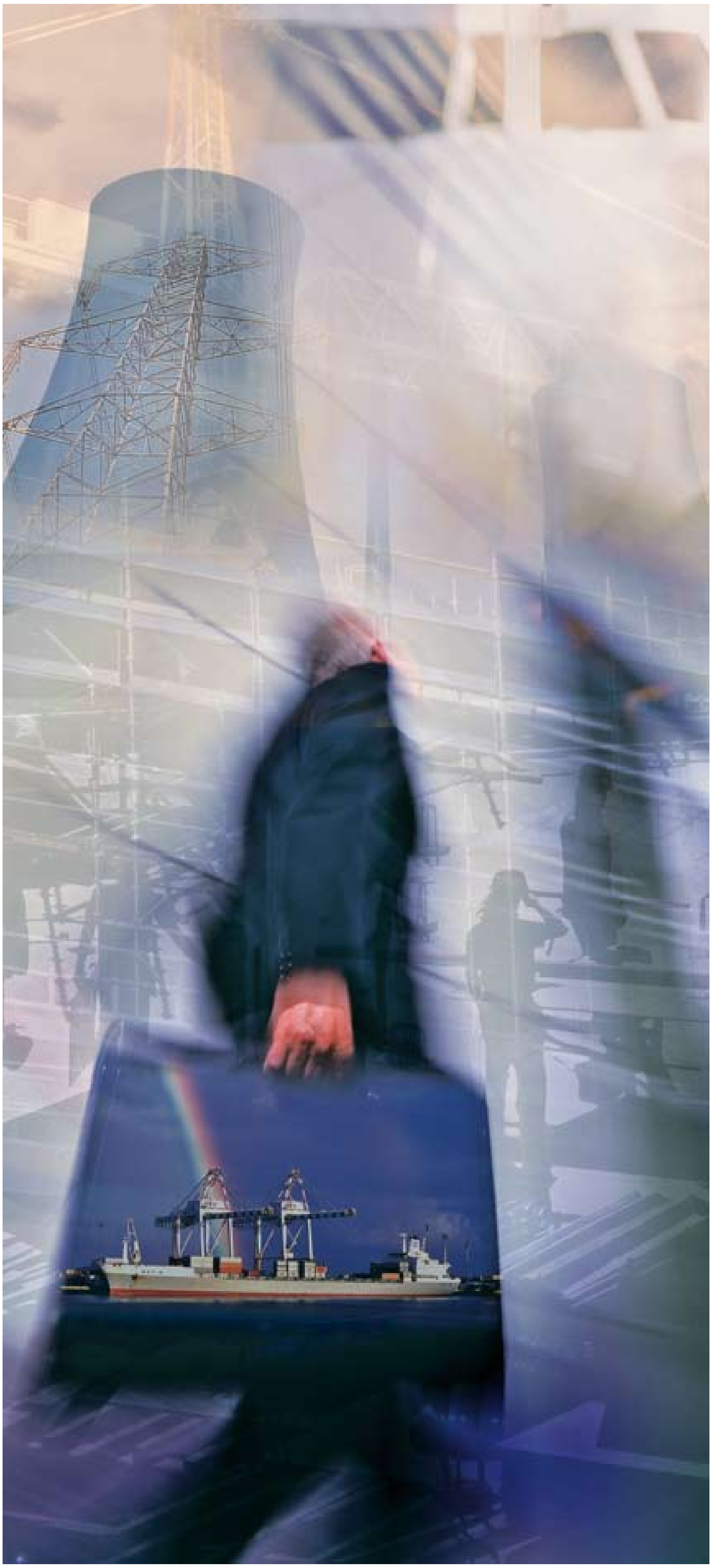


Queensland

The Economic Society of Australia Inc.

Proceedings of the 37th Australian Conference of Economists

Papers delivered at ACE 08

30th September to 4th October 2008
Gold Coast Queensland Australia

ISBN 978-0-9591806-4-0

Welcome

The Economic Society of Australia warmly welcomes you to the Gold Coast, Queensland, Australia for the 37th Australian Conference of Economists.

The Society was formed 83 years ago in 1925. At the time, the Society was opposed to declarations of policy and instead focused on open discussions and encouraging economic debate. Nothing has changed today, with the Society and the conference being at the forefront of encouraging debate.

This year we have a large number of papers dealing with Infrastructure, Central Banking and Trade.

Matters of the greatest global importance invariably boil down to be economic problems. Recent times have seen an explosion of infrastructure spending, after world-wide population growth has seen demand outpace aging supply. The world has become more globalised than at any time since World War I but the benefits of this (and the impact on our climate) has been questioned by some.

At the time of preparing for this conference we could not have known that it would have been held during the largest credit crisis since the Great Depression. The general public and politicians both look to central banks for the answers.

We are also very pleased to see a wide selection of papers ranging from applied economics to welfare economics. An A – Z of economics (well, almost).

Another feature of this conference is that we have gone out of our way to bring together economists from all walks of life, in particular from academia, government and the private sector. We are grateful to all of our sponsors, who are as diverse as the speakers.

The Organising Committee

James Dick
Khorshed Alam (Programme Chair)
Michael Knox
Greg Hall
Allan Layton
Rimu Nelson
Gudrun Meyer-Boehm
Jay Bandaralage
Paula Knight

Published November 2008

GPO Box 1170
Brisbane Queensland Australia
ecosocqld@optushome.com.au

Our Gold Sponsors

QIC

Queensland Treasury Corporation

Reserve Bank of Australia

Queensland Government Department of Infrastructure and Planning

Keynote Sponsors

Australian Government Productivity Commission

Australian Government The Treasury

Queensland University of Technology
Faculty of Business
School of Economics and Finance

The University of Queensland Australia

Goldman Sachs JBWere

The University of Queensland Australia

NCER National Centre for Econometric Research

ES Central Council

Special Session Sponsors

Griffith University

The Higher Education Academy Economics Network

Unless we have specifically been requested to do otherwise, all the papers presented at the conference are published in the proceedings in full. A small number of papers will have versions that have also been made available for special editions of Journals, Economic Analysis and Policy, and the Economic Record. Authors will retain the right to seek additional publication for papers presented at the conference so long as it differs in some meaningful way from those published here.

The opinions expressed in the papers included in the proceedings are those of the author(s) and no responsibility can be accepted by the Economic Society of Australia Inc, Economic Society of Australia (Queensland) Inc, the publisher for any damages resulting from usage or dissemination of this work.

The Paper following forms part of - *Proceedings of the 37th Australian Conference of Economists*
ISBN 978-0-9591806-4-0

A Multivariate Analysis of Savings, Investment, Foreign Capital Inflows and Economic Growth in India

R. Verma and E. J. Wilson

School of Economics
University of Wollongong
Northfields Avenue
Wollongong NSW 2500
AUSTRALIA

E-mail: edgar_wilson@uow.edu.au
reetu@uow.edu.au
Phone: 61 2 42213666
Fax: 61 2 42213725

Australian Conference of Economists – ACE 2008
Surfers Paradise, Australia
30 September – 3 October, 2008

A Multivariate Analysis of Savings, Investment, Foreign Capital Inflows and Economic Growth in India

R. Verma and E. J. Wilson*

ABSTRACT

This paper considers the interdependencies between per worker household, private corporate and public sector savings and investment, foreign capital inflows and GDP in a multivariate setting for India. This is in response to shortcomings relating to previous studies which predominantly analyse savings and investment aggregates only, over long time periods which contain structural changes, using bivariate estimation techniques, which are short run in nature.

A sectoral model is developed to provide a theoretical basis for the empirical research and to demonstrate the possible complex interdependencies between these variables and sectors. The analysis is applied over the period 1951 to 2005 with two endogenously determined structural breaks occurring in 1966 and 1981. The long run cointegrating relationship is estimated in a multivariate setting using Johansen's procedure to determine which variables are subject to permanent, semi-permanent and transitory shocks according to Pagan and Pesaran's (2008) innovative classification. Consistent with the recent DSGE and structural VAR modelling, a VAR containing these specifications is estimated to determine the short run interdependencies using statistical tests and the analysis of forecast error variance decompositions.

The findings show that the causation runs from per worker household savings and investment positively to private corporate savings and then to private corporate investment, which in turn affects household savings and investment. Per worker public investment is found to negatively (with small elasticity) affect GDP, which negatively affects foreign capital inflows, which subsequently negatively affects private corporate savings. These results imply the need to encourage savings, which is being realised with higher growth rates during the recent period of financial deregulation in India. However the offsetting reduction in the rates of growth in investment during the 1990s, the lack of any identified links to output and the apparent negative influence of public investment, means that policy prescriptions to promote economic growth in India are not straightforward.

Keywords: Savings, investment and economic growth.
JEL Classifications: F43, E21, E22, C22.

* The authors would like to thank, without implicating, the thoughtful and insightful comments provided by the participants at a workshop held by the Monetary Policy Department of the Reserve Bank of India, Mumbai.

1. Introduction

The roles of savings, investment and foreign inflows in promoting economic growth have received considerable attention in India since independence. However, there have been relatively few studies on Indian savings and investment behaviour for the period starting with the economic crises of the late 1980s and subsequent financial reforms initiated in the early 1990s. Krishnamurty, Krishnaswamy and Sharma (1987) was the first study for this period, followed by Laumas (1990), Pandit (1991) and Ketkar and Ketkar (1992). Surprisingly, this research provides little empirical evidence to support the role that savings and investment play in promoting economic growth via the Solow, Harrod-Domar or endogenous growth theories. The studies commonly test for Granger causality between Indian savings and growth and to a lesser extent, between Indian investment and growth. In contrast to the theories of economic growth, there is robust support for the Carroll-Weil hypothesis that savings do not cause economic growth, with growth causes savings.

Subsequent studies reinforce this finding. Sahoo, Nataraj and Kamaiah (2001) use annual data for the period 1950/51 to 1998/99 to examine the link between savings and growth in India. They find one-way causality from gross domestic product to gross domestic savings in real terms, both in the long run and short run. Mahambare and Balasubramanyam (2000) conclude "…the Granger causality test suggests that causality runs from growth to savings" for India. Agrawal (2000) examines the savings rate and the growth rate of real GNP using VAR specifications. His analysis also finds causality from growth to the savings rate.

The focus naturally led researchers to analysing the possible relationships between sectoral measures of savings. Mühleisen (1997) conducts Granger causality tests by running bivariate VARs on the growth in real GDP and the levels of total, public and private savings rates. Whilst these tests indicate there is significant causality from growth to savings, they consistently reject 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 period to 2000/01 in order to analyse the consequences of India's financial reforms in the 1990s. He estimates bivariate VARs between the log of real GDP and total, public, private and foreign savings rates. The results support Mühleisen's conclusions in that causality runs from output to savings and not in the opposite direction.

---

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

All of this contrasts with the studies of investment, which are surprisingly few. Whilst Seshaiah and Sriyval (2005) demonstrate close links between savings and investment, most research is unable to detect any statistically significant links between investment and economic growth in India. The exceptions find (similar to savings) that economic growth provides an accelerator effect on investment. Sandilands and Chandra (2003) and Verma and Wilson (2004) conclude that capital accumulation is the result rather than the cause of economic growth. Of all the known studies, only Athukorala and Sen (2002) find support for the view that investment is the "proximate" cause of economic growth. Saggar (2003) shows that total and private investment rates Granger cause real GDP growth. However, this discovery is put into doubt when he finds no evidence of causality from the growth in real GDP to the different measures of investment. Saggar (2003, p. 116) wisely concludes:

> *We find it is not easy to decipher causality between saving and growth and investment and growth, given the low power of the unit root tests and limitations of VAR and cointegrating methodologies in the face of relatively small sample sizes. The Carroll-Weil hypothesis is upheld, perhaps more as a statistical quirk and it is best to interpret these results with caution …. While this paper has provided new evidence …further theoretical and empirical work is necessary…"*

There are four problems associated with all of these studies. The first is the predominant use of savings and investment aggregates, and where disaggregated measures are used, the household sector is excluded. Only Saggar (2003) examines all sectors including the household sector (although his econometric estimation aggregates household and private corporate savings). There is a need to disaggregate because the household/private corporate split averages 75/25 per cent of total private gross domestic savings and around 55/45 percent of total private gross domestic investment. There may be important undetected relationships between these sectoral measures and with others.

The second problem relates to the "need for further investigation … in a multivariate setting" (Saggar, 2003, p. 111). The reliance on bivariate estimation in these studies will possibly find spurious relationships. Given the possible complex interdependencies among the variables, a simultaneous VAR estimation method is appropriate.

Extending the analysis to include multi-variable VAR methods introduces the third problem. The VAR specification is only short run in nature and the associated Granger causality tests will be misspecified since they incorrectly exclude the error correction to long run equilibrium. It is essential to use cointegration estimation techniques to run multivariate Granger causality analysis which include short run disequilibrium behaviour.

The final difficulty is that the samples used, although having relatively few observations, covers up to 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.

We expect that these complications will make it difficult to find robust and statistically significant relationships between household, private corporate and public sector savings and investment, foreign capital inflows and real output. Indeed the growth rate in real GDP has consistently exceeded five per cent throughout the 1980s and 1990s.[2] We will therefore focus on the difficult task of identifying and quantifying the links, in particular, between sectoral savings and GDP and sectoral investment and GDP, in the long run and the short run. Because of the lack of empirical validation of the Solow and endogenous growth models a disaggregated model is presented in the next section to provide a reference for our empirical explorations.

2. A Disaggregated Reference Growth Model

Verma and Wilson's (2004) four sector open economy growth model with government is adapted in order conceptualise and identify the possible complex interrelationships between the key variables and sectors.[3] The private sector is disaggregated into two sectors, namely households and private corporate firms.[4] A typical household supplies labour services for a real per worker wage rate, *w*, to produce real per worker household output via the production function, $f_h\left(k_h\right)$, where k_h represents the households capital per worker.[5] Households also arbitrage their supply of their labour to private corporate firms, which equilibrates the per worker 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

---

3 The overseas sector is modelled via the capital and financial account.

4 All variables are real and expressed in per worker terms in order to keep the maths simple.

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

real return, rb_p (all in per worker terms). The household pays net per worker taxes to the government, , τ_h and purchases government debt, $\dot{b}_g$, with real per worker return, rb_g. Consumption goods, *c*, again expressed in per worker terms are also purchased by households from private corporate firms.[6] Household investment per worker, $\dot{k}_h$, returns rk_h, based on the assumption that the real returns, *r*, are arbitraged and therefore equal across sectors. The budget constraint for the representative household is given by:

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

where the right hand side represents total per worker household disposable income, which is spent on purchases of consumption goods, *c*, and shares, $\dot{b}_p$, from private firms, and government bonds, $\dot{b}_g$.[7]

The household selects the time path of per worker consumption which maximises intertemporal utility, $U(c) = \int_{t_0}^{\infty} u\left[c(t)\right] e^{-\rho t} dt$, where $u(c)$ is a concave instantaneous utility function.[8] The Appendix derives the optimal household savings path, s_h, which maximise household intertemporal utility:

$$s_h = \dot{b}_p + \dot{b}_g = \alpha y_h - e^{\int_0^t \theta(r(s)-\rho)ds}. \tag{2}$$

The second component of savings in (2) 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:

$$\dot{k}_g = \left(\tau_h + \tau_p\right) + \left(\dot{b}_g - rb_g\right) \tag{3}$$

where receipts comprise taxation per worker 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 in per worker terms, $\dot{k}_g$.[9] Government per worker budget (dis)savings are therefore defined as:

---

6 Households may receive transfer payments from the government which are included in net taxes.

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

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

9 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.

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

The other component of household savings in the form of shares, $\dot{b}_p$ in (2) involves the private corporate sector. The representative firm employs household labour and household owned capital per worker, k_p, to competitively produce per worker output according to the production function, $f_p\left(k_p, k_g, A\right)$.[10] This specification assumes that government capital per worker, k_g promotes production and parameter A represents total per worker factor productivity.

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

$$c + \dot{k}_g + \dot{b}_p + \dot{b}_f = w + rb_p + rb_f + \tau_p . \tag{5}$$

Per worker savings by firms, s_p are given by:[11]

$$s_p = -\left(\dot{b}_p + \dot{b}_f\right) = \beta y_p - y_h + rb_g - rb_f .\text{[12]} \tag{6}$$

---

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

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

[12] 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 .

with the substitutions, $y_p = c + \dot{k}_g$ and $y_h - rb_g = w + rb_p$, 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 (6) can also be rearranged to determine the endogenous overseas borrowings in the form of foreign capital inflows:

$$\dot{b}_f = -\beta y_p + y_h - \dot{b}_p - rb_g + rb_f \tag{7}$$

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

$$S_p\left(k_p\right) = \int_{t_0}^{\infty} s_p\left[k_p\left(t\right)\right] e^{-\rho t} dt \tag{8}$$

where the constant discount rate, ρ is assumed to be the same for households. The solution of this maximisation in the Appendix gives optimal per worker capital formation:

$$\dot{k}_p = \phi\left[\int_t^{\infty}\left(\beta y'_{p,k_p} - y'_{h,k_p}\right) e^{-\rho(s-t)} ds - 1\right] \tag{9}$$

where: $y'_{p,k_p} = \partial y_p / \partial k_p$ and $y'_{h,k_p} = \partial y_h / \partial k_p$ represent the per worker marginal products of the firm's and household's capital. The term, $\int_t^{\infty}\left(\beta y'_{p,k_p} - y'_{h,k_p}\right) e^{-\rho(s-t)} ds$ represents the sum of the weighted net present values of all future per worker marginal products, $\beta y'_{p,k_p} - y'_{h,k_p}$. This maximisation is also adapted in the Appendix to determine the optimum time path of household investment, $\dot{k}_h$:

$$\dot{k}_h = \varphi\left[\int_t^{\infty} \alpha y'_{h,k_p} e^{-\rho(s-t)} ds - 1\right] \tag{10}$$

The endogenous growth model, comprising equations (2)−(4), (6)−(7), (9) and (10), indicate high degrees of interdependence between the variables and relationships. Equations (2) and (10) show that household per worker 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 (3) shows the government sector per worker (dis)saving (5) as a function of household savings and tax receipts paid by households and private corporate firms. Private sector per worker savings (6) and investment (9) are determined by competitive firms maximising intertemporal savings of firms who may borrow from overseas in the form of foreign capital inflows (7). Real output per worker is given by the aggregate production function:

$$y = f_h(k_h) + f_p(k_p, k_g, A) \qquad (11)$$

which includes the endogenous growth effects of 'learning by doing' and causes of changes in total factor productivity in *A*. 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 per worker			
Household	*HHS*	$s_h = \dot{b}_p + \dot{b}_g = \alpha y_h - e^{\int_0^t \theta(r(s)-\rho)ds}$	(2)
Private corporate	*PRS*	$s_p = -(\dot{b}_p + \dot{b}_f) = \beta y_p - y_h + rb_g - rb_f$	(6)
Government	*PUS*	$s_g = -(\dot{b}_g - rb_g) = (\tau_h + \tau_p) - \dot{k}_g$	(4)
Investment per worker			
Household	*HHI*	$\dot{k}_h = \varphi\left[\int_t^\infty \alpha y'_{h,k_p} e^{-\rho(s-t)} ds - 1\right]$	(10)
Private corporate	*PRI*	$\dot{k}_p = \phi\left[\int_t^\infty \left(\beta y'_{p,k_p} - y'_{h,k_p}\right) e^{-\rho(s-t)} ds - 1\right]$	(9)
Government	*PUI*	$\dot{k}_g = (\tau_h + \tau_p) + (\dot{b}_g - rb_g)$	(3)
Foreign capital inflows per worker	*FCI*	$\dot{b}_f = -\beta y_p + y_h - \dot{b}_p - rb_g + rb_f$	(7)
Production per worker	*GDP*	$y = f_h(k_h) + f_p(k_p, k_g, A)$	(11)

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

The relationships, summarised in Table 1, for the household and private corporate savings in (2) and (6) clearly show that savings are positive functions of same sector income and output. However the model specifies capital formation as being primarily influenced by the respective marginal products of capital in the household (10) and private corporate sectors (9). However, the model importantly indicates a more flexible relationship between sectoral savings and investment. If production is characterised by constant returns to scale then there will be a one-to-one relationship between output and productivity, and therefore a correspondence between savings and investment, consistent with the Solow model. The complex interdependencies will be estimated for India in the next section.

3. Stationarity and Structural Breaks

The household sector comprises individuals, non-profit institutions and non-government non-corporate enterprises.[13] The private corporate sector comprises co-operative institutions and non-governmental corporate enterprises.[14] The public sector includes government administrations as well as departmental and non-departmental enterprises.

All data used in this study are annual observations for the period from 1950/51 to 2004/05. The nominal savings and investment data for the household, private corporate and public sectors have been taken from the *National Accounts Statistics of India* (2002). The nominal foreign capital inflows come from the *Centre of Monitoring Indian Economy* (2002). The difficulty is that the national accounts measure household savings as household investment plus household holdings of financial assets (*FSA*). We cannot therefore sensibly include both *HHS* and *HHI* in the estimation due to double counting. Instead we consider *FSA* and *HHI* and where appropriate, test the parameter restrictions which give statistical tests of the sum of the coefficients. All variables are transformed into constant prices,[15] per worker[16] and Naperian logs. Whilst putting the variables in per worker terms is consistent with the theoretical model above the major motivation is to attempt to de-trend the time series, commonly applied in DSGE and structural VAR research. The resulting variables

[13] Examples include sole proprietorships and partnerships owned or controlled by individuals.

[14] These include financial and non-financial corporate enterprises.

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

[16] The data for the labour force is obtained from the Indian Planning Commission. The labour force data are only available for the census years 1951, 1961, 1971, 1981, and 1991. The values of the labour force for other years were estimated using simple interpolations between the census figures. Because all variables are equally divided by the same labour force figures for each year, they only differ by a common constant of proportionality.

[18] Since public savings are negative for the period 1999 to 2004, the values for *PUS* are set to zero and a dummy variable (d_1) takes values one for these years (and zero elsewhere).

comprise the log of real per worker measures of household financial assets (*FSA*) and investment (*HHI*); per worker private corporate savings (*PRS*) and investment (*PRI*); per worker public savings (*PUS*) and investment (*PUI*); per worker foreign capital inflows (*FCI*) and per worker real GDP (*GDP*) .[18]

Given that the ADF test for stationarity of a time series is biased towards the non-rejection of the null hypothesis of *I*(1) if structural change is present this paper employs Lee and Strazicich's (2003) one and two-break unit root test.[19] The results reported in Table 2 (which include both intercept and trend) indicate that *PRS*, *HHI*, *FCI* and *GDP* are non-stationary in the presence of the identified years of the structural breaks.

Table 2

Summary of Lee and Strazicich's Structural Change Tests

Variable	2 Breaks					1 Break	
	Intercept and Trend				Intercept	Intercept and Trend	Intercept
	$\hat{k}$	T_{b_1}	T_{b_2}				
FSA	3	1961***	1970*	*I*(0)	*I*(1)	*I*(1)	*I*(1)
PRS	0	1963	1989***	*I*(1)	*I*(1)	*I*(1)	*I*(1)
PUS	5	1976	1996***	*I*(0)	*I*(1)	*I*(0)	*I*(1)
HHI	7	1969***	1979***	*I*(0)	*I*(1)	*I*(1)	*I*(1)
PRI	7	1961***	1978***	*I*(0)	*I*(1)	*I*(0)	*I*(0)
PUI	3	1967***	1986***	*I*(0)	*I*(1)	*I*(0)	*I*(1)
FCI	1	1967***	1981***	*I*(1)	*I*(1)	*I*(1)	*I*(1)
GDP	6	1966***	1979***	*I*(1)	*I*(1)	*I*(1)	*I*(1)

Notes: *** denotes significant at the 1 per cent level; ** significant at the 5 per cent level; * significant at the 10 per cent level.

Further evidence reported in Table 2 also indicates the possibility of *HHI* also being non-stationary. Indeed the results for the test with intercept only, indicates all variables are non-stationary. This raises the issue of the role of the trend in these tests, particularly when all the series have been de-trended by the labour force. As a consequence we will assume

[19] There are numerous variations on detecting structural change detailed in Perron (1989), Banerjee, Lumsdaine and Stock (1992) Zivot and Andrews (1992), Perron and Vogelsang (1992), Perron (1997),

the variables *PRS*, *HHI*, *FCI* and *GDP* belong in the cointegrating vector(s) but allow the possibility of error corrections for the remaining variables. We include these effects via two structural dummy variables; d_{66} and d_{81} for the periods characterised by the years 1966 and 1981.[20]

4. VAR Estimation

Our estimation is based on the pathbreaking demonstration of Pagan and Peseran (2008), that in light of DSGE modeling, the structural VAR should incorporate Blanchard and Quah's (1989) important distinction between permanent and transitory shocks. However we make a number of modifications to this innovative procedure. The first is to incorporate semi-permanent shocks into the structural VAR. The second modification is to determine these three types of shocks (fully permanent, semi-permanent and transitory) from empirical tests of the data, rather than imposing them *a priori* as per Dungey and Fry (2008) and Dungey and Pagan (2008).

Our exploratory procedure comprises three steps. The first is to determine the rank, φ of $\Pi = \sum_{i=1}^{\kappa} \Phi_i - \mathbf{I}$ in the structural VAR for the endogenous variables, $\underline{y}_t$ (which is partitioned into the four $I(1)$ and four $I(0)$ endogenous variables):[21]

$$\mathrm{A}\underline{y}_t = \sum_{i=1}^{\kappa} \Phi_i \underline{y}_{t-i} + \Psi \underline{x}_t + u_t \ , \qquad t = 1, 2, ..., n .$$

The vector $\underline{x}_t$ comprises the unconstained intercept and trend (consistent with Lee and Strazicich's (2003) structural change test) and the three $I(0)$ dummy variables. The rank, φ of $\Pi = \underline{\alpha\beta}'$ allows the Johansen (1991, 1995) efficient estimation of the φ cointegrating vectors $\underline{\beta}'\underline{y}_t$ and the error corrections, α .

The second step involves testing whether each error correction is significantly different from zero and unity. If $0 < \alpha < 1$ then there error correction will be classified as repesenting a semi-permanent effect and included in the VAR:

Lumsdaine and Papell (1998), Lee and Strazicich (2003) and Bai and Perron (2003). There are also many applications including Strazicich, Lee and Day (2004) and Pahlavani, Valadkhani and Wilson (2005).

20 The first variable takes the value one for the years 1966 to 2005 and the second variable for the later period 1981 to 2005 (with both variables zero elsewhere).

21 We assume initially that A is the identity matrix, which rules out contemporaneous effects.

24 The, Hanna–Quinn (HQC) and Akaike Information (AIC) measures are non-informative, indicating the maximum rank of four.

$$\Delta \underline{y}_t = -\Pi \underline{y}_{t-1} + \sum_{i=1}^{\kappa-1} \Gamma_i \Delta \underline{y}_{t-i} + \Psi \underline{x}_t + v_t \ .$$

Any estimates of α which are not significantly different from zero will be treated as demonstrating permanent effects of shocks for the relevant variable and the error correction term will be excluded from the VAR for the variable. Similarly, any estimates which are not significantly different from unity will be classified as transitory effects and the error correction will be set to -1. In essence, Pagan and Peseran (2008) partition the error correction matrix into, $\alpha' = \left(\alpha^*_{\eta_1\times\varphi} \quad 0_{\eta_2\times\varphi} \quad -1_{\eta_3\times\varphi}\right)$, with $\eta_1 + \eta_2 + \eta_3 = 8$. However, unlike Pagan and Peseran (2008), we will not restrict the transitory shocks to equal the number cointegrating vectors, φ.

The Schwarz Bayesian criterion (SBC) indicates the optimum lag of the VAR is $\kappa = 1$ and the calculated eigenvalues, using Johansen's (1991, 1995) method are: {0.568, 0.302, 0.209, 0.072}. The likelihood ratio (LR) tests based on the maximal eigenvalue and trace of $\Pi = \underline{\alpha\beta}'$ and the SBC model selection criteria indicate a rank of one, at the five per cent level of significance.[24] The cointegrating vector, exactly identified using Johansen's restrictions, is: {0.693*PRS* + 0.782*HHI* − 0.071*FCI* − 2.371*GDP*}. Whilst the long run foreign capital inflow should be bounded in the long run according to equation (7) (and the accompanying footnote) the variable *FCI* was not excluded because it is measured in logs and the Chi-squared test rejected the zero restriction at the five percent level of significance. The error correction for *PRS* was calculated as −0.549 with a ninety-five percent confidence interval: $\left(0.0912 < \left|\overline{PRS}\right| < 0.987\right)$ which narrowly misses the transitory cut off.[26] The error correction is therefore classified as (just) semi-permanent. The error corrections for *HHI* of −0.632 and *FCI* of −0.631 have ninety-five percent confidence intervals: $\left(0.632 < \left|\overline{HHI}\right| < 0.901\right)$ and $\left(0.238 < \left|\overline{FCI}\right| < 0.850\right)$ respectively, which also indicate semi-permanent error corrections to shocks.[27] The error correction value for *GDP* was calculated

---

26 The standard errors for the error correction for each variable were adjusted for serial correlation and heteroscedasticity using the Newey-West method with Parzen weights and a truncation lag of ten. The intercept, trend and dummy variables, d_{66} and d_{81} were all significant at the five per cent level for the $\triangle PRS$ error correction.

27 The intercept and d_{81} dummy were significant for the *HHI* error correction whilst the intercept, trend and d_{81} dummy were significant for the *FCI* error correction.

as the very small value 0.014 which was not significantly different from zero at the five per cent level. Shocks to this variable were therefore classified as having permanent effects, consistent with equation (11) above and the DSGE and real business cycle modeling of permanent technological shocks on GDP.[28]

The VAR: $\Delta \underline{y}_t = -\Pi \underline{y}_{t-1} + \sum_{i=1}^{\kappa-1} \Gamma_i \Delta \underline{y}_{t-i} + \Psi \underline{x}_t + v_t$ was then estimated with one lag and the results show that ΔHHI_{t-1} and ΔFCI_{t-1} affect ΔPRS_t with elasticities 0.293 and −0.277 respectively at the one per cent level of significance. It was also found that ΔFSA_{t-1} affects ΔPRS_t and applying the restriction using the estimate for the ΔHHI_{t-1} elasticity, shows that ΔHHS_{t-1} affects ΔPRS_t with an elasticity of 0.559 at the one per cent level of significance.[29] Conversely, ΔPRS_{t-1} was found to affect ΔPRI_t with an elasticity of 2.299 although it is only significant at the ten per cent level. ΔPRI_{t-1} in turn affects ΔHHS_t (with appropriate coefficient restrictions) with an elasticity 0.445 at the one per cent level of significance, and ΔHHI_t with an elasticity of 0.075 at the five per cent level. There is an inverse relationship between *GDP* and *FCI* with ΔGDP_{t-1} affecting ΔFCI_t elastically (−2.052 at the five percent level) and ΔFCI_{t-1} inelastically affecting ΔGDP_t (−0.032 at the ten per cent level). Finally there is also feedback detected between *GDP* and *PUI* with ΔGDP_{t-1} having a positive 1.257 elasticity with ΔPUI_t at the ten per cent level and ΔPUI_{t-1} having a negative −0.107 elasticity with ΔGDP_t at the one per cent level.

Considering only the one and five per cent significant findings, it appears that GDP does not affect household and private sector savings as implied by equations (2) and (6). However, the findings that sectoral investment affects savings are consistent with these two equations. Moreover, equations (9) and (10) correctly indicate that sectoral investment are not determined by sectoral savings, consistent with the empirical findings. Finally, the finding of the negative effect that GDP has on foreign capital inflows is consistent with equation (7).

It needs to be stressed that these are preliminary findings and we now wish to consider the structural VAR extension given by the non-zero, appropriately identified, A matrix in:

---

28 Neither the intercept, trend or dummy variables were significant.

29 The restriction is: $\beta_{\Delta HHS_{t-1}} = \beta_{\Delta HHI_{t-1}} + \beta_{\Delta FSA_{t-1}}$

$$\mathrm{A}\underline{y}_t = \sum_{i=1}^{\kappa} \Phi_i \underline{y}_{t-i} + \Psi \underline{x}_t + u_t$$

. Whilst this allows for contemporaneous effects of the variables on each other it requires the estimation of the reduced form since OLS provides biased and inconsistent estimates. It also allows the analysis of the possible contemporaneous and lagged interdependencies in terms of impulse responses to shocks associated with individual structural equations. The analytic benchmark model above shows the possible interdependencies are numerous and complex and therefore difficult to encapsulate in single estimated elasticities. The impulse analysis of shocks is best done in terms of forecast error variance decomposition of the model which uses proportionate relative variation in the variables due to shocks. An example of a shock to private sector corporate savings *PRS* in the previously estimated VAR is given in Figure 1. Note the positive and lasting effect this has in increasing *PRI* by around 20 per cent over the five year period, which is double the effect on *PRS*. *PUS* also increases and declines along the lines of *PRS*. This contrasts with household savings, *FSA* which initially falls and then slowly regains its original position, whilst household investment, *HHI* declines over the period. Figure 2 shows the effects of a shock to *HHI* and unlike the previous shock, there is undershooting. All sectoral savings and investment measures increase monotonically over time at differing rates, whilst the effect on *FCI* is delayed. The simulations of the structural VAR will provide rich evidence of the dynamic relationships between the variables.

Figure 1

Generalise Impulse Response to a Shock in *PRS*

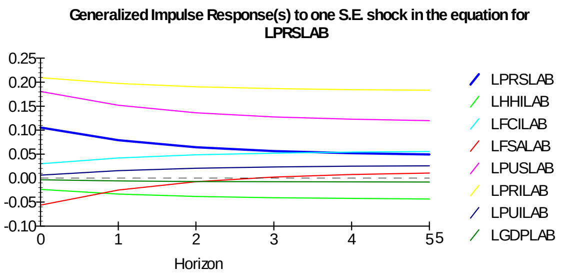
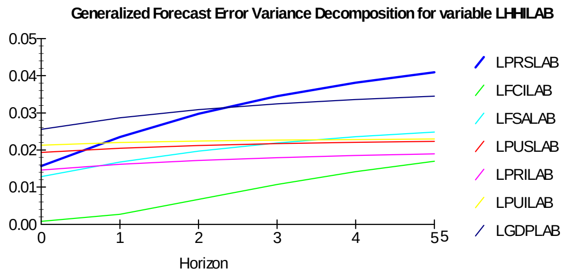


Figure 2

Generalise Impulse Response to a Shock in *HHI*



5. Summary and Conclusions

This paper considers the interdependencies between per worker household, private corporate and public sector savings and investment, foreign capital inflows and GDP in a multivariate setting. This is in response to the four shortcomings relating to previous studies on savings and investment in India. These studies predominantly analyse savings and investment aggregates only, over long time periods which contain structural changes, using bivariate estimation techniques, which are short run in nature.

To broaden the analysis a theoretical sectoral model is developed to provide a theoretical basis for the empirical research and to demonstrate the possible complex interdependencies between these variables and sectors.

The analysis is applied to all eight non-stationary variables over the period 1951 to 2005 when two endogenously determined structural breaks have occurred in the periods centred around 1966 and 1981. The long run cointegrating relationship is estimated in a multivariate setting using Johansen's FIML procedure. The long run variables are determined as subject to semi-permanent and permanent shocks according to Pagan and Pesaran's (2008) classification. Consistent with the recent DSGE and structural VAR modeling a VAR is then estimated to determine the short run interdependencies in terms of statistical tests and two examples of impulse analysis of shocks are presented. (The paper will present the results of the estimated structural VAR and the analysis of forecast error variance decomposition as work in progress).

The findings show that per worker household savings and investment positively affect private corporate savings which in turn positively affect private corporate investment. Private corporate investment is also shown to positively affect household savings and investment, which completes the circle. Per worker public investment is found to negatively (with small elasticity) affect GDP, which negatively affects foreign capital inflows, which subsequently negatively affects private corporate savings. Five of these links are at one per cent, two are at five per cent and one is at ten per cent levels of significance.

The analysis of Indian sectoral savings and investment, in a non-stationary multivariate setting with endogenously determined structural breaks provides some support for the Solow savings constraint model and the endogenous growth models, whereby investment drives other macroeconomic variables. The popular view that increases in savings are a necessary condition for economic growth is partly supported. This implies the need to encourage savings, which is being realised with higher growth rates during the recent period of financial deregulation in India. However the offsetting reduction in the rates of growth in investment during the 1990s, the lack of any identified links to output and the apparent small but negative influence of public investment, means that policy prescriptions to promote economic growth in India are not straightforward.

APPENDIX

The budget constraint for the representative household is:

$$c + \dot{b}_p + \dot{b}_g = \left(w + rb_p + rb_g + \dot{k}_h\right) - \tau_h \tag{A1}$$

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

$$H = u(c)e^{-\rho t} + \mu\left(\dot{b}_p + \dot{b}_g\right) \tag{A2}$$

where: $\dot{b}_p + \dot{b}_g = w + rb_p + rb_g + \dot{k}_h - \tau_h - c$, to give the well known result for the utility maximising growth in consumption, $\dot{c} = \theta(r - \rho)$. The elasticity of marginal utility with respect to consumption term is specified as, $-1/\theta = u''(c)/u'(c)$. Integrating forward with respect to time gives the accumulated value of the utility maximising consumption per worker, $c(t) = e^{\int_0^t \theta(r(s)-\rho)ds}$ with initial value of consumption standardised at unity, $c_0 = 1$. The optimal household savings path, s_h, can be derived from this result by defining household per worker gross (pre-tax) income as, $y_h = w + rb_p + rb_g + \dot{k}_h$. Assuming household taxes are a proportion of household per worker income, $\tau_h = \alpha_h y_h$, substituting in (A1) 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:

$$s_h = \dot{b}_p + \dot{b}_g = \alpha y_h - e^{\int_0^t \theta(r(s)-\rho)ds}. \tag{2}$$

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

$$S_p\left(k_p\right) = \int_{t_0}^{\infty} s_p\left[k_p(t)\right] e^{-\rho t} dt \tag{A3}$$

where the constant discount rate, ρ is assumed to be the same for households. For the Hamiltonian, $H = s_p\left(k_p\right)e^{-\rho t} + \mu\left[-\left(\dot{b}_p + \dot{b}_f\right)\right]e^{-\rho t}$, 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, $\mu = \xi q_p e^{-\rho t}$. Capital formation in this system will involve costs of adjustment and whilst we will not explicitly define these costs here, we assume that investment, $\dot{k}_p$ is net of these costs, which are used up in production. The Hamiltonian for this frictional system becomes

$$H = s_p\left(k_p\right)e^{-\rho t} + \xi q_p\left[-\left(\dot{b}_p + \dot{b}_f\right)\right]e^{-\rho t} \tag{A4}$$

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 the per worker marginal products of the firm's and household's capital. This solves for q_p, to give the well known result:

$$q_p\left(t\right) = \int_t^{\infty}\left(\beta y'_{p,k_p} - y'_{h,k_p}\right)e^{-\rho(s-t)}ds\,. \tag{A5}$$

which clearly shows that Tobin's q_p is the sum of the weighted net present values of all future per worker marginal products, $\beta y'_{p,k_p} - y'_{h,k_p}$. Since q_p represents the marginal valuation of capital relative to its replacement cost when frictions are present, then values of $q_p > 1$ will encourage investment by firms according to the per worker investment function:

$$\dot{k}_p = \phi\left(q_p - 1\right) \quad \text{with} \quad \phi' > 0\,. \tag{A6}$$

When $q_p = 1$, investment will be zero, $\dot{k}_p = 0$, and when $q_p < 1$, there will be disinvestment $\dot{k}_p < 0$. Using (A5) to substitute for q_p in (A6) gives the required result for per worker capital formation as a function of the net present value of the marginal products of per worker capital used in production:

$$\dot{k}_p = \phi\left[\int_t^{\infty}\left(\beta y'_{p,k_p} - y'_{h,k_p}\right)e^{-\rho(s-t)}ds - 1\right]. \tag{9}$$

Tobin's q can also be used to determine the optimum time path of household investment, $\dot{k}_h$. Modifying the Hamiltonian (A2) to:

$$H = u\left(c\right)e^{-\rho t} + \mu\left(\dot{b}_p + \dot{b}_g\right) \tag{A7}$$

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, $\dot{q}_h = r q_h - \alpha y'_{h,k_p}$. This solves to, $q_h(t) = \int_t^\infty y'_{h,k_p} e^{-\rho(s-t)} ds$, which determines optimal household investment:

$$\dot{k}_h = \varphi\left[\int_t^\infty \alpha y'_{h,k_p} e^{-\rho(s-t)} ds - 1\right] \tag{10}$$

REFERENCES

Agrawal, P. (2000), 'Savings, Investment and Growth in South Asia', mimeo, Indira Gandhi Institute of Development Research, Mumbai.

Arrow, K.J. (1962), 'The Economic Implications of Learning by Doing', *Review of Economic Studies*, 29, pp. 155-173.

Athukorala, P. and K. Sen (2002), *Savings, Investment and Growth in India*, Oxford University Press, New Delhi.

Bai, J. and P. Perron (2003), 'Critical Values for Multiple Structural Change Tests', *Econometrics Journal*, 6, pp. 72-78.

Barro, R.J. (1990), 'Government Spending in a Simple Model of Endogenous Growth', *Journal of Political Economy*, 98, pp. S103-S125.

Barro, R.J. (1991), 'Economic Growth in a Cross-Section of Countries', *Quarterly Journal of Economics*, 106, pp. 407-443.

Carroll, C. and Weil, D, (1994), 'Saving and Growth: A Reinterpretation', *Carnegie-Rochester Conference Series on Public Policy,* 40, pp.133-192.

Centre for Monitoring Indian Economy (2002), *Foreign Trade and Balance of Payments*, Mumbai.

Sandilands, R. J. and R. Chandra (2003), 'Does Investment Cause Growth: A Test of Endogenenous Demand-Driven Theory of Growth Applied to India 1950-96', in S. Neri (ed.) *Old and New Growth Theories*: *An Assessment*, Edward Elgar, Cheltenham, pp. 244-265.

Chaudhri, D. P. and E. J. Wilson, (2000), 'Savings, Investment, Productivity and Economic Growth of Australia 1861-1990: Some Explorations', *The Economic Record*, 76, pp. 55-73.

Dungey, M. and R. Fry (2008), 'The Identification of Fiscal and Monetary Policy in a Structural VAR', *New Zealand Treasury Working Paper*, forthcoming.

Dungey, M. and A. Pagan (2008), 'Extending an SVAR Model of the Australian Economy', *NCER Working Paper Series*, No. 21, January.

Johansen, S. (1991), 'Estimation and Hypothesis Testing of Cointegrating Vectors in Gaussian Vector Autoregressive Models', *Econometrica,* 59, pp. 1551-1580.

Johansen, S. (1995), *Likelihood Based Inference on Cointegration in the Vector Autoregressive Model*, Oxford University Press, Melbourne.

Johansen, S. and K. Julius (1992), 'Testing Structural Hypotheses in a Multivariate Analysis of the PPP and UIP for UK', *Journal of Econometrics*, 53, pp. 211-244.

Harrod, R. (1948), *Towards a Dynamic Economics*, Macmillan, London.

Ketkar K. W. and S. L. Ketkar (1992), 'Banking Nationalisation, Financial Savings and Economic Development: A Case Study of India', *Journal of Developing Areas*, 27, pp. 69-84.

Krishnamurty, K., K. S. Krishnaswamy and P. Sharma (1987), 'Determinants of Saving Rates in India', *Journal of Quantitative Economics*, 3, pp. 335-357.

Laumas, P.S. (1990), 'Monetization, Financial Liberalization, and Economic Development', *Economic Development and Cultural Change*, 38, pp. 377-390.

Lee, J. and M. Strazicich (2003), 'Minimum Lagrange Multiplier Unit Root Test with Two Structural Breaks', *Review of Economic and Statistics*, 85, pp. 1082-1089.

Lucas, R. (1988), 'On the Mechanics of Economic Development', *Journal of Monetary Economics*, 22, pp. 3-42.

Lumsdaine, R. L., and D. H. Papell (1997), 'Multiple Trend Breaks and the Unit Root Hypothesis', *Review of Economics and Statistics*, 79, pp. 212-218.

Mahambare, V. and V. M. Balasubramanyam (2000), 'Liberalisation and Savings in Developing Countries: The Case of India', Working Paper No. 4, Lancaster University Management School, Lancaster.

Mühleisen, M. (1997), 'Improving India's Saving Performance', *IMF Working Paper WP197/4*, International Monetary Fund, Washington, D.C.

National Accounts Statistics of India (2002), Economic and Political Weekly Research Foundation, Mumbai.

Pagan, A. and M. H. Pesaran (2008), 'On Econometric Analysis of Structural Systems with Permanent and Transitory Shocks and Exogenous Variables', *Journal of Economic Dynanics and Contol*, forthcoming.

Pahlavani, M., A. Valadkhani and E. J. Wilson (2005), 'Identifying Major Structural Breaks in Iranian Macroeconomic Variables', *International Journal of Applied Business and Economic Research*, 3, December (forthcoming).

Pandit, B. L. (1991), *The Growth and Structure of Savings in India,* Oxford University Press, Delhi.

Perron, P. (1989), 'The Great Crash, The Oil Price Shock, and The Unit Root Hypothesis', *Econometrica*, 57, pp. 1361-1401.

Perron, P. (1997), 'Further evidence on breaking trend functions in macroeconomic variables', *Journal of Econometrics*, 80, pp. 355-385.

Perron, P. and T. J. Vogelsang (1992), 'Nonstationarity and Level Shifts with an Application to Purchasing Power Parity', *Journal of Business and Economic Statistics*, 10, pp. 301-320.

Pesaran, M. H. and B. Pesaran (1997), *Working with Microfit 4: Interactive Econometric Analysis*, Oxford University Press, Oxford.

Phillips, P. C. B. and P. Perron (1988), 'Testing for a Unit Root for Time Series Regression', *Biometrika*, 71, pp. 335-346.

Reserve Bank of India (1982), 'Capital Formation and Saving in India, 1950-51 to 1979-80', *Report of the Working Group on Saving,* Raj Committee, Mumbai.

Reserve Bank of India (2002), *Handbook of Statistics of the Indian Economy: Reserve Bank of India 2001-2002*, Mumbai.

Romer, P. M. (1986), 'Increasing Returns and Long Run Growth', *Journal of Political Economy*, 94, pp. 1002-1037.

Romer, P.M. (1990) 'Endogenous Technological Change', *Journal of Political Economy*, 98, pp. S71-S102.

Saggar, M. (2003), 'A Perspective on Saving, Investment and Macroeconomic Policies in India in the 1990s', in Jha, R. (ed.), *The Indian Economic Reforms*, Palgrave Macmillian, Sydney, pp. 92-117.

Sahoo, P., Nataraj, G. and Kamaiah, B (2001). 'Savings and Economic Growth in India: the Long-Run Nexus', *Savings and Development,* No.1. pp. 67-79.

Seshaiah, V. and V. Sriyval (2005), 'Savings and Investment in India: A Cointegration Approach', *Applied Economics and International Development*, 5, pp. 25-44.

Strazicich, M., J. Lee and E. Day (2004), 'Are Incomes Converging Among OECD Counties? Time Series Evidence with Two Structural Breaks', *Journal of Macroeconomics*, 26, pp. 131-145.

Solow, R. (1970) *Growth Theory: An Exposition*, Clarendon Press, Oxford.

Swan, T. W. (1956), 'Economic Growth and Capital Accumulation', *The Economic Record*, 32, pp. 334-361.

Verma, R. and E. J. Wilson (2004), 'Savings, Investment, Foreign Inflows and Economic Growth of the Indian Economy: 1950-2001', *Conference Proceedings of the 33rd Conference of Economists*, University of Sydney, September.

Zivot, E. and K. Andrews (1992), 'Further Evidence on the Great Crash, the Oil Price Shock, and the Unit Root Hypothesis', *Journal of Business and Economic Statistics*, 10, pp. 251-270.