. Cash outflows are, $w + rb_p + rb_f + \tau_p$, giving the firm's cash flow constraint:

$$c + \dot{k}_g + \dot{b}_p + \dot{b}_f = w^{n_p} + rb_p + rb_f + \tau_p . \qquad (6)$$

Savings by firms, s_p are given by:[6]

$$s_p = -\left(\dot{b}_p + \dot{b}_f\right) = \beta y_p - y_h + rb_g - rb_f .^7 \qquad (7)$$

with the substitutions, $y_p = c + \dot{k}_g$ and $y_h - rb_g = w^{n_p} + rb_p$, and defining the company tax rate to be a fixed proportion of corporate income, $\tau_p = \beta_p y_p$, so that, $\beta = 1 - \beta_p$. Equation (7) can also be rearranged to determine the endogenous overseas borrowings in the form of foreign capital inflows:

$$\dot{b}_f = -\beta y_p + y_h - \dot{b}_p - rb_g + rb_f \qquad (8)$$

The competitive firm accumulates capital to maximise the intertemporal net present value of the savings, $s_p\left(k_p\right)$:

$$S_p\left(k_p\right) = \int_{t_0}^{\infty} s_p\left[k_p(t)\right] e^{-\rho t} dt \qquad (9)$$

where the constant discount rate, ρ is assumed to be the same for households. As per Appendix A, the Hamiltonian, $H = s_p\left(k_p\right)e^{-\rho t} + \mu\left[-\left(\dot{b}_p + \dot{b}_f\right)\right]e^{-\rho t}$, defines the costate

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[6] In order to ensure model stability it is necessary to constrain private, government and overseas borrowing. We restrict total borrowings $\left(\dot{b}_p + \dot{b}_g + \dot{b}_f\right)$ to be less than capital formation, $\left(\dot{k}_h + \dot{k}_p + \dot{k}_g\right)$ in net present value terms. That is:

$$\int_t^{\infty}\left[\dot{b}_p(t) + \dot{b}_g(t) + \dot{b}_f(t)\right]e^{-\rho(s-t)}ds < \int_t^{\infty}\left[\dot{k}_h(t) + \dot{k}_p(t) + \dot{k}_g(t)\right]e^{-\rho(s-t)}ds.$$

[7] To the extent that firm's rely on selling shares to households and bonds to overseas, then these are dissavings, $-\left(\dot{b}_p + \dot{b}_f\right)$. Additional savings by the firm can be easily included in terms of the depreciation of capital δk_p.

variable μ as the net present value of Tobin's q at the current time period, t, that is, $\mu = \xi q_p e^{-\rho t}$. The Hamiltonian becomes:[8]

$$H = s_p\left(k_p\right)e^{-\rho t} + \xi q_p\left[-\left(\dot{b}_p + \dot{b}_f\right)\right]e^{-\rho t} \qquad (10)$$

and the costate equation $\dot{\xi} = -H_{k_p}$ gives the result: $\dot{q}_p = rq_p - \beta y'_{p,k_p} + y'_{h,k_p}$, where: $y'_{p,k_p} = \partial y_p / \partial k_p$ and $y'_{h,k_p} = \partial y_h / \partial k_p$ represent marginal products of the firm's and household's capital. This solves for q_p,

$$q_p\left(t\right) = \int_t^{\infty}\left(\beta y'_{p,k_p} - y'_{h,k_p}\right)e^{-\rho(s-t)}ds. \qquad (11)$$

which clearly shows that Tobin's q_p is the sum of the weighted net present values of all future marginal products, $\beta y'_{p,k_p} - y'_{h,k_p}$. Tobin's q_p is the marginal valuation of capital relative to its replacement cost such that for $q_p > 1$, firms will invest according to:

$$\dot{k}_p = \phi\left(q_p - 1\right) \quad \text{with} \quad \phi' > 0\,^{9}. \qquad (12)$$

Using (10) and (11) derives:

$$\dot{k}_p = \phi\left[\int_t^{\infty}\left(\beta y'_{p,k_p} - y'_{h,k_p}\right)e^{-\rho(s-t)}ds - 1\right]. \qquad (13)$$

This extends (10) in Appendix A.

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[8] Capital formation in this system will involve costs of adjustment. We will not explicitly define these costs here and assume that investment $\dot{k}_p$ is net of these costs, which are used up in production (*vide*: Wilson and Chaudhri, 2000).

[9] When $q_p = 1$, investment will be zero, $\dot{k}_p = 0$, and when $q_p < 1$, there will be disinvestment $\dot{k}_p < 0$.

Tobin's q can also be used to determine the optimum time path of household investment, $\dot{k}_h$. Modifying the Hamiltonian (2) to:

$$H = u(c)e^{-\rho t} + \mu\left(\dot{b}_p + \dot{b}_g\right) \tag{14}$$

where $\mu = \xi q_h e^{-\rho t}$ and $\dot{b}_p + \dot{b}_g = \alpha y_h - \tau_h - c$, and maximising gives the equivalent result, $\dot{q}_h = rq_h - \alpha y'_{h,k_p}$. This solves to, $q_h(t) = \int_t^{\infty} y'_{h,k_p} e^{-\rho(s-t)} ds$, which determines optimal household investment:

$$\dot{k}_h = \varphi\left[\int_t^{\infty} \alpha y'_{h,k_p} e^{-\rho(s-t)} ds - 1\right] \tag{15}$$

The endogenous growth model, comprising equations (1) to (15), indicate high degrees of interdependence between the variables and relationships. Equations (3) and (15) show that household savings and investment are determined by households who select the time path of consumption and capital which maximise intertemporal utility. The government constraint with endogenous public investment in (5) shows the government sector (dis)saving (4) as a function of household savings and tax receipts paid by households and private corporate firms. Private sector savings (7) and investment (13) are determined by competitive firms maximising intertemporal savings of firms who may borrow from overseas in the form of foreign capital inflows (8). Real output is given by the aggregate production function, $y = f_h\left({k^n}_h\right) + f_p\left(k_p, k_g, n_p, A\right)$, which includes in A the endogenous growth effects of Romer (1986) in the form of Lucas (1988) "learning by doing" and other causes of changes in total factor productivity. The inclusion of k_g in the production function captures the possible positive effects of the strategic provision infrastructure by the government.

Table 1 - Summary of Important Relationships

Variable Specification		Equation	
Savings			
Household	HHS	$s_h = \dot{b}_p + \dot{b}_g = \alpha y_h - e^{\int_0^t \theta(r(s)-\rho)ds}$	(3)
Private corporate	PRS	$s_p = -\left(\dot{b}_p + \dot{b}_f\right) = \beta y_p - y_h + rb_g - rb_f$	(7)
Government	PUS	$s_g = -\left(\dot{b}_g - rb_g\right) = \left(\tau_h + \tau_p\right) - \dot{k}_g$	(5)
Investment			
Household	HHI	$\dot{k}_h = \varphi\left[\int_t^\infty \alpha y'_{h,k_p} e^{-\rho(s-t)} ds - 1\right]$	(15)
Private corporate	PRI	$\dot{k}_p = \phi\left[\int_t^\infty \left(\beta y'_{p,k_p} - y'_{h,k_p}\right) e^{-\rho(s-t)} ds - 1\right]$	(13)
Government	PUI	$\dot{k}_g = \left(\tau_h + \tau_p\right) + \left(\dot{b}_g - rb_g\right)$	(4)
Foreign capital inflows	FCI	$\dot{b}_f = -\beta y_p + y_h - \dot{b}_p - rb_g + rb_f$	(8)
Production	GDP	$y = f_h\left(k^n{}_h\right) + f_p\left(k_p, k_g, n_p, A\right)$	

Note:	HHS:	Household savings;	HHI:	Household investment;
	PRS:	Private corporate savings;	PRI:	Private corporate investment;
	PUS:	Public savings;	PUI:	Public investment;
	FCI:	Foreign capital inflow;	GDP:	Gross domestic product.

APPENDIX E

STATISTICS OF THE ARDL MODELS

1. Gross Domestic Product (LGDP)

1.1 Key Regression Statistics:

R^2 = 0.9991

F (14, 38) = 2965.4 (0.000)

Durbin-Watson Statistic = 1.982

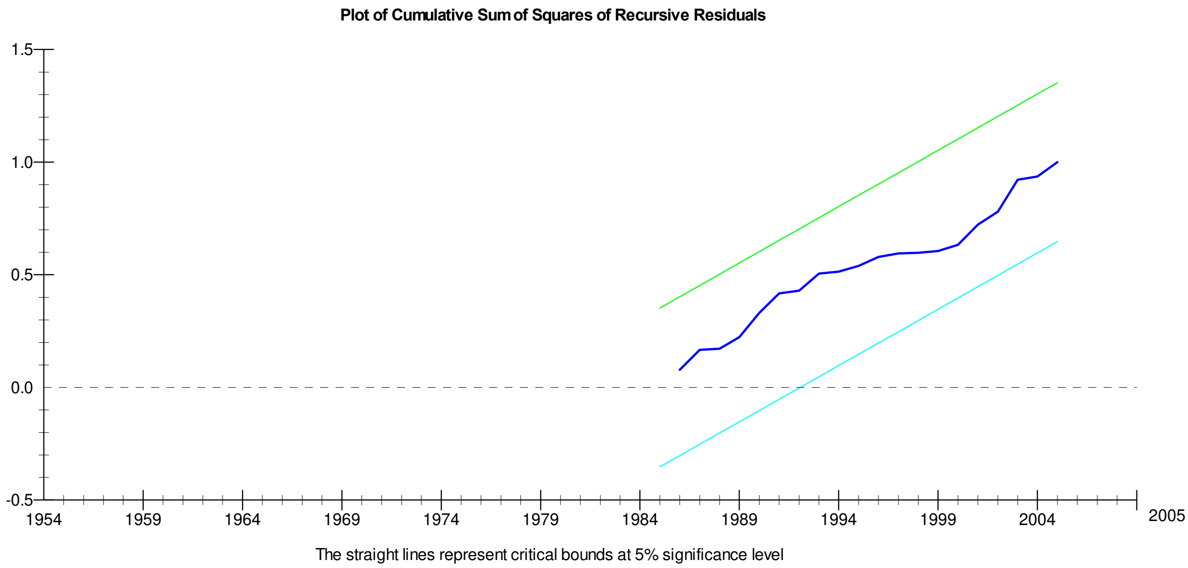
1.2 Diagnostic Tests Results

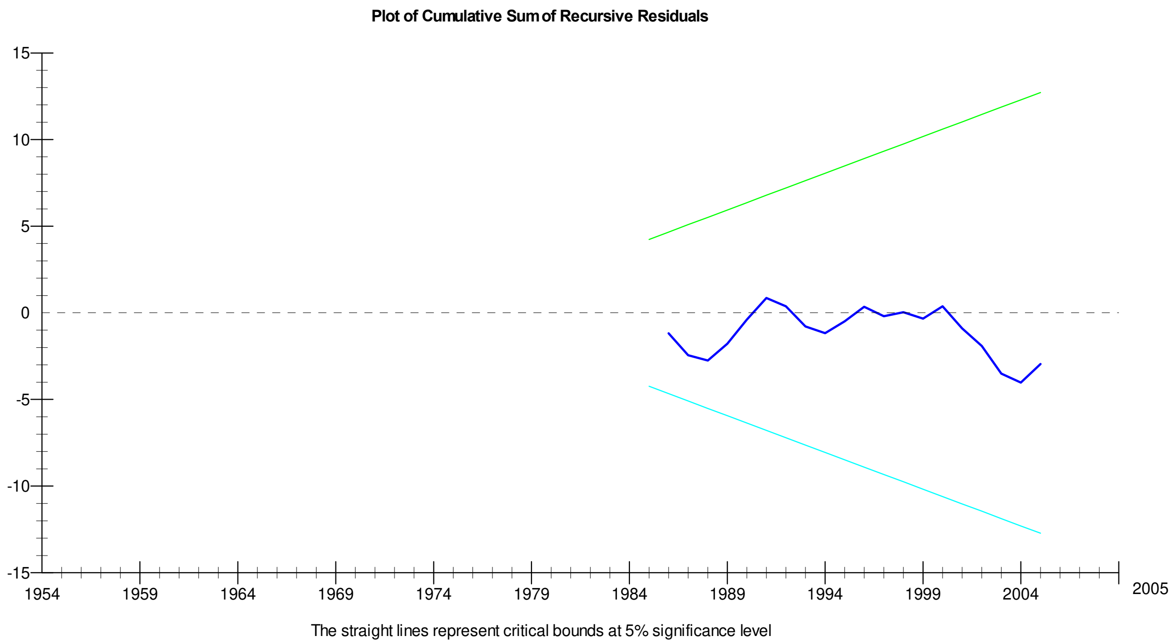
LM Test Statistics	χ^2 **Statistic**	**Probability**
Serial Correlation [a] $\chi^2(1)$	0.0009	0.975
Functional Form [b] $\chi^2(1)$	7.2519	0.007
Normality [c] $\chi^2(2)$	0.6669	0.716
Heteroscedasticity [d] $\chi^2(1)$	3.1018	0.078

a Breusch-Godfrey LM test for serial correlation.
b Ramsey RESET test for omitted variables/functional form.
c Jarque-Bera normality test.
d White test for heteroscedasticity.

1.3 Plot of CUSUM and CUSUMSQ (Stability Test)

The CUSUM and CUSUMSQ plotted against the critical bound of the five percent significance level show that the model is stable over time.





2. Household Savings (LHHS)

2.1 Key Regression Statistics:

R^2 = 0.9926

F (15, 37) = 329.8446 (0.000)

Durbin-Watson Statistic = 1.9928

2.2 Diagnostic Tests Results

LM Test Statistics	χ^2 Statistic	Probability
Serial Correlation [a] $\chi^2(1)$	0.0079	0.929
Functional Form [b] $\chi^2(1)$	0.2157	0.642
Normality [c] $\chi^2(2)$	0.3789	0.827
Heteroscedasticity [d] $\chi^2(1)$	1.2266	0.268

a Breusch-Godfrey LM test for serial correlation.

b Ramsey RESET test for omitted variables/functional form.

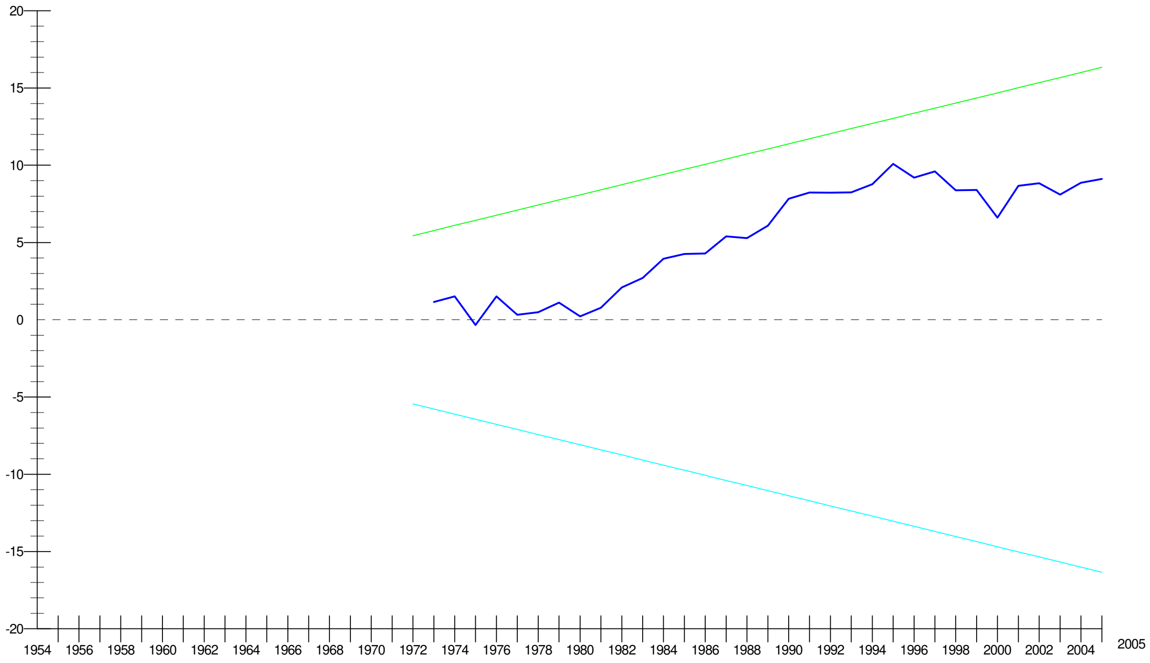
c Jarque-Bera normality test.

d White test for heteroscedasticity.

2.3 Plot of CUSUM and CUSUMSQ (Stability Test)

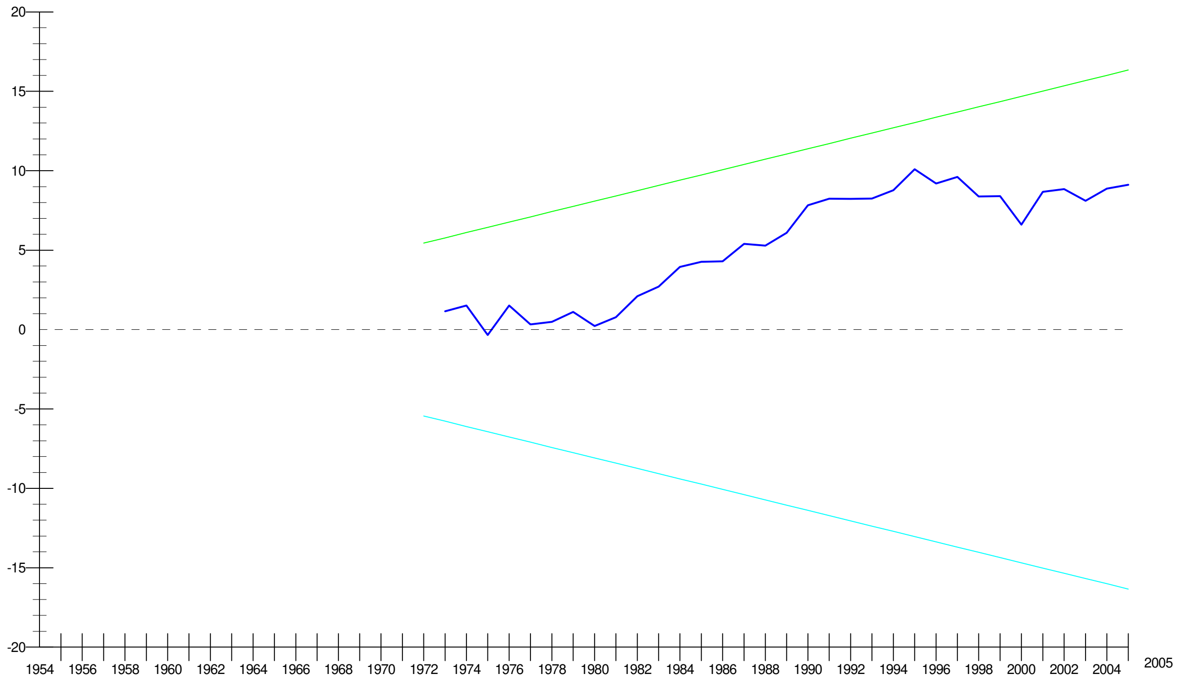
The CUSUM and CUSUMSQ plotted against the critical bound of the five percent significance level show that the model is stable over time.

Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

3. Private Savings (LPRS)

3.1 Key Regression Statistics:

$R^2 = 0.9958$

F (18, 34) = 452.5219 (0.000)

Durbin-Watson Statistic = 1.9825

3.2 Diagnostic Tests Results

LM Test Statistics	χ^2 Statistic	Probability
Serial Correlation [a] $\chi^2(1)$	0.0038	0.951
Functional Form [b] $\chi^2(1)$	0.0710	0.790
Normality [c] $\chi^2(2)$	2.4781	0.290
Heteroscedasticity [d] $\chi^2(1)$	0.2874	0.592

a Breusch-Godfrey LM test for serial correlation.

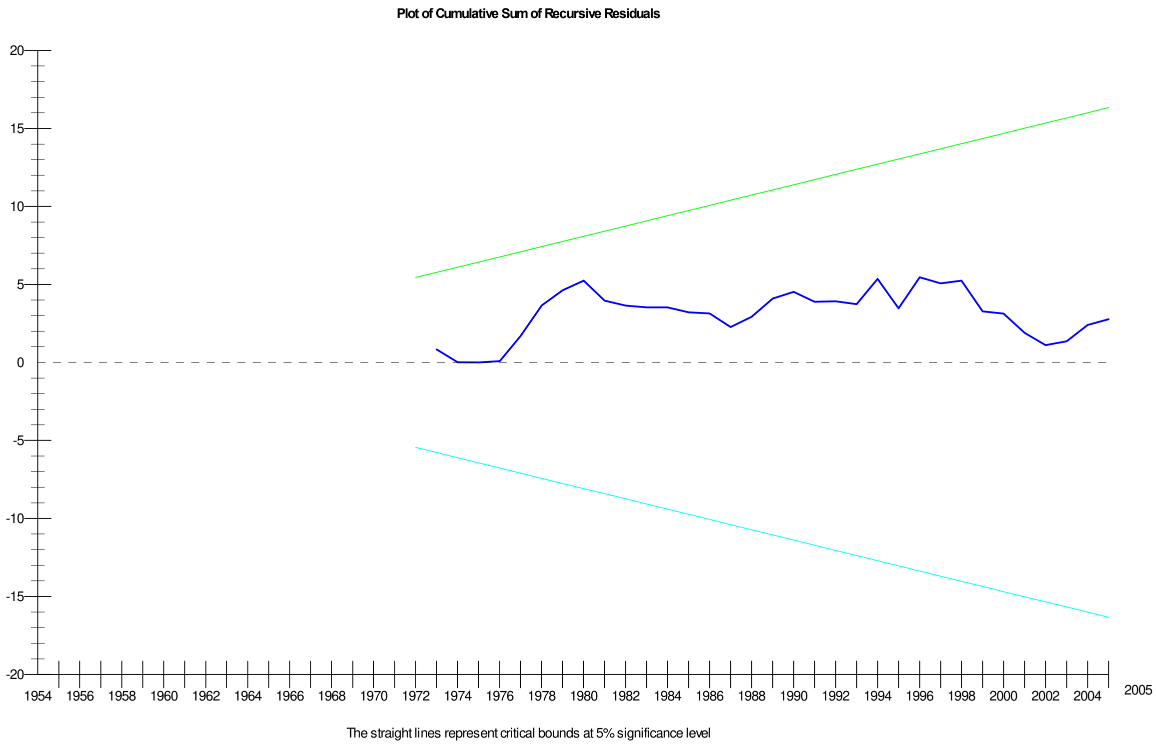
b Ramsey RESET test for omitted variables/functional form.

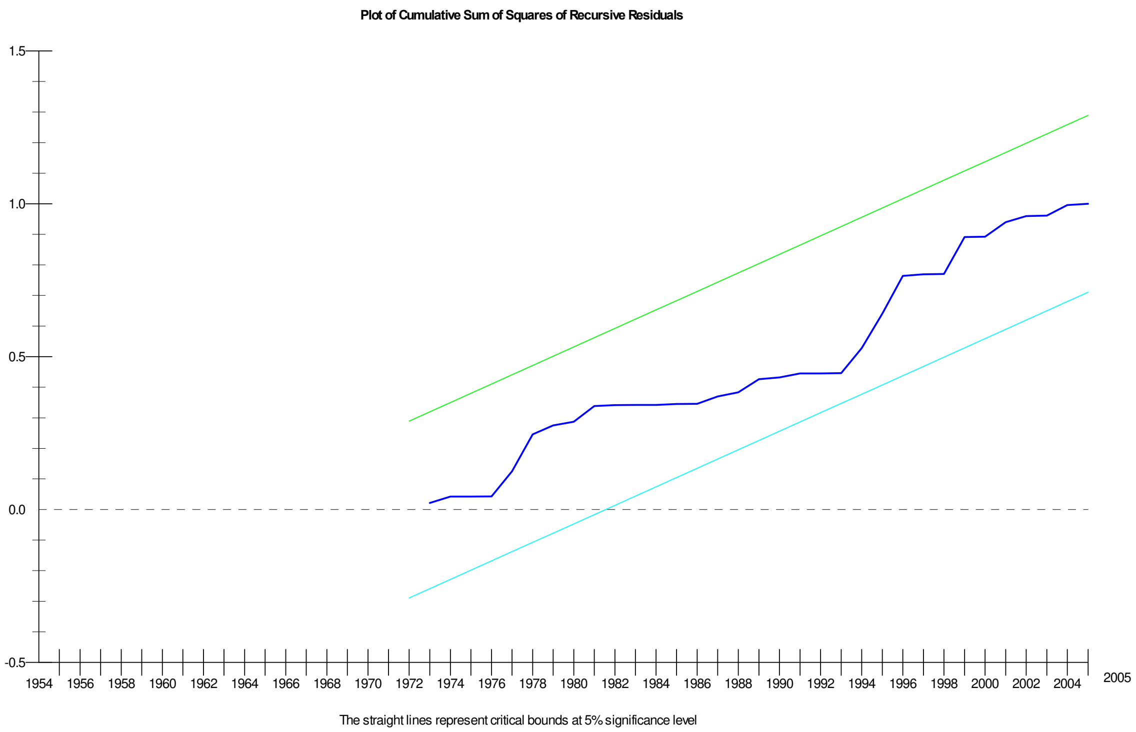
c Jarque-Bera normality test.

d White test for heteroscedasticity.

3.3 Plot of CUSUM and CUSUMSQ (Stability Test)

The CUSUM and CUSUMSQ plotted against the critical bound of the five percent significance level show that the model is stable over time.





4. Public Savings (LPUS)

4.1 Key Regression Statistics:

R^2 = 0.7826

F (12, 40) = 11.9993 (0.000)

Durbin-Watson Statistic = 1.7757

4.2 Diagnostic Tests Results

LM Test Statistics	χ^2 Statistic	Probability
Serial Correlation [a] $\chi^2(1)$	1.7314	0.188
Functional Form [b] $\chi^2(1)$	36.2412	0.000
Normality [c] $\chi^2(2)$	193.6931	0.000
Heteroscedasticity [d] $\chi^2(1)$	9.1576	0.002

a Breusch-Godfrey LM test for serial correlation.

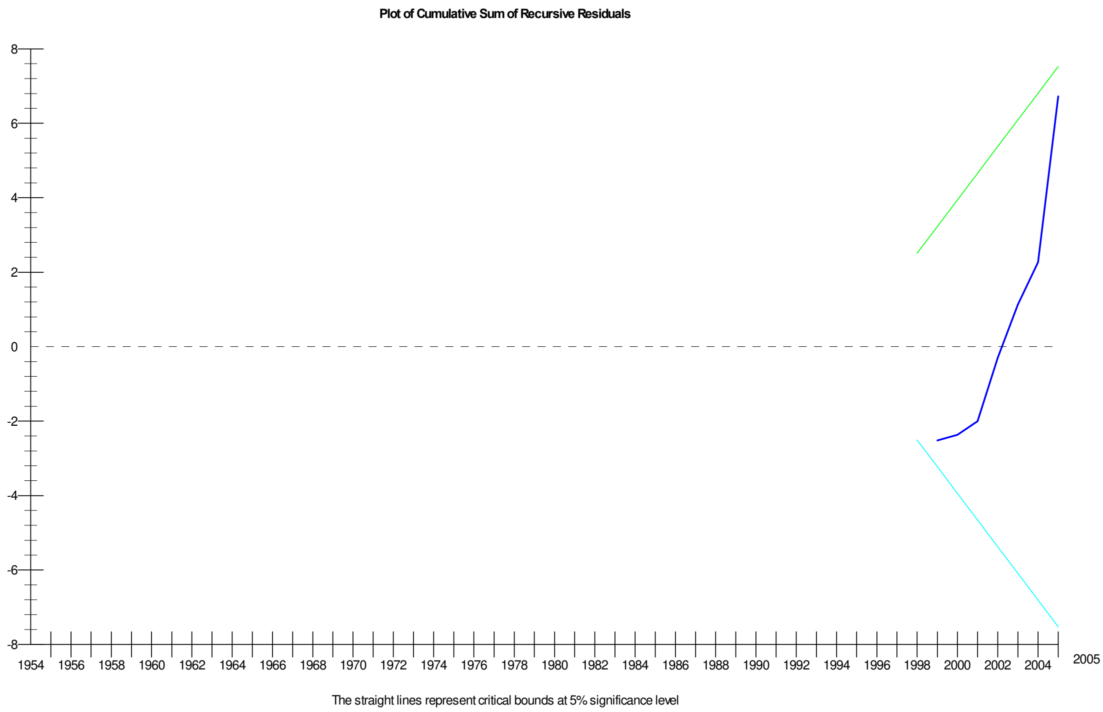
b Ramsey RESET test for omitted variables/functional form.

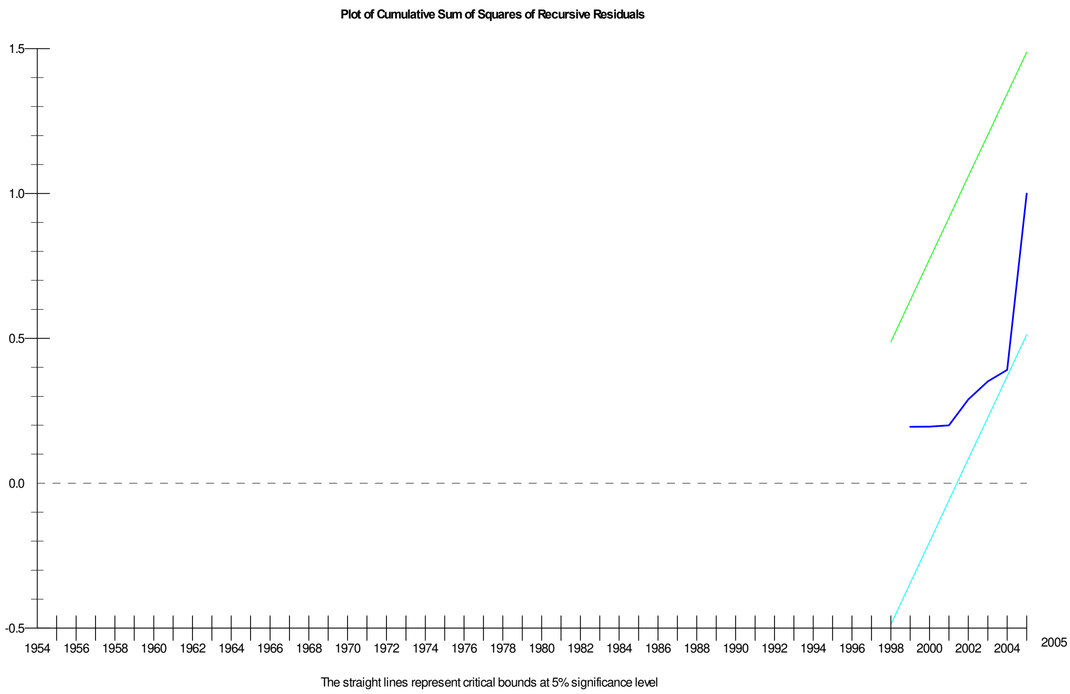
c Jarque-Bera normality test.

d White test for heteroscedasticity.

4.3 Plot of CUSUM and CUSUMSQ (Stability Test)

The CUSUM and CUSUMSQ plotted against the critical bound of the five percent significance level show that the model is stable over time.





5. Household Investment (LHHI)

5.1 Key Regression Statistics:

R^2 = 0.9891

F (15, 37) = 224.0284 (0.000)

Durbin-Watson Statistic = 2.0527

5.2 Diagnostic Tests Results

LM Test Statistics	χ^2 Statistic	Probability
Serial Correlation [a] $\chi^2(1)$	0.2189	0.640
Functional Form [b] $\chi^2(1)$	2.0983	0.147
Normality [c] $\chi^2(2)$	1.2656	0.531
Heteroscedasticity [d] $\chi^2(1)$	3.2864	0.070

a Breusch-Godfrey LM test for serial correlation.

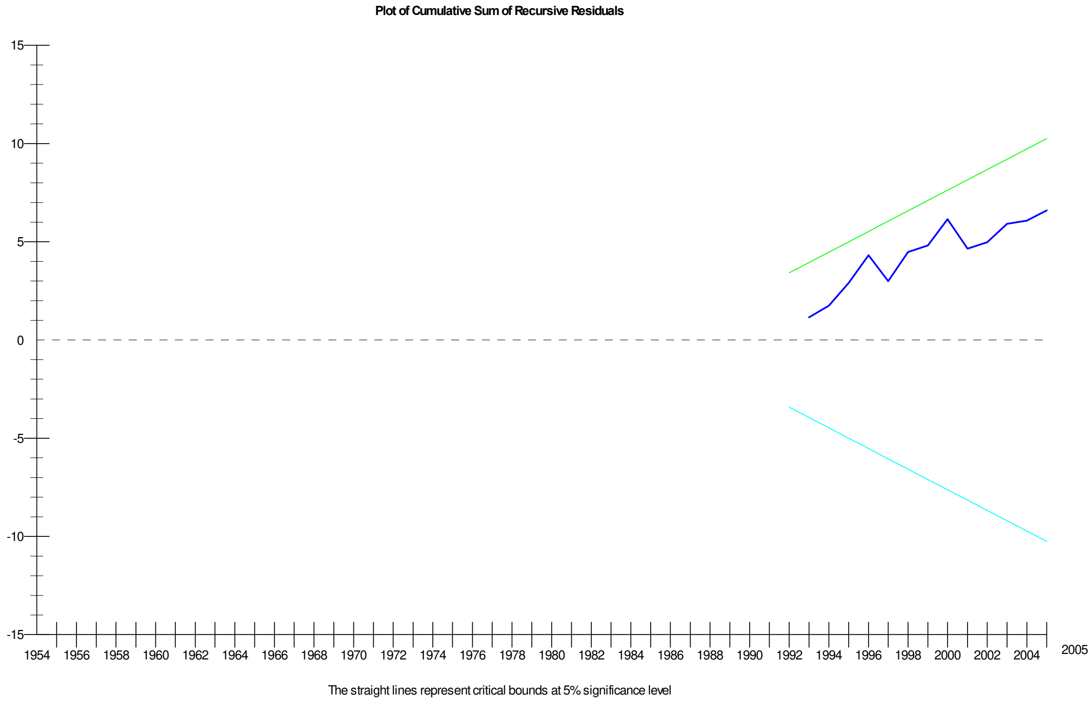
b Ramsey RESET test for omitted variables/functional form.

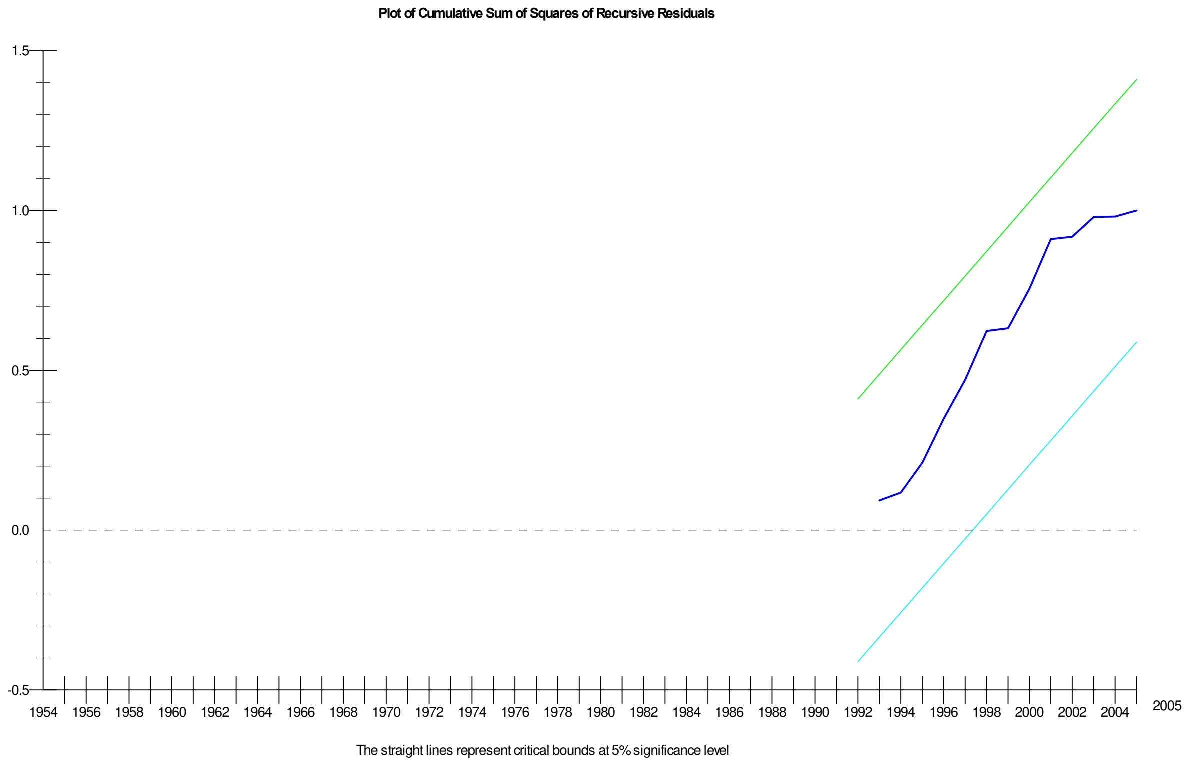
c Jarque-Bera normality test.

d White test for heteroscedasticity.

5.3 Plot of CUSUM and CUSUMSQ (Stability Test)

The CUSUM and CUSUMSQ plotted against the critical bound of the five percent significance level show that the model is stable over time.





6. Private Investment (LPRI)

6.1 Key Regression Statistics:

R^2 = 0.98071

F (18, 34) = 96.0116 (0.000)

Durbin-Watson Statistic = 2.0781

6.2 Diagnostic Tests Results

LM Test Statistics	χ^2 Statistic	Probability
Serial Correlation [a] $\chi^2(1)$	0.2911	0.590
Functional Form [b] $\chi^2(1)$	21.4253	0.000
Normality [c] $\chi^2(2)$	7.1663	0.028
Heteroscedasticity [d] $\chi^2(1)$	0.7835	0.376

a Breusch-Godfrey LM test for serial correlation.

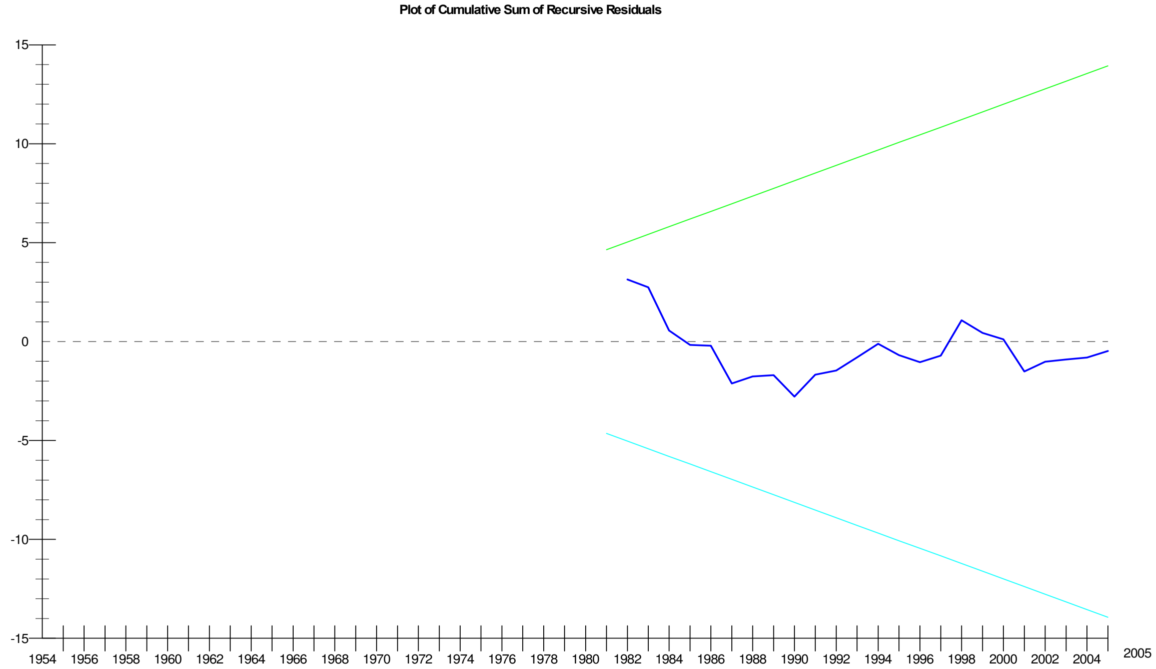
b Ramsey RESET test for omitted variables/functional form.

c Jarque-Bera normality test.

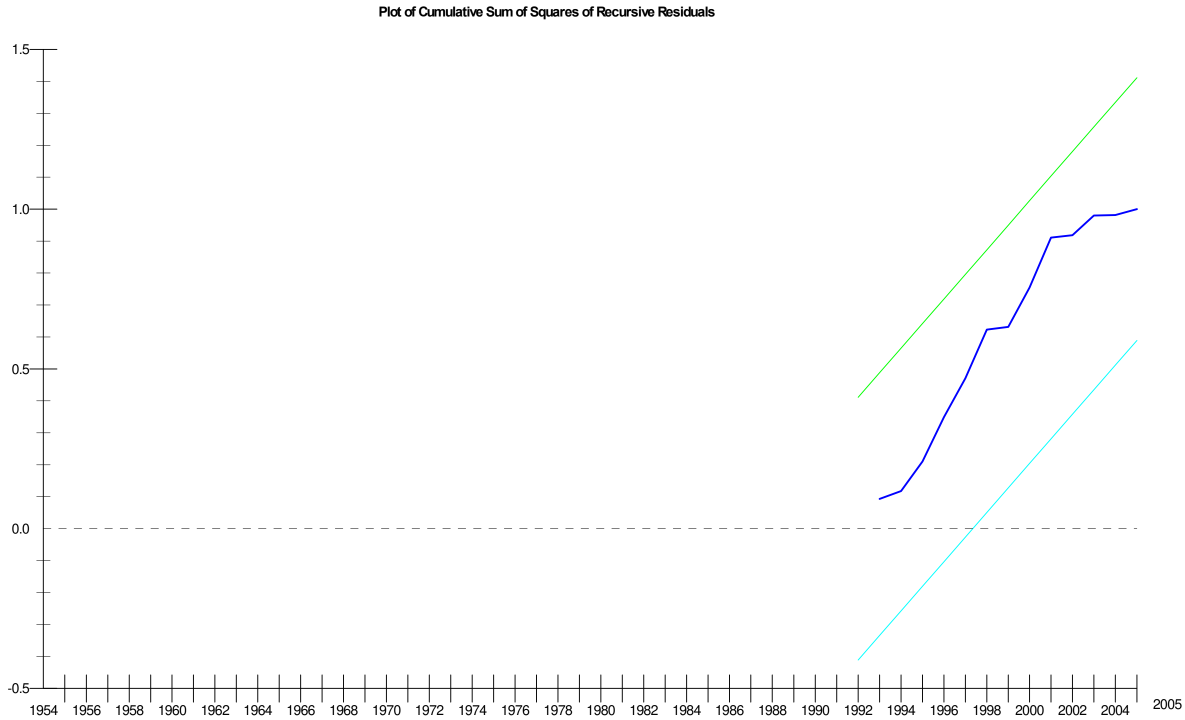
d White test for heteroscedasticity.

6.3 Plot of CUSUM and CUSUMSQ (Stability Test)

The CUSUM and CUSUMSQ plotted against the critical bound of the five percent significance level show that the model is stable over time.



The straight lines represent critical bounds at 5% significance level



The straight lines represent critical bounds at 5% significance level

7. Public Investment (LPUI)

7.1 Key Regression Statistics:

R^2 = 0.9933

F (15, 37) = 365.4867 (0.000)

Durbin-Watson Statistic = 2.0683

7.2 Diagnostic Tests Results

LM Test Statistics	χ^2 Statistic	Probability
Serial Correlation [a] $\chi^2(1)$	0.4901	0.484
Functional Form [b] $\chi^2(1)$	1.5557	0.212
Normality [c] $\chi^2(2)$	1.0480	0.592
Heteroscedasticity [d] $\chi^2(1)$	0.2743	0.600

a Breusch-Godfrey LM test for serial correlation.

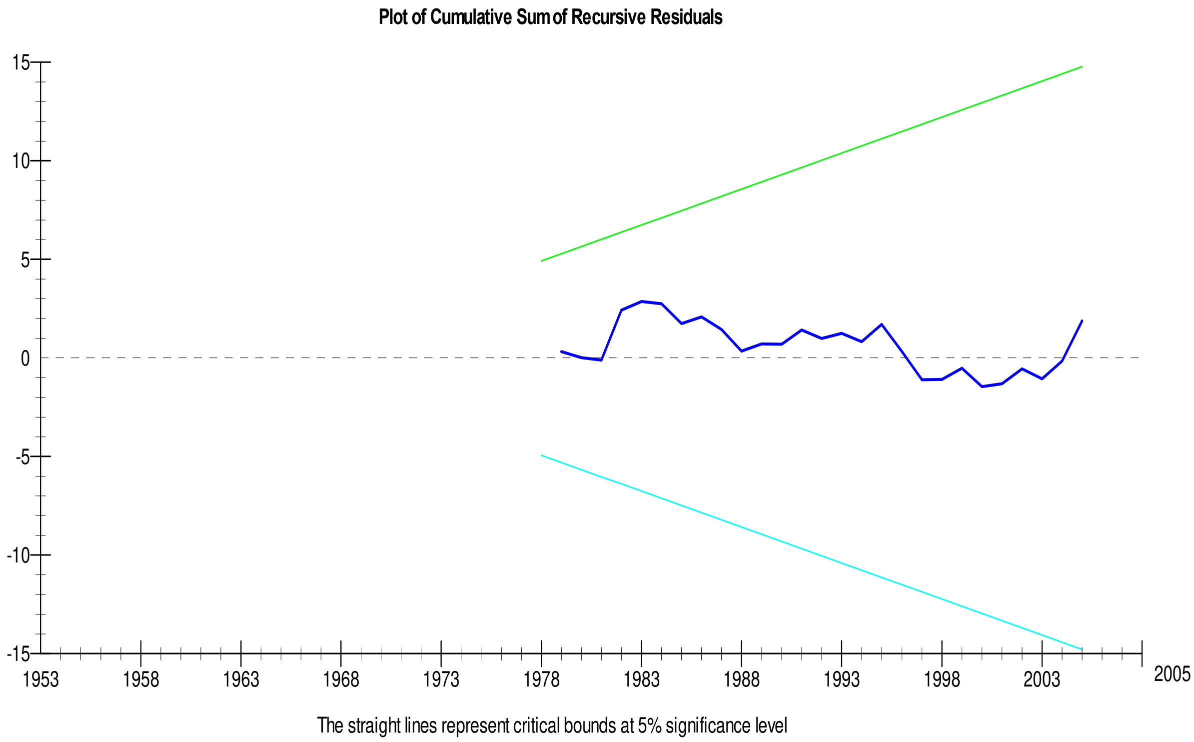
b Ramsey RESET test for omitted variables/functional form.

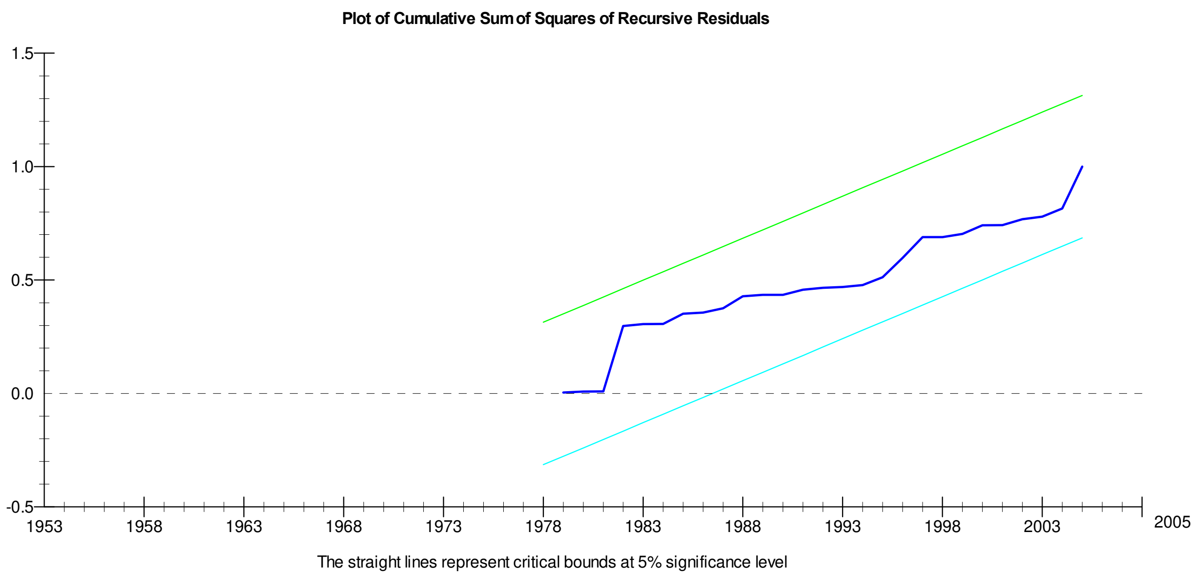
c Jarque-Bera normality test.

d White test for heteroscedasticity.

7.3 Plot of CUSUM and CUSUMSQ (Stability Test)

The CUSUM and CUSUMSQ plotted against the critical bound of the five percent significance level show that the model is stable over time.





8. Foreign Capital Inflows (LFCI)

8.1 Key Regression Statistics:

R^2 = 0.9851

F (16, 36) = 148.4390 (0.000)

Durbin-Watson Statistic = 2.1746

8.2 Diagnostic Tests Results

LM Test Statistics	χ^2 Statistic	Probability
Serial Correlation [a] $\chi^2(1)$	0.7498	0.387
Functional Form [b] $\chi^2(1)$	0.3541	0.552
Normality [c] $\chi^2(2)$	2.1832	0.336
Heteroscedasticity [d] $\chi^2(1)$	0.5111	0.475

a Breusch-Godfrey LM test for serial correlation.

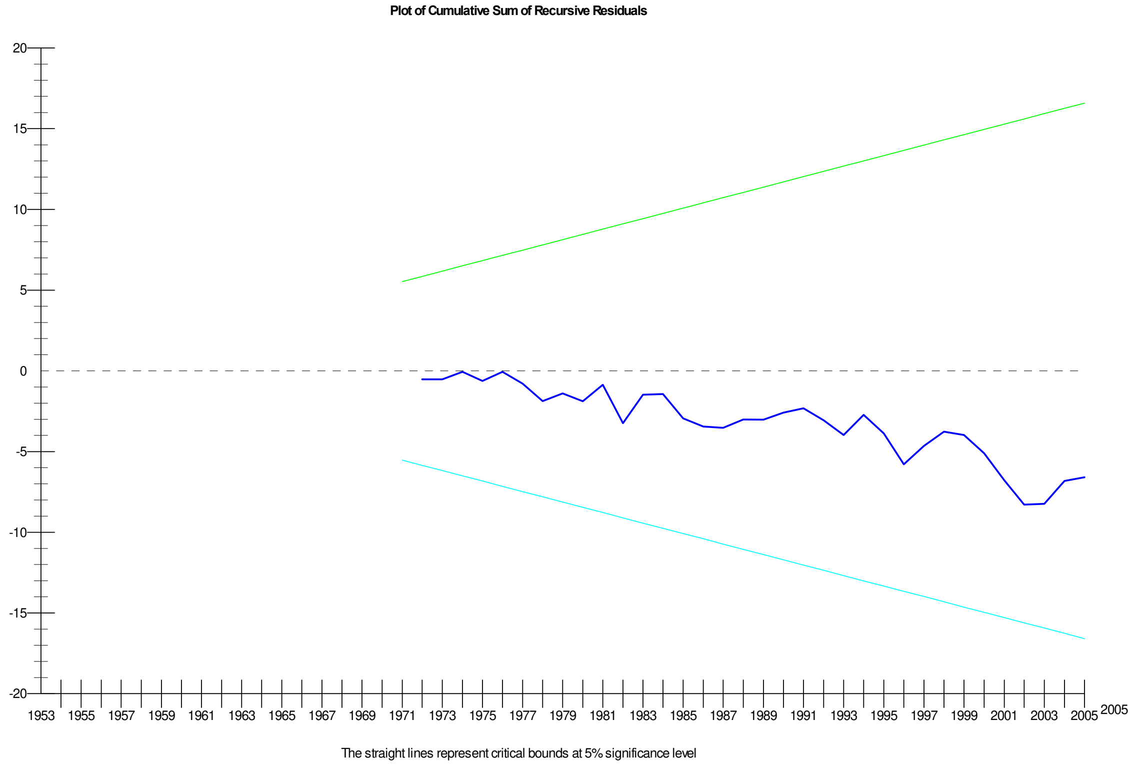
b Ramsey RESET test for omitted variables/functional form.

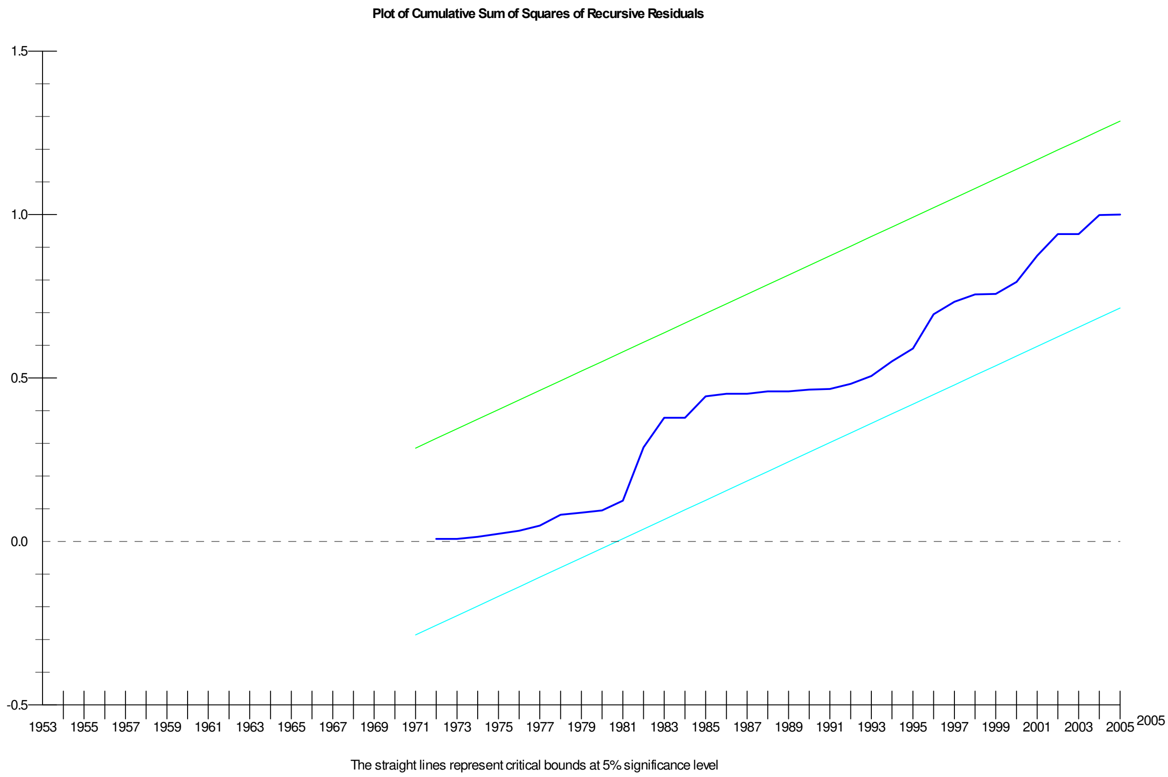
c Jarque-Bera normality test.

d White test for heteroscedasticity.

8.3 Plot of CUSUM and CUSUMSQ (Stability Test)

The CUSUM and CUSUMSQ plotted against the critical bound of the five percent significance level show that the model is stable over time.





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