Consumption, Fiscal Policy and Endogenous Growth:
The Case of India

by
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A thesis submitted to the University of Surrey for the Degree of Doctor of Philosophy in the Department of Economics

November 1995
Abstract

A Structural Adjustment Programme is typically accompanied by fiscal policy changes aimed at reducing government spending and budget deficits as in India in recent years. The objective of this thesis is to analyse the impact of these changes on the economy. Since the eventual disengagement of indebted countries from international lending agencies like the IMF and the World Bank has been seen to come with economic growth which is one of the objectives of the SAP, and as small differences in the long-run growth rate have a significant impact on standards of living, our focus is on the effect of government spending policies on the long-run steady state growth rate. We present an endogenous growth model in which the impact of fiscal policy is through non-Ricardian effects on the demand side and externalities arising from public capital on the supply side.

Preliminary results suggest that the Indian economy is non-Ricardian. An aggregate consumption function that incorporates finite horizons, population growth, liquidity constraints and tax distortions is estimated to investigate non-Ricardian effects on demand. With supply side parameters that are observed or imposed, the model is calibrated to examine the impact of changes in the debt/GDP ratio, the tax rate and the share of development expenditure in total government spending. Simulations suggest a very strong positive impact of public investment on the long-run growth rate. At the same time our analysis shows that non-Ricardian demand side effects though present, have only a marginal effect on our empirical analysis. The major policy implication that emerges from our results is that the present trend of a decline in the proportion of development spending is counter-productive to the objective of growth. A clear definition of the role of public investment and an analysis of the impact of the components of public expenditure is essential for a successful SAP.
DECLARATION OF ORIGINALITY

I, Ila Patnaik, hereby declare that the material contained in this dissertation is, to the best of my knowledge, original.

Signed  
Dated 15 Nov '95

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Dated 15 Nov '95
Acknowledgments

I would like to express my deepest gratitude to my supervisor Prof. Paul Levine from whom I received invaluable insights, ideas, guidance and encouragement throughout the duration of my research. I would also like to thank Prof. Wojceich Charemza of the University of Leicester for his suggestions for my empirical work. I am grateful for the financial support I received from the British Council and from the Department of Economics, University of Surrey. I would also like to acknowledge the help I received from staff of the National Council for Applied Economic Research and the National Institute of Public Finance and Policy, New Delhi.

I am grateful for comments and criticisms offered by friends and colleagues especially Fotis Mouzakis and Thomas Krichel. And finally, I am indebted to my husband Ajay, without whose support this work would not have been possible.
## Contents

*Acknowledgment*

*Table of notations*  
 i-iii

### Introduction  
1-7

### Chapter 1  
8-29

**Public Spending and Debt in India**

1.1. Development Strategy  
9
1.2. Financing Development  
13
1.3. Growth of Public Expenditure  
14
1.4. Tax Revenue  
16
1.5. Growth of Public Debt  
18
1.6. The External Crisis  
20
1.7. Stabilisation and Structural Adjustment  
21
1.8. Cut in Development Expenditure  
24

### Chapter 2  
29-46

**Debt Neutrality: Theory and Evidence**

2.1. A Representative Agent model  
30
2.2. The Ricardian Equivalence Hypothesis  
34
2.3. Empirical Studies  
37
2.4. Excess Sensitivity  
42
2.5. Evidence for India  
44

### Chapter 3  
47-57

**The Aggregate Consumption Function: Finite Horizons, Liquidity Constraints and Population Growth with Income Redistribution**

3.1. Liquidity Constraints  
47
3.2. Finite Horizons  
48
3.3. Population Growth and Income Redistribution  
49
Chapter 4

Estimation and Results

4.1. Eliminating Human and Non-human Wealth
4.2. Non-Linearity
4.3. Properties of the Disturbance Term
4.4. Generalised Method of Moments
4.5. Approaches to Estimation
4.6. Data
4.7. Restrictions
4.8. Estimation and Results
4.9. Supporting Evidence

Chapter 5

Policy Evaluation in an Endogenous Growth Model

5.1. Traditional Models of Growth
5.2. Endogenous Growth
5.3. The Model
5.3.1. Households
5.3.2. Private Sector Output and Investment
5.3.3. The Government
5.3.4. Output Equilibrium
5.3.5. The Steady-State
5.4. Fiscal Policy and Long-Run Growth
5.5. Calibration and Estimation for India
5.5.1. The Development Expenditure Multiplier
5.5.2. The Tax Multiplier
5.5.3. The Debt Multiplier
5.6. Non-Ricardian Effects
5.6.1. Finite Horizons
List of Tables

Table 1.1: Gross Fixed Capital Formation in the Public and Private Sectors
Table 1.2: Direct and Indirect Tax revenues of the Centre and States combined
Table 1.3: Total Outstanding Liabilities of the Government of India
Table 1.4: Measures of Deficit of the Central Government
Table 1.5: Development expenditure of Centre and States
Table 2.1: Excess Sensitivity of Consumption
Table 4.1: An Estimate of the Rate of Growth of Population of Unconstrained Consumers
Table 4.2: Share of Agriculture in National Income
Table 4.3: Per Capita NDP in agriculture
Table 4.4: Change in Income Distribution in Rural India, 1970-80
Table 4.5: Changes in Poverty in Rural India, 1970-80
Table 5.1: Summary of Calibration
Table 5.2: The Multipliers for Selected Values of γ1.
Table 5.3: The Multipliers for the Ricardian and Non-Ricardian Cases
Table 5.4: The Debt Multipliers
Table 5.5: The Tax Multiplier
Table 5.6: The Development Expenditure Multiplier
List of Figures

Fig 1.1: Gross Fixed Capital Formation in the Public and Private Sector
Fig 5.1: The Yaari Blanchard and Linear Technology Curves
Fig 5.2: γ1 and the Development Expenditure Multiplier
Fig 5.3: γ1 and the Tax Multiplier
Fig 5.4: γ1 and the Debt Multiplier
Fig 5.5: Finite Horizons and the Debt Multiplier
Fig 5.6: Finite Horizons and the Tax Multiplier
Fig 5.7: Liquidity Constraints and the Tax Multiplier
Fig 5.8: Growth, Tax Rate and Development Expenditure
Fig 5.9: Growth, Tax Rate and γ1
Fig 5.10: Growth, Tax Rate and the Debt/GDP Ratio
Fig 5.11: Liquidity Constraints and the Growth Rate
Fig 5.12: The Debt/GDP ratio and the Tax Multiplier
Fig 5.13: The Debt/GDP ratio and the Development Expenditure Multiplier
Table of Notations

(subscript $t$ denotes the variable in period $t$)

<table>
<thead>
<tr>
<th>Notation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_t$</td>
<td>consumption</td>
</tr>
<tr>
<td>$\bar{C}$</td>
<td>bliss level of consumption</td>
</tr>
<tr>
<td>$C_t^*$</td>
<td>effective consumption</td>
</tr>
<tr>
<td>$C^c_t$</td>
<td>consumption of constrained consumers</td>
</tr>
<tr>
<td>$C^u_t$</td>
<td>consumption of unconstrained consumers</td>
</tr>
<tr>
<td>$r_t$</td>
<td>pure real rate of interest</td>
</tr>
<tr>
<td>$Y_t$</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>$Y_{i,t}$</td>
<td>output of firm $i$</td>
</tr>
<tr>
<td>$T_t$</td>
<td>taxes</td>
</tr>
<tr>
<td>$N_t$</td>
<td>labour income</td>
</tr>
<tr>
<td>$I_t$</td>
<td>private investment</td>
</tr>
<tr>
<td>$G_t$</td>
<td>government expenditure</td>
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<td>government consumption expenditure</td>
</tr>
<tr>
<td>$G^I_t$</td>
<td>government investment expenditure</td>
</tr>
<tr>
<td>$D_t$</td>
<td>domestic public debt</td>
</tr>
<tr>
<td>$U_t$</td>
<td>utility</td>
</tr>
<tr>
<td>$W_t$</td>
<td>total wealth</td>
</tr>
<tr>
<td>$W^u_t$</td>
<td>total wealth of unconstrained consumers</td>
</tr>
<tr>
<td>$V_t$</td>
<td>non-human wealth</td>
</tr>
<tr>
<td>$H_t$</td>
<td>human wealth</td>
</tr>
<tr>
<td>$\Omega_t$</td>
<td>post-tax labour income</td>
</tr>
</tbody>
</table>
\( \Omega^u_t \) post-tax labour income of unconstrained consumers

FD\(_t\) budget deficit

K\(_t\) private physical capital

K\(^G\)_\(_t\) public physical capital

\( \beta \) birth rate

p probability of death

g rate of growth of population of unconstrained consumers

\( g^* \) rate of growth of total population

\( \delta \) rate of time preference

J\(_{ft}\) labour input in efficiency units

\( \varepsilon_{ft} \) measure of the efficiency of raw labour input

\( \pi \) rate of depreciation

n rate of growth of output

\( \tau \) rate of taxation

\( \gamma \) proportion of development expenditure in total government spending

\( \sigma \) intertemporal elasticity of substitution

\( \theta \) measure of substitutability between private spending and government consumption

\( \mu \) propensity to consume out of life-time wealth

\( \lambda \) proportion of post tax labour income received by unconstrained consumers

\( \gamma_1 \) capital externality
$L_{s,s}$  size of the cohort born during $[s, s+1]$ who are still alive at the end of period $t$

$E_t$  expectations operator

$L$  Lag operator
Introduction

In advanced industrialised countries the role of fiscal policy has traditionally been seen to be one of demand management. Government tax and spending decisions are considered to be instruments for correcting short-term macroeconomic imbalances. Though public expenditure has been an important tool to promote economic growth in developing countries, its role as such did not find a place in models of economic growth. Recent developments in macroeconomics provide us with a framework for analysing the impact of fiscal policy on long-run growth. In this study we analyse the effect on economic growth of fiscal changes that typically accompany a structural adjustment programme.

A large external debt and persistent current account deficits create circumstances under which a country borrows from international lending agencies like the International Monetary Fund and the World Bank. The IMF views the causes of external imbalance to lie in the divergence between aggregate demand and supply. This divergence is traced to inappropriate policies that expand aggregate demand too rapidly relative to the growth of productive capacity in the economy. To rectify this situation, the country concerned undertakes a Structural Adjustment Programme (SAP). The programme consists of policy measures to be adopted by the borrowing country and the disbursement of each successive stage of the loan is conditional upon the government adopting these measures.

The broad objectives of a SAP are the attainment of a viable balance of payments, satisfactory long term growth performance and low inflation. Apart from monetary and exchange rate policies, a typical SAP includes fiscal measures. The aim of a SAP is both to reduce demand, especially in the short run, and to increase supply. Under a SAP fiscal
measures are treated as instruments of demand management. This treatment is typical of the approach that fiscal policy affects aggregate demand and levels of consumption, saving, investment and output, but leaves their long-run growth rates unaffected. The long-run growth rate is determined exogenously. It may, for instance, depend on the rate of technical progress which is assumed to be determined, not by activity within the economy, but, say, as a function of time. There is no role for fiscal policy in the determination of the long-run growth rate in such models.

Recently the belief that the crucial issue is growth rather than business cycles and the counter cyclical fiscal and monetary policies of the government, has shifted the focus of macroeconomics to growth. A boom in research in the area has found explanations of growth in various factors such that growth is endogenous. The engine of growth may be learning by doing or research and development that leads to the creation and accumulation of knowledge, externalities associated with private or public capital or human capital that arises from education and training. In endogenous growth theory government policy which influences these factors has an important role to play in determining the long-run growth rate of the economy. The basic premise of this study is similar to that which has motivated research on economic growth since the mid 1980s - that the determinants of the long-run economic growth rate, are crucial because even small differences in growth rates, when cumulated over a generation or more, have much greater consequences for standards of living than the kinds of short-term business fluctuations that have typically occupied most of the attention of macroeconomists (Barro and Sala-i-Martin (1995)).

It has also been seen that the eventual disengagement from the IMF comes with sustained growth (Bird (1993)). We therefore focus on the objective of growth rather than macroeconomic balance. An understanding of the effect of government policies that have
even small effects on the long-run growth rate may prove to be eventually more significant than policies that aim to correct short-term macro economic imbalances. We here attempt to study the effects on growth of changes in government policy. In the present context, endogenous growth models provide us with the framework for analysing the effect on long-run growth of the conditionalities intended for demand management.

Our methodology is to study a country currently undergoing a typical Structural Adjustment Programme - India. In the 1980s, the growth of public expenditure in India was higher than the growth of revenue. A large part of the increase was in current government expenditure. While the 1970s typically witnessed balanced revenue accounts, the 1980s saw chronic budget deficits. The eighties also saw a rise in the current account deficit and a large external debt which assumed crisis proportions by mid-1991. India turned to the IMF and World Bank for loans. The government committed itself to a Structural Adjustment Programme. This commitment is detailed in the Government of India's letters of intent to the IMF and World Bank. Apart from many measures relating to industrial, export-import, investment, foreign capital and other policies, the government accepted the loan conditionality relating to fiscal measures. These included a reduction in fiscal deficits, government spending and tax rates.

Under the SAP the role of fiscal policy was clearly perceived to be one of demand management. This was regardless of the fact that in India policy makers have considered fiscal policy crucial in promoting economic growth. Left to the private sector, it was believed, there would be little investment in infrastructure, education etc., and economic growth would be slow. The role of the public sector, as envisaged by the planners, was complementary to the private sector. The government invested in industries and sectors where the private sector was unwilling to invest but which were crucial for economic
growth. Even today nearly half of government spending consists of such ‘development’
expenditure. However, over the last few years, especially under the SAP, the proportion of
development expenditure in total government spending has been falling. Since it is
politically much more difficult to cut current consumption expenditure, the government can
meet its commitment of cutting the deficit and spending by cutting public investment.

If public investment affects the long-run growth rate of output then ignoring its role
may lead to results contrary to the objectives of the SAP. We, therefore, study the effects
not only of changes in the tax rate or the debt/GDP ratio that are intended to meet loan
conditionalities, but also changes in the proportion of public investment in total government
spending, a fall-out of the government's commitment to the IMF and the World Bank. The
framework of an endogenous growth model allows us to analyse the impact of these fiscal
variables on the long-run growth rate.

Another development in macroeconomics that helps us analyse the case of a
developing country more accurately is the modelling of non-Ricardian effects on
consumption. The simple crowding-out hypothesis was negated by the Ricardian
Equivalence theorem which defined conditions under which there would be no crowding-
out at all. It contested the view that public debt would always crowd out private spending.
The hypothesis was shown to hold only under certain assumptions that included infinite
horizons or the operation of an inter-generational bequest mechanism, an absence of
liquidity constraints, lump sum taxes, no population growth and forward looking rational
consumers who understand the government's intertemporal budget constraint. Since the
Ricardian theorem was true under only very strict assumptions, the following debate on the
effect of debt focused on how the violation of each of its assumptions led to a deviation
from the equivalence between taxes and debt. Though the conclusion was that of the
traditional view, the analysis was rigorous, the techniques improved and the causes of crowding out clearly defined.

In a developing country, Ricardian assumptions of infinite horizons, perfect credit markets, no population growth and non-distortionary taxes are unlikely to be satisfied. Following Hayashi (1982), Blanchard (1985) and Weil (1989) we introduce liquidity constraints, finite horizons and population growth into the modelling of consumer behaviour in the economy. To take account of structural changes that accompany the process of development, we allow for income redistribution. A discrete time model following Frenkel and Razin (1992) provides an estimable form of the consumption function.

We use the Generalized Method of Moments to examine non-Ricardian effects on consumption. Proposed by Hansen (1982), this method has recently been employed for estimating aggregate consumption (Darby and Ireland (1994) and by the ESRC Macromodelling Bureau to re-estimate the Weale (1990) model). The method can provide consistent and efficient estimates when the function is non-linear, regressors are correlated with the error term and when disturbances are autocorrelated and/or heteroskedastic.

Following Levine (1994) a steady state equilibrium model is constructed for a closed economy with consumption, production and government sectors. Using mostly estimated or observed parameters, we compute an order-of-magnitude-feel for the effects on long-run growth of the debt/GDP ratio, the tax rate and the proportion of development expenditure in total government spending.

Chapter 1 provides an outline of the issues concerning fiscal policy and economic growth in India. We discuss the strategy of development, the financing of plans and the pattern of public spending and taxation that led to the growth of public debt in India. This is
followed by a brief discussion on recent changes in the economy under the Structural Adjustment Programme including changes in fiscal policy like tax rates and the proportion of development expenditure in total government spending.

Chapters 2-4 relate to the consumption side of the model. We derive the consumption function first under Ricardian assumptions and later model deviations from these assumptions. Chapter 2 describes the behaviour of a representative agent who maximizes utility subject to his life-time wealth. Horizons are assumed to be infinite and taxes are lump sum. The government's budget constraint and solvency condition are defined. The household and government sector's intertemporal budget constraints are combined to provide a simple exposition of the Ricardian Equivalence theorem. Methods of testing this proposition are discussed and the model is estimated for India.

The consumption function of the representative agent in chapter 2 is derived under the assumptions of an absence of liquidity constraints, population growth, distortionary taxes and finite horizons. In chapter 3, these assumptions are dropped. We define consumption behaviour of individuals and then aggregate over the population. The population is defined to consist of liquidity constrained and unconstrained groups of consumers with the possibility of migration from one group to another. This permits us to include individuals with different consumption behaviour in one population. In chapter 4 we first define the aggregate consumption function in terms of observable variables by excluding human and non-human wealth. Aggregate consumption is now defined in terms of current and lagged values of income and consumption. Next we discuss the methodology of estimation and describe the Generalized Method of Moments. The model is estimated for India and results are analysed. We then provide supporting evidence for our results relating to income distribution.
Chapter 5 first presents the production function that underlines our growth model. Output exhibits constant returns to a broad concept of capital that includes both private capital and public infrastructure. Combining this with the household and government sectors described earlier, we derive a model of endogenous growth in a closed economy. Conditions for steady state growth are defined and the model is calibrated for India. We derive tax, debt and development expenditure multipliers to examine the impact of fiscal policy variables on long-run growth. We then discuss the implications of our results and the impact of non-Ricardian assumptions on the multipliers. This is followed by our conclusions and a discussion on the direction of future research.
Chapter 1

Public Spending and Debt in India

In mid-1991 a severe balance of payment crisis forced India to borrow from the IMF. The loan for a Structural Adjustment Programme came with the conditionality that the fiscal deficit be reduced. The underlying theoretical basis of this policy is the view that an increase in public borrowing increases aggregate demand. This has a spillover effect and so to reduce a balance of trade deficit, fiscal deficit must be reduced. The attempt to reduce the fiscal deficit in India has resulted in a reduction primarily in government spending earmarked for public investment.

In this chapter we present a brief discussion of the economic changes in India since the beginning of the planning process. We also examine the most recent changes including the opening up of the economy and the reduced role of the public sector. We focus upon the reasons for the growth of public debt and measures taken to reduce it under the Structural Adjustment Programme under way. We briefly discuss the causes for the growth of government expenditure and public debt, and for the balance of payment crisis that forced India to borrow from the IMF and to finally tackle the issue of the high fiscal deficit as part of the loan conditionality.

The arrangements with the IMF and World Bank came with the conditionalities - "correction of macro-economic imbalances, an internationally competitive economy, a rapid increase in our exports, and improved efficiency of the public sector" (Singh (1992)). The government committed itself to reduce the Union Government deficit to
6.5 per cent in 1991-92 and 5 percent in 1992-3. Half of the adjustment was to be achieved by higher taxes and the other half by lowering public expenditure.¹

The attempt to reduce fiscal deficit led to a cut in public investment and development outlays, while current expenditure continued to rise. To examine the reasons for the growth of public debt we shall look at the pattern of public expenditure and taxation, budget deficits and the consequent growth of public debt. The discussion shall begin with a brief outline of India's development strategy which provided the rationale for public investment and expenditure.

1.1. Development Strategy

The major objectives of economic development in India were growth, self-reliance and social justice. As there was little to redistribute but poverty, growth gained overriding importance. Industry was to be the engine of growth and development of the Indian economy. The major obstacle in the path of industrial expansion was seen to be the lack of adequate productive capacity. The strategy of industrialisation chosen emphasised an increase in capital stock through a high rate of investment. Following a severe balance of payment crisis in 1957-58 foreign exchange was also viewed as a major constraint. The economy was to be a mixed economy and the path of development a planned one. The Indian planning model was inspired by the planning model of the USSR. As the onus of promoting growth lay on the public sector, a large part of the financial burden of economic development rested on the shoulders of the government.

¹ The memorandum as sent to the IMF by the finance minister, Dr. Manmohan Singh, on August 27, 1991, and circulated in Parliament on December 16, 1991.
Indian planners were pessimistic about the growth of Indian exports and they tried to overcome the foreign exchange constraint by reducing imports. This implied import substitution in as many products as possible. It also meant expanding the capacity to produce a large number of consumer goods. As the economy was viewed as virtually closed, capital goods had to be produced domestically and the rate of growth of productive capacity was to be maximised by producing 'machine making machines'. Production of 'machine making machines' meant investment in large scale capital intensive industry involving large initial capital outlays, long gestation lags and high risks. As private investors were unlikely to undertake such investment, it fell upon the public sector to promote the capital and basic goods industry sector. Table 1.1 shows the Gross Fixed Capital Formation in the private and public sectors as a proportion of GDP. The relative size of the public sector remains quite high from the second plan period right upto 1990. This can be clearly seen in Figure 1.1.

Industrial output saw a significant deceleration in growth in the period 1966-67 to 1981-82. There is considerable debate about the cause of this slowdown in growth rate from 6.9 per cent in the preceding decade to 5.0 during this period. Some economists attribute it to the significant reduction in public investment that took place at this time (Bardhan (1984)). Fixed capital formation in the public sector at 1970-71 prices grew at an annual rate of 11.3 per cent in the period 1950-51 to 1965-66, and declined to a rate of less than half, that is 5.5 per cent, in the period 1966-67 to 1981-82. Since public investment accounts for nearly half the total gross fixed capital formation in the economy and about five times the amount in the private corporate sector, this cut back had a considerable effect on growth.
Table 1.1: Gross Fixed Capital Formation in the Public and Private Sectors as a per cent of GDP

<table>
<thead>
<tr>
<th>Year</th>
<th>Public Sector</th>
<th>Private Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-55</td>
<td>2.84</td>
<td>6.1</td>
</tr>
<tr>
<td>1955-60</td>
<td>5.26</td>
<td>7.54</td>
</tr>
<tr>
<td>1960-65</td>
<td>6.96</td>
<td>7.32</td>
</tr>
<tr>
<td>1965-70</td>
<td>6.34</td>
<td>8.72</td>
</tr>
<tr>
<td>1970-75</td>
<td>6.2</td>
<td>7.92</td>
</tr>
<tr>
<td>1975-80</td>
<td>8.02</td>
<td>9.88</td>
</tr>
<tr>
<td>1985-90</td>
<td>10.4</td>
<td>11.6</td>
</tr>
<tr>
<td>1990-91</td>
<td>9.4</td>
<td>13.8</td>
</tr>
<tr>
<td>1991-92</td>
<td>9.5</td>
<td>12.7</td>
</tr>
<tr>
<td>1992-93</td>
<td>8.5</td>
<td>13.0</td>
</tr>
<tr>
<td>1993-94</td>
<td>8.4</td>
<td>12.5</td>
</tr>
</tbody>
</table>


An important factor was also that the cut backs from the mid-sixties onwards were on sectors like railways and electricity that were crucial for growth in the private sector. The deceleration was seen mainly in the basic and capital goods industry where growth rates more than halved. These included mainly heavy industries such as basic metals, metal products, electrical and non-electrical machinery, and transport equipment. The reduction in public investment meant a decline not only in the infrastructure facilities like power, fuel and transport, much of which is in the public sector, but also in the demand for the products of capital goods industries that public investment generates.
Gross Fixed Capital Formation in the Public and Private Sectors

Agriculture was the dominant sector in the Indian economy. It accounted for more than 50 per cent of the share of output and 70 per cent of the labour force employed. Growth in agriculture was initially expected to take place through an increase in irrigation and an improvement in land distribution. Food output, however, barely kept up with the rate of growth of population. Availability of food fluctuated greatly with rainfall. The drought in 1965 created shortages and forced India to import large quantities of wheat from the US under PL 480. The desire to reduce external dependence for food was crucial in bringing about the Green Revolution. Changes in the technology of wheat production were ushered in into certain pockets of the country which were well irrigated and where the institutional structure was conducive to the adoption of new technology. The technology was promoted by providing a number of subsidies on power, imported inputs, credit and machinery.
Due to the externalities and indivisibilities involved in investment in infrastructure facilities in agriculture, public investment was crucial. Growth prospects of Indian agriculture are vitally dependent on public investment in irrigation, drainage and flood control, in land shaping and land consolidation, in prevention of soil erosion and salinity, in the development of a widespread research and extension network, and in rural electrification and provision of productive credit. The expansion of irrigation and state and community projects for tapping groundwater through public tube-wells, for flood control and for soil improvements can have dramatic results. Since the average size of land holdings even among the better-off farmers is small in many parts of the country, the capacity of the farmer to invest is limited. There is thus a need for supplementary public investment.

1.2. Financing Development

Public expenditure in India consists of plan expenditure and non-plan expenditure. Plan expenditure is the outlay on Five Year Plans. These include outlays on industry, agriculture, energy, health, education, social services, etc. The main source of financing plan expenditure was borrowing. The returns from the investments made were expected to be adequate to pay off the debt. Non-plan expenditure was mainly current expenditure and was to be financed by revenue. The main sources of budgetary revenue were expected to be direct and indirect taxes and profits of public sector enterprises. However, most public sector enterprises, except oil companies, were running losses and had to be heavily subsidised.
1.3. Growth of Public Expenditure

Plan expenditure covered government spending on infrastructure, power, capital and basic goods industries like iron and steel plants, education, health, etc. These were essential for the long term economic and industrial development of the country but were largely unprofitable investments. Returns were low and due after a long time.

Non-plan or current expenditure consisted mainly of government spending on public administration, defence and subsidies. India had inherited the colonial administrative structure with its high costs and low efficiency. The public sector employed more than half the labour force employed in the organised sector. Government consumption expenditure has two components: compensation to employees and purchase of consumer goods and services. More employees imply more office equipment, transport, etc. Given the employment, other complementary expenditure becomes partially committed. Compensation to employees consists of wages and salaries that are the main component, and pensions and other benefits to employees.

Public spending on education consists of spending in primary, secondary, vocational and higher education including universities, medical, engineering and management schools, research and development, etc. Education is highly subsidised especially at the higher level. Government expenditure on health and education consists mainly on employment of persons. About 92 per cent of the expenditure on education by the government and 72 per cent of the expenditure on health is on salaries and wages (Bhattacharya (1992) p.119).

Total employment in the public sector was rapidly growing at a rate faster than the rate of growth of the population till 1984, after which some effort was made to
slow it down. Real wages in the public sector grew faster than per capita real national income in the ‘eighties. Average emoluments in public enterprises in 1988-89 were 9.5 times per capita real national income against 8.7 times in 1980-81. (Bhattacharya (1992) p.121-125).

Defence spending was high and rising because of external political uncertainties. The defence budget accounts for about 4 per cent of GDP and 16 per cent of total government expenditure. Taking related expenditure into account it is probably higher at 5 per cent of GDP and 20 per cent of total government expenditure though it is still relatively low in international comparison (Bhattacharya (1992)).

Subsidies on food, fertilisers and exports were rising. The share of government expenditure on agriculture rose after the green revolution as the state provided incentives to farmers in the form of subsidies on seeds, fertilisers, credit, etc. Real investment, both public and private in agriculture slowed down in the ‘eighties. The sharp rise in subsidies, both open and implicit, eroded the surplus available for public investment in agriculture to a considerable extent (RBI (1994),p.109)

It is estimated that in the early seventies aggregate government expenditure was declining in real terms. In the late seventies nominal expenditure growth rose to over 13 per cent per annum and real expenditure started growing quite rapidly. After 1979 nominal expenditure growth rose to 18.6 per cent but due to the higher inflation rate real growth in expenditure remained stable. Real growth rose sharply in the period after 1983 (Mundle and Rao (1992), p.230-31).

Another trend in the pattern of public expenditure is the declining share of capital expenditure in total public expenditure. The economic classification of expenditure reveals that from 1971-72 to 1987-88 the share of capital expenditure shrunk from
over 56 per cent of total central government expenditure to only 30 per cent. This was mainly because of the dramatic increases in the share of interest payments, subsidies and compensation to government employees (Mundle and Rao (1992) Table 3, p.233)

1.4. Tax Revenue

The was a considerable growth in tax revenues over this period even though it did not increase at the same rate as public expenditure. The tax to GDP ratio rose from 6 per cent in 1950-51 to about 11 per cent by 1970-71 and further to about 17 percent in the eighties.

The increase in tax revenue was accompanied by a significant increase in the share of indirect taxes. This was due to a fall in the contribution of direct taxes. They fell from about 30 per cent of tax revenue in the early sixties to 14 per cent in 1989-90 (Mundle and Rao (1992) p.236). In the 1980’s there has been a slight increase in the share of direct taxes as seen in Table 1.2.

Table 1.2: Direct and Indirect Tax revenues of the Centre and States combined (as a per cent of GDP)

<table>
<thead>
<tr>
<th>Year</th>
<th>Direct</th>
<th>Indirect</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980-81</td>
<td>2.6</td>
<td>11.9</td>
<td>14.5</td>
</tr>
<tr>
<td>1985-86</td>
<td>2.7</td>
<td>13.7</td>
<td>16.4</td>
</tr>
<tr>
<td>1990-91</td>
<td>2.7</td>
<td>13.8</td>
<td>16.5</td>
</tr>
<tr>
<td>1991-92</td>
<td>3.1</td>
<td>13.6</td>
<td>16.7</td>
</tr>
<tr>
<td>1992-93</td>
<td>3.2</td>
<td>13.0</td>
<td>16.2</td>
</tr>
<tr>
<td>1993-94(RE)</td>
<td>3.2</td>
<td>12.0</td>
<td>15.2</td>
</tr>
</tbody>
</table>

The tax base for both direct and indirect taxes is narrow. In the case of indirect taxes, most services are completely excluded from the tax base and many goods, especially those produced in the informal sector, escape taxation. The base for personal income tax has been rendered extremely narrow by excluding agricultural income, administrative difficulties of taxing the unorganised non-agricultural sector, and the provision for exemptions and deductions for various purposes. The base for corporate taxes has been eroded by making generous deductions for depreciation and reinvestment and contributions for a wide variety of social purposes. Though agriculture constitutes the largest sector in terms of output and employment, yet, problems of estimation and costs of collection prevent agricultural incomes from being taxed. This has created horizontal inequity in the system. It has prevented the taxation of large landowners and rich farmers. It has also provided a means of tax evasion for those who have income from both agricultural and non-agricultural sources. For the tax payers, this led to marginal income tax rates that were very high (up to 97 per cent). This encouraged tax evasion. At the same time, legal and tax administration machinery was loose and tax evaders were not penalised. While the actual magnitude of income tax evasion is difficult to estimate and different studies suggest different figures, it can easily be said that it was large enough to considerably affect tax revenues.

Apart from the inadequate growth in tax revenues, the income from non-tax revenues has also contributed to the growth in revenues lagging behind. Implicit subsidies by way of unrecovered costs are provided on a whole range of social and economic services provided by the government.
1.5. Composition of Public Debt

The 1980s saw a rapid rise in public expenditure in India. The current expenditure of the government as a ratio of GDP rose from 11.5 per cent in 1970-71 to almost 23.1 per cent in 1989-90. As mentioned above, while expenditure was rising, receipts were not rising at the same rate since taxes, especially direct taxes, were not buoyant. Over the 1980s, the gap between expenditure and receipts was increasing. While there was a budgetary surplus in the 1970s, the 1980s saw a rise in budget deficits. During the eighties the deficit on the budget was slowly rising and by 1989-90 the fiscal deficit rose to 12.8 per cent of the GDP. About 72 per cent of the gap was financed by domestic borrowing, 7 per cent from external assistance and 21 per cent from deficit financing (Economic Survey, 1990-91).

Till the mid-1980’s, the government bond market was more or less a captive market as government securities were bought by financial institutions like banks and insurance companies to fulfil their Statutory Liquidity Ratio (SLR) requirements, which had risen to 38.5 per cent, even though rates of interest on government bonds were very low and even negative in real terms. If public debt was larger than the amount the financial institutions had to hold, then the surplus would be monetised as the Reserve Bank of India was obliged to lend to the government. In the 1980s special government bonds were issued under various schemes like the Indira Vikas Patras and Kisan Vikas Patras at nominal rates of interest of up to 9 to 10 percent. In addition, tax concessions were given to those who purchased these bonds. The high interest rates of government commercial borrowing from households as well as the tax concessions proved to be a burden on the exchequer.
This led to a substantial increase in interest payments made on public debt. The rising interest payments since the 1980's are a consequence of three factors - the increase in total debt, the increase in the interest rate and the increase in the proportion of high interest bearing liabilities in the government's debt. The internal liabilities of the Government of India have been classified into two categories, the "internal debt" and the "other liabilities". The internal debt consists of (i) market loans, (ii) Treasury Bills, (iii) Special Securities issued to the RBI, (iv) Special Bearer Bonds, and (v) Balances of expired loans, Prize Bonds, Premium Prize Bonds, etc. "Other liabilities" comprise (i) small savings, (ii) state provident funds, (iii) Public provident fund etc. These so-called "other liabilities" carry a higher rate of interest than internal debt and there has been a rise in the proportion of "other liabilities" in the government's total liabilities. The consequence of higher interest payments is a significant rise in the magnitude of public debt. Table 1.3 shows the sharp increase in the debt/GDP ratio since 1980-81.

Table 1.3: Total Outstanding Liabilities of the Government of India (as a percent of GDP)

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980-81</td>
<td>43.9</td>
</tr>
<tr>
<td>1984-85</td>
<td>49.0</td>
</tr>
<tr>
<td>1985-86</td>
<td>52.4</td>
</tr>
<tr>
<td>1990-91</td>
<td>59.1</td>
</tr>
<tr>
<td>1991-92</td>
<td>57.8</td>
</tr>
<tr>
<td>1992-93</td>
<td>57.0</td>
</tr>
<tr>
<td>1993-94(RE)</td>
<td>58.7</td>
</tr>
</tbody>
</table>

This led to widespread concern at the rising public debt and a number of studies like Seshan (1987), Rangarajan et al. (1989), Buiter and Patel (1990) and Chelliah (1992) concluded that the path was unsustainable. However, no serious attempt was made to curtail government borrowing. This was despite an official declaration of intent to arrest further deterioration of budget deficits made in the Long Term Fiscal Policy (LTFP) statement of 1985 which suggested certain specific measures to reverse the decline in public savings - a reduction in subsidies and unproductive administrative expenditure and increasing the contribution of public enterprises through proper pricing and other policies. The Centre's borrowing remained at 7 per cent of GDP against the target of 4 per cent set by the LTFP and public saving did not go beyond 2.4 per cent despite the target of 4 per cent. The seventh five year plan finalised in 1985 provided for a rate of growth of non-plan expenditure no higher than the rate of growth of GDP in an attempt to contain public borrowing. But the growth of non-plan expenditure was three times as high during the seventh plan period (Jalan (1992)).

1.6. The External Crisis

At the same time, during the 1980s, a balance of payment crisis was developing. 1979 saw the second oil price shock and a rise in US interest rates and LIBOR raising the burden of servicing the existing external debt. Due to the recession in industrial countries and the uncompetitiveness of the exchange rate, export growth was slow.

Some attempts at liberalisation saw growth in new industries like automobiles and electronics, both heavily dependent on imports of technology and components. As the economy grew at relatively much higher rates of growth of 5.5 per cent over the
decade, imports grew rapidly. The widening current account deficit was increasingly financed by non-concessional loans. According to World Bank debt data, India’s total outstanding foreign debt increased from $18.7 billion in 1980 to $56.3 billion in 1989 and debt to private creditors increased from about $2 to $21.4 billion during this period (Jalan(1992)). The Gulf crisis resulted in a higher import bill and a loss in foreign remittances. The collapse of the USSR and Eastern Europe led to a decline in Indian exports.

The above trends led to a balance of payment crisis in June 1991. India was left with only two weeks imports worth of foreign exchange. Her credit rating fell sharply and foreign private lending was cut off. For the first time there was a serious possibility of default. Faced with this crisis the government was forced to act.

1.7. Stabilisation and Structural Adjustment

Emergency stabilisation measures aimed at reducing inflation, which had risen to 12 per cent, and the current account deficit, that stood at 3 per cent of GDP and 40 per cent of exports, were taken. Emergency import controls, that were later eased, were imposed. Gold backed external borrowing was undertaken. The rupee was devalued by 22 per cent. A scheme of tradable import entitlements for exporters was introduced. A tight monetary policy implied reducing money supply and raising rates of interest. The July 1991 budget set a target for reducing the central government’s fiscal deficit from 9 per cent to 6.5 per cent of GDP.

The immediate aims of the measures were to bring the current account deficit to 2.7 per cent of the GDP and inflation down to 9 per cent. Loans were negotiated with the IMF and the World Bank for stabilisation and structural adjustment. The reforms,
as outlined in the letters of intent from the finance minister to the IMF and the World Bank, were designed to remove impediments to domestic and foreign private investment and to deregulate industry. The import regime was drastically simplified, tariffs were reduced, export subsidies simplified and the rupee made convertible thus letting market forces determine the exchange rate. This trade and exchange rate liberalisation was also accompanied by tax reform, reform of public sector enterprises and the financial sector which had direct implications for the fiscal deficit. The tax reform consists of a cut in import duties, a streamlining of personal taxes: a cut in tax rates and a reduction in exemptions, restructuring of capital gains and wealth taxes. New measures include an increase in the corporate tax rate, a reduction in generous depreciation allowances that had tended to encourage capital-intensive methods of production, a tax on the gross interest receipt of banks, increases in excise duties, and a reduction in the rates of import duties.  

The reform of the financial sector consists primarily of a reduction in the Statutory Liquidity Ratio and a rationalisation of subsidised credit to priority sectors, relaxation of interest controls and restrictions on firms' access to capital markets, and more autonomy to public sector banks. The major reform in the case of public sector enterprises consisted of eliminating privileges such as protection from external and domestic competition and preferential access to budget and bank resources. Though the condition relating to an effective ‘exit policy’ for closure or restructuring of money loosing firms in the private and public sector has not been fulfilled, the reforms made have largely been in line with the programme’s objectives.

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The most important change appears to be in the opening up of the economy to foreign capital and the removal of exchange restrictions on imports. Consequently, in 1994 India attained Article VIII status and joined the ranks of the 96 other such member countries of the IMF. International monetary arrangements after the Bretton Woods Conference required members of the IMF to restore current account convertibility. The obligation as defined in Article VIII, Sections 2, 3 and 4 stipulates that member countries should have no restrictions on current payments and avoid discriminatory currency practices. The first major step towards current account convertibility was taken with the unification of the exchange rate and the removal of exchange restrictions on imports through the abolition of foreign exchange budgeting at the beginning of 1993-94. Relaxation in payment restriction in the case of a number of invisible transactions followed the budget for 1994-95. In August 1994, the final step towards current account convertibility was taken by further liberalisation of invisibles payments and acceptance of the obligations VIII of the IMF, under which India is committed to forsake the use of exchange restrictions in current international transactions as an instrument in managing the balance of payments.

In 1993-94 imports stood at 10.5 percent of GDP. External debt had been reduced from 41 percent in 1991-92 to 40 per cent in 1992-93 and further to 36 per cent in 1993-94. Direct foreign investment quadrupled from $150 million in 1991-92 to $620 million in 1993-94. In the first half of 1994-95, it was 50 per cent higher than in the first half of 1993-94 (Economic Survey 1994-95, p.9). The current account deficit was brought down to nearly 0.1 per cent of GDP in 1994-95. While the reforms appear to be successful in the context of the external sector, their success as far as the government expenditure and deficit is concerned appears to be limited.
1.8. Cut in Development Expenditure

The rates targeted for the reduction in fiscal deficit have not been achieved. For example, though the gross fiscal deficit (GFD) was brought down from 8.39 per cent of GDP in 1990-91 to below 6 per cent in the next two years, there was a deterioration in the following years. The GFD to GDP ratio increased to 7.3 per cent in 1993-94 (Revised Estimates) as against budget estimates of 4.7 per cent. As data from the RBI Annual Report 1993-94 indicates there was an increase in the revenue account gap from the budget estimates of 2.3 per cent of GDP to 4.2 per cent of GDP. This may be explained by both the shortfall in revenue proceeds and the overruns in expenditure. The shortfall in revenue receipts in 1993-94 accounted for 37.2 per cent of the total increase in GFD during 1993-94. This was due to the decline in customs and excise duties due to sluggish industrial activity and the reduction in custom duty rates. Total revenue collection was 9.6 per cent lower than estimated in the budget. In the following years, including in the 1995-96 budget, there has been a further reduction in custom duties which would reduce revenue collection from this source. Expenditures also grew by 9.6 per cent over the budget estimates; subsidies were 48.0 per cent higher while defence was 12.1 per cent higher. Both food and fertiliser subsidies increased. Since 1992 the government has taken some steps in an attempt to cut the growth of consumption expenditure. These include a reduction of posts at various levels, overall cut in consumption of petrol, diesel, reduction in expenditure on telephones and restriction on purchases of additional vehicles. The strength of the staff of the Central Government showed an estimated decline of about fifty thousand from March 1992 to March 1994 (Economic Survey 1994-95, p.16). However,
consumption expenditure still grew from 3.8 per cent of GDP to 4.1 per cent of GDP from 1992-93 to 1993-94 and led to a rise in revenue deficit.

Another major area of concern is the growing interest burden that accounted for 43.8 per cent of total non-plan expenditure and 53.4 per cent of revenue receipts in the 1994-95 budget. As discussed earlier this is the consequence of the high fiscal deficits in the eighties that have resulted in the accumulation of a large public debt and of the application of market related interest rates in the sale of government securities that has led to an increase in the service cost on internal debt.

**Table 1.4: Measures of Deficit of the Central Government (as a per cent of GDP at current market prices)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Gross Fiscal Deficit</th>
<th>Net Primary Deficit</th>
<th>Revenue Deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980-85</td>
<td>6.26</td>
<td>2.99</td>
<td>1.11</td>
</tr>
<tr>
<td>1985-90</td>
<td>8.21</td>
<td>3.80</td>
<td>2.58</td>
</tr>
<tr>
<td>1990-91</td>
<td>8.39</td>
<td>3.32</td>
<td>3.49</td>
</tr>
<tr>
<td>1991-92</td>
<td>5.90</td>
<td>1.46</td>
<td>2.64</td>
</tr>
<tr>
<td>1992-93</td>
<td>5.69</td>
<td>1.66</td>
<td>2.63</td>
</tr>
<tr>
<td>1993-94</td>
<td>4.71</td>
<td>0.44</td>
<td>2.25</td>
</tr>
</tbody>
</table>

(Budget Estimate)

1993-94          | 7.29 | 2.72 | 4.24 |

(Revised Estimate)


In recent years there has been an increase in net primary deficit (defined as GFD less net lending less net interest payments). As Table 1.4 shows it has increased from 1.7 per cent of GDP in 1992-93 to 2.7 per cent of GDP in 1993-94 despite the target
of 0.44 per cent. This is likely to lead to a further rise in the debt to GDP ratio and interest burden in the future. Total debt servicing consisting of interest payments and repayment of debt was 112.8 per cent of total revenue receipts in 1993-94 (Economic Survey, 1994-95). Table 1.4 also shows that instead of falling from 5.7 per cent to 4.7 per cent from 1992-93 to 1993-94 as was the budget estimate, the Gross Fiscal Deficit rose to 7.3 per cent.

The sharp deterioration in the revenue deficit has changed the composition of the GFD such that it explained 58 per cent of GFD in 1993-94 as against 46 per cent in 1992-93 and 17.0 per cent in the first half of the eighties. In other words, 58 per cent of government borrowing in 1993-94 was to cover current expenditure. There was a squeeze in capital outlay from 2.3 percent of GDP in 1990-91 to 1.6 per cent in 1993-94 (RBI (1994), p.36-37)

The State Government budgets also show a similar trend “large budgetary gaps particularly on revenue account, rising non-developmental expenditure, reduction in the availability of resources for investment and a sluggish revenue performance.” (RBI, (1994) p.42) The overall deficit nearly doubled from 1993-94 to 1994-95 while revenue deficit went up by one-third. The GFD is thus expected to be 28 per cent higher. As compared with an average surplus of 16.8 per cent of GFD in early eighties, the revenue deficit was 28 per cent of GFD. Consequently, as compared to only 7.7 per cent of overall borrowing being utilised to finance current expenditure in the latter half of the ‘eighties, 28.1 per cent of the overall borrowing was siphoned off to finance current expenditure. The availability of funds for capital outlay and net lending that reflects the states’ investment operations gets correspondingly reduced. While the central government had greater flexibility in its budget as it could borrow
from the public, the access of state governments to public borrowing was much more limited. Consequently, state government's showed substantial shortfalls in actual outlays in relation to plan projections. Since the primary responsibility for investment in social sectors, agriculture and irrigation is that of the states, there was a decline in these areas (Jalan, 1992).

The composition of expenditure shows that non-development expenditure (i.e. interest payments, administrative services, pensions and miscellaneous general services) rose faster than the development component from an average of 22.9 per cent in the late eighties to 31.1 per cent in 1994-95.

The increased reliance on borrowing both from the Centre and the market implies higher repayments and interest payments in the future which would further curtail development expenditure. For the Centre and State budgets combined the rising committed outlays for interest payments and administrative expenses have increased from 9.9 per cent of GDP in 1985-86 to 11.6 per cent in 1993-94. The combined government sector capital outlay has declined from 5.0 per cent to 3.2 per cent of GDP over this period. The share of non-development expenditure has increased from 32.4 per cent to 42.4 per cent of total expenditure over this period and is expected to rise further.

The overall picture that emerges from the above account of government spending and expenditure is a fall in the proportion of capital outlays and development expenditure in total government expenditure. Table 1.5 shows that the proportion of development expenditure has declined by more than 10 per cent since 1980.
Table 1.5: Development expenditure of Centre and States (as a per cent of total expenditure)

<table>
<thead>
<tr>
<th>Year</th>
<th>Development Expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980-81</td>
<td>66.0</td>
</tr>
<tr>
<td>1984-85</td>
<td>64.6</td>
</tr>
<tr>
<td>1985-86</td>
<td>65.1</td>
</tr>
<tr>
<td>1990-91</td>
<td>58.8</td>
</tr>
<tr>
<td>1991-92</td>
<td>55.5</td>
</tr>
<tr>
<td>1992-93</td>
<td>55.7</td>
</tr>
<tr>
<td>1993-94 (RE)</td>
<td>54.3</td>
</tr>
</tbody>
</table>


To analyse the effect of the ongoing changes in government expenditure and debt in India we shall first test the Ricardian equivalence hypothesis. We then present a general model encompassing both the Ricardian and the non-Ricardian models. This model is estimated for India to determine the underlying behavioural parameters that are crucial in determining the impact of debt on growth. Finally, we present a model of endogenous growth driven by capital externalities arising from both private capital and public capital and infrastructure. Since the fiscal deficit is equal to the revenue and capital expenditures and net domestic lending minus revenue receipts and grants measuring the overall resource gap, it is possible to reduce it by a cut in capital expenditures rather than government consumption expenditure. Therefore, we examine the effect of not just government borrowing, change in tax rate and the change in the ratio of public investment to total government on long-run growth rate of the GDP.

We limit the scope of this study to the effects, rather than the causes for the growth in non-development versus development expenditure. The political economy of
the forces that generate the pressures on current expenditures of the government at the expense of public investment in India is another study in itself (for example, Bardhan (1989)).
Chapter 2
Debt Neutrality
Theory and Evidence

Standard economic theory suggests that an expansionary fiscal policy raises aggregate demand in an economy. It leads to a reduction in private spending, especially in private investment associated with an increase in real interest rates caused by fiscal expansion. This phenomenon is referred to as 'crowding-out'. Barro (1974) suggested that the underlying premises of the crowding out hypothesis is that consumers perceive a cut in taxes to be a rise in permanent income. If consumers were rational and far sighted, they would expect a cut in current taxes to be followed by a rise in taxes at some time in the future. They would, therefore, not perceive the cut as a rise in permanent income and would not change their consumption levels. This hypothesis has come to be known as Ricardian Equivalence.¹

In this chapter we shall discuss the Ricardian Equivalence theorem of debt-neutrality. Section 1 sets out the representative agent model. Section 2 introduces the government into the model and discusses Barro's hypothesis. Section 3 examines some of the evidence on Ricardian Equivalence. In section 4 we examine the evidence for India.

2.1 A Representative Agent Model

Consumption is determined by life-time resources rather than income in the current period. Life-time resources represent permanent income which can be thought of as a constant resource flow that can be sustained throughout the planning horizon. If current income exceeds permanent income, the individual saves. He can acquire physical or

¹ The hypothesis is associated with Ricardo (1951) in whose writings this idea finds its first articulation. Even though Ricardo had doubts about the equivalence hypothesis, the proposition continued to be linked with his name. The term Ricardian Equivalence was first introduced to macroeconomists by James Buchanan (1976).
financial assets. Both yield the same rate of return and are assumed to be perfect substitutes in his portfolio basket. If current income falls short of permanent income, the individual borrows. Debt is treated as a negative asset. There are no constraints or imperfections in the market which prevent him from borrowing at the market rate of interest.

Preferences are assumed to be intertemporally additive. Lifetime utility is the sum of the sub-utilities of consumption in each period discounted at the subjective discount rate. This reflects the impatience because of which consumers attach a lower weight to the utility of future consumption. The utility function of the representative consumer at time $t$ may be written as

$$u_t = \sum_{i=0}^{\infty} \left( \frac{1}{1+\delta} \right)^i u(C_{t+i})$$

(2.1)

where $\delta$ is the constant rate of time preference and $u(\cdot)$ is a time invariant, concave utility function. As in Barro (1974) it is assumed that agents take account of the welfare and resources of their prospective descendants. This inter-generational interaction is modelled by assuming that an agent maximises utility subject to a budget constraint over an infinite horizon. Thus, although an agent has a finite life, his planning horizon is infinite to take care of his immortal extended family. The infinite planning horizon assumption thus corresponds to finite lived individuals connected via a pattern of operative inter-generational transfers. These transfers are assumed to be bequests that are based on altruism and assumed to be non-negative.

The consumer's budget identity in period $t$ may be written as

$$V_t = (1+r) V_{t-1} + \Omega_t - C_t$$

(2.2)

where
\( V_t \) = non-human wealth at the end of period \( t \)

\( r \) = rate of interest assumed constant

\( C_t \) = consumption in period \( t \)

\( \Omega_t \) = post tax labour income in period \( t \)

Rearranging (2.2) and solving forward in time the budget identity become the solvency constraint

\[
(1 + r) V_{t-1} = \sum_{i=0}^{\infty} \left[ \frac{1}{(1 + r)^i} \right] [C_{t+i} - \Omega_{t+i}] 
\]  

(2.3)

provided that the transversality condition \( \lim_{t \to \infty} \left[ \frac{1}{(1 + r)^t} \right] V_{t+i} = 0 \) holds or that wealth does not grow at a rate faster than the rate of interest.

The representative agent's intertemporal budget constraint implies that the total value of consumption over time is equal to the total human and non-human wealth possessed by the consumer. Non-human wealth is represented by \( V_t \) and includes the financial and non-financial assets owned by the consumer. Human wealth is the present value of a future stream of disposable income and may be represented by

\[
H_t = \sum_{i=0}^{\infty} \left[ \frac{1}{(1 + r)^i} \right] \Omega_{t+i} 
\]  

(2.4)

Maximising the representative individual's objective function (2.1) subject to the intertemporal budget constraint (2.3), we obtain the first order condition
(where φ is the Lagrange multiplier) along with the intertemporal budget constraint. Thus,

\[ \phi = \left( \frac{1 + r}{1 + \delta} \right)^i u'(C_{t+i}) = \text{constant for all } i \]

The Euler equation is:

\[ u'(C_{t+i}) = \left( \frac{1 + \delta}{1 + r} \right) u'(C_{t+i-1}) \tag{2.6} \]

The two instantaneous utility functions that we encounter frequently in the literature are the quadratic and the constant elasticity of substitution utility functions.

If the utility function is quadratic

\[ u(C_t) = -\frac{(\bar{C} - C_t)^2}{2} \]

where \( \bar{C} \) is the bliss level of effective consumption. Then we can derive the Euler equation,

\[ C_t = \alpha + \beta C_{t-1} \]

where, \( \alpha = \frac{(r - \delta)}{(1 + r)} \bar{C} \) and \( \beta = \frac{(1 + \delta)}{(1 + r)} \) \tag{2.7} \]

The other form of the utility function that we shall come across in the following chapters is the isoelastic or the constant elasticity of substitution function.
$$u(C_t) = \frac{1}{1 - \frac{1}{\sigma}}C_t^{1-\sigma} \quad \text{if } \frac{1}{\sigma} > 0, \frac{1}{\sigma} \neq 1$$

$$= \ln(C_t) \quad \text{if } \sigma = 1$$

(2.8)

where $\sigma$ is the intertemporal elasticity of substitution. It measures how responsive is the ratio of consumption in the two periods to relative prices. Estimates of $\sigma$ vary substantially but usually lie around or below unity (Blanchard and Fischer(1987) p.44). In case $\sigma = 1$, the utility function is logarithmic in form. In the case of the logarithmic utility function the Euler equation is linear and of the form

$$C_t = \beta C_{t-1}$$

where, $$\beta = \frac{(1+r)}{(1+\delta)}$$

(2.9)

2.2. The Ricardian Equivalence Hypothesis

If it is assumed that the utility function is logarithmic then by combining (2.9) with the budget constraint (2.3) we can show that

$$C_t = \mu [(1+r)V_{t-1} + H_t]$$

(2.10)

where $\mu = \delta/1+\delta$. and it represents the marginal propensity to consume out of lifetime wealth which consists of human and non-human wealth. (2.10) represents the consumption function of the representative agent. Since $H_t$ is the discounted value of post tax labour income, it is not independent of taxes.

We now introduce the government into the model. It can be shown that policies that have a transitory effect on income are incapable of having an effect on consumption.
We can then demonstrate that if it is assumed as in Barro(1974) that consumers understand the implications of the government budget constraint, they do not regard a tax cut, given government spending, as permanent. They are fully aware that a cut in contemporaneous taxes implies a future tax increase. Hence, under these circumstances a tax cut leads to no change in consumption. It leads to only a transitory change in income which has no effect on consumption.

It is assumed that the government obtains no revenue from the creation of money.

The government sector has a budget identity of the form

\[ D_t = (1 + r)D_{t-1} + G_t - T_t \]  

(2.11)

where \( D_t \) is public debt at the end of period \( t \).

Rearranging and solving forward in time, the budget identity (2.11) becomes the solvency constraint

\[ (1+ r)D_{t-1} = \sum_{i=0}^{\infty} \left[ \frac{1}{(1+ r)} \right]^i [T_{t+i} - G_{t+i}] \]  

(2.12)

provided that the transversality condition \( \lim_{t \to \infty} \left[ \frac{1}{(1+ r)} \right]^i D_{t+i} = 0 \) holds. According to (2.12), a government with a positive debt must eventually run primary surpluses to be solvent. This is a weak solvency condition as the government can be solvent even though its real debt and its debt/GDP ratio grows without a bound. Our definition of solvency merely requires that this ratio does not grow faster than the growth adjusted real interest rate in the long run. It does not require a stable debt/GDP ratio which is referred to as a strong solvency condition (Buiter and Patel(1991), Krichel and Levine (1995)).

The Ricardian equivalence theorem assumes that the representative individual is "forward looking" and rational in regard to the fiscal affairs of the government. He
understands the implications of the intertemporal government budget constraint specified in equation (2.12). He recognises the future tax obligations implicit in the issue of current period and existing government debt and its servicing. We can rewrite the individual’s intertemporal budget constraint as

$$\sum_{i=0}^{\infty} \left[ \frac{1}{(1 + r)} \right]^i C_{t+i} = (1 + r)V_{t-1} + \sum_{i=0}^{\infty} \left[ \frac{1}{(1 + r)} \right]^i [N_{t+i} - T_{t+i}]$$

since $$\Omega_{t} = N_t - T_t$$

where $$N_t =$$ labour earnings in period t (assumed to be exogenous) and $$T_t =$$ Tax payments (net of transfers) in period t.

We can integrate the private and public sectors by substituting the government constraint into the representative agent’s budget constraint. The budget constraint of the representative individual is now

$$\sum_{i=0}^{\infty} \left[ \frac{1}{(1 + r)} \right]^i C_{t+i} = (1 + r)[V_{t-1} - D_{t-1}] + \sum_{i=0}^{\infty} \left[ \frac{1}{(1 + r)} \right]^i [N_{t+i} - G_{t+i}]$$

(2.13)

Thus if the agent is rational and understands the government’s budget constraint and incorporates it into his own, his intertemporal budget constraint is represented by (2.13). Using (2.10) we can now show that

$$C_t = \mu \left[ (1 + r)[V_{t-1} - D_{t-1}] + \sum_{i=0}^{\infty} \left[ \frac{1}{(1 + r)} \right]^i (N_{t+i} - G_{t+i}) \right]$$

(2.14)

The consumption function of the rational representative agent is now independent of the level of taxes or debt issued in period t or after. Any change in taxes leaves
consumption unaffected. A rise in government spending has a negative net wealth effect and reduces consumption. This is because the government would have to raise taxes at some time to pay for higher spending, thus reducing the lifetime wealth of the consumer. (2.14) therefore represents the consumption function corresponding to the Barro-Ricardian model. Keeping the level of government spending constant, it demonstrates that if the consumer incorporates the government's intertemporal budget constraint into his own, a change in the level of taxes does not affect his life-time wealth i.e. it has no net wealth effect. A shift from current taxes to a deficit has no impact on aggregate demand.

2.3. Empirical Studies

The most common approach to empirically test the Ricardian theorem was to include fiscal variables in a regression of private consumption in order to test whether a debt financed tax cut led to an increase in private consumption expenditure (Feldstein(1982), Kornendi(1983)). Private consumption was specified as a function of income, taxes, government expenditure and private wealth including public debt and the proposition was tested in terms of the restrictions placed on these. The model was estimated usually for the US. Differences in measurement and restrictions led to different conclusions. This approach was criticised on the grounds of the arbitrariness with which variables were included or excluded from the model. This resulted from not specifying the underlying theoretical model. The approach did not explicitly test the assumptions of the equivalence proposition and expectations behaviour was not incorporated into the estimating model. Following Aschauer (1985) we derive a model based explicitly on Ricardian assumptions and a government expenditure expectation function based on rational expectations.
We assume that utility is a function of the total consumption by an individual of both public and private goods.

\[ C_t^* = C_t + \theta G_t \quad (2.15) \]

where \( C_t^* \) denotes the level of "effective" consumption in period \( t \). It is a linear combination of private consumption \( C_t \), and government goods and services \( G_t \). In terms of effective consumption, the budget constraint of the representative individual is:

\[
\sum_{i=0}^{\infty} \left[ \frac{1}{(1+r)} \right]^i C_{t+i}^* = (1+r)[V_{t-1} - D_{t-1}] + \sum_{i=0}^{\infty} \left[ \frac{1}{(1+r)} \right]^i (N_{t+i} + (\theta - 1)G_{t+i})
\]

Thus the present discounted value of effective consumption is constrained by the economy wide wealth plus the present discounted value of labour earnings plus \((\theta-1)\) times the value of government expenditure. Rearranging

\[
(1+r)D_{t-1} - (1+r)V_{t-1} + \sum_{i=0}^{\infty} \left[ \frac{1}{(1+r)} \right]^i [C_{t+i}^* - N_{t+i} - (\theta - 1)G_{t+i}] = 0 \quad (2.16)
\]

Maximising effective consumption (2.15) subject to the budget constraint (2.16) and if the utility function is assumed to be quadratic then

\[ C_t^* = \alpha + \beta C_{t-1} \quad (2.17) \]

where, \( \alpha = \frac{(r - \delta)}{(1+r)} \bar{C} \) and \( \beta = \frac{(1 + \delta)}{(1+r)} \).
where $\bar{C}$ is the bliss level of effective consumption. If $E_t$ is the expectations operator conditional on information available up to period $t$ then the expected consumption in period $t$ may be defined as

$$E_t C_t^* = \alpha + \beta C_{t-1}^* + \rho_t$$  \hfill (2.18)

where $\rho_t$ is the error term.

Lagging equation (2.15) by one period and substituting into equation (2.18) gives

$$E_t C_t^* = \alpha + \beta[C_{t-1} + \theta G_{t-1}] + \rho_t = C_t + \theta G_t + \zeta_t$$  \hfill (2.19)

where $E_t C_t^* = C_t^* + \zeta_t$

If $G_t = E_{t-1} G_t + \lambda_t$  \hfill (2.20)

where $\lambda_t$ is the error term.

We obtain

$$\alpha + \beta C_{t-1} + \beta \theta G_{t-1} = C_t + \theta E_{t-1} G_t + \xi_t$$

Or, $C_t = \alpha + \beta C_{t-1} + \beta \theta G_{t-1} - \theta E_{t-1} G_t + \xi_t$  \hfill (2.21)

where the error term $\xi_t$ includes the effect of measurement errors, revisions in expectations and shocks.

The value of government spending is predicted on the basis of past values of government spending and deficits. It is assumed that $E_{t-1} G_t$ the expected value of $G_t$ at time $t-1$ is given by

$$E_{t-1} G_t = \gamma + \varepsilon(L) G_{t-1} + \omega(L) D_{t-1} + \nu_t$$  \hfill (2.22)
where $L$ is the lag operator and $FD_t$ is the government deficit in period $t$. The error term $v_t$ is such that it satisfies the orthogonality condition $E(v_t | I_{t-1}) = 0$, $I_t$ being the information set available to the agent at time $t$ so that $v_t$ is serially uncorrelated. If expectations depend only on last period's spending and deficits he obtains the following the two equation system

$$G_t = \gamma + \varepsilon G_{t-1} + \omega FD_{t-1} + v_t \quad (2.23)$$

and

$$C_t = \alpha' + \beta C_{t-1} + \eta G_{t-1} + \mu FD_{t-1} + \pi_t$$

where $\alpha' = \alpha - \theta \gamma$

$$\eta = \theta (\beta - \varepsilon) \quad (2.24)$$

$$\mu = -\omega \theta$$

Ricardian Equivalence requires that the cross equation restrictions are not violated because they imply that the consumer takes the government's tax and expenditure decisions into account. As expectations are assumed to be rational the government's behaviour which satisfies the intertemporal budget constraint is correctly predicted by individual consumers.

Aschauer(1985) found evidence in support of Ricardian Equivalence. He reports that the estimated coefficient on the lagged value of consumption is highly significant and equal to unity implying that holding fixed the level of government spending - private consumption expenditure follows a random walk. The point estimate for substitutability of public spending for private consumption is positive and is significantly different from zero at the five percent level.
Further, likelihood ratio statistics suggest that the data does not reject the hypothesis at conventional significance levels. First government spending and consumption functions are estimated subject to the restrictions on consumption. Next the system is estimated without imposing the restrictions. To test the hypothesis of Ricardian equivalence he examines the validity of the restrictions. This is done by calculating the log-likelihood ratio test statistic. If \( L_1 \) is the value of the likelihood function for the maximum of the unconstrained model and \( L_0 \) is the value when the constraints are imposed then the likelihood ratio test statistic is computed as \( LR = 2(L_1 - L_0) \). This statistic has a \( \chi^2 \) distribution with degrees of freedom equal to the number of restrictions. If the estimated value of \( LR \) is less than the value of the \( \chi^2 \) distribution at a given level of significance then it indicates that there is no significant discrepancy between the constrained and the unconstrained values of the log-likelihood function and thus we the null hypothesis that the constrained model is true cannot be rejected.

Gupta (1992a) estimates the model for some developing countries. His results are mixed. His evidence suggests that the coefficient of lagged consumption is statistically significant and positive in all cases and is not significantly different from unity in most cases. In India it is 0.65 and is significantly different from unity. The coefficient of government expenditure in India is negative and is found to be statistically different from unity. However, the null hypothesis of Ricardian Equivalence cannot be rejected by the likelihood ratio test.
2.4. Excess Sensitivity

The Ricardian Equivalence hypothesis assumes the existence of perfect credit markets. Evidence indicates a role for current income in explaining consumption over and above that which is due to a revision in expectation of future income as signalled by current income (Flavin(1981), Hayashi(1982), Jappelli and Pagano(1989)). Flavin (1981) analysed the role of current income in providing new information about the future. She found that the response of consumption to current income was beyond that attributable to the role of current income in signalling changes in permanent income. The permanent income hypothesis suggests that individual consumption depends on the resources available to the consumer over his entire lifetime. However, if a consumer is constrained by credit market imperfections and is unable to borrow and lend the amount he requires to undertake his optimal consumption plan then his desired consumption will be constrained by his current income.

To take account of the 'excess sensitivity' of consumption to current income, Hayashi (1982) explicitly included the presence of some households in the economy who consume only their current income. The 'excess sensitivity' of consumption expenditure to contemporaneous disposable income may be attributed to liquidity constraints. If liquidity constrained consumers are significant in proportion then aggregate consumption reveals excess sensitivity to current income.

The economy is assumed to comprise of two groups of consumers - the liquidity constrained consumers and the unconstrained consumers.
Aggregate consumption is assumed to be the sum of the consumption of constrained and unconstrained consumers.

\[ C_t = C_t^c + C_t^u \]  

(2.25)

where

\[ C_t = \text{Aggregate consumption} \]
\[ C_t^c = \text{Consumption of constrained consumers} \]
\[ C_t^u = \text{Consumption of unconstrained consumers} \]

We assume that unconstrained consumers receive a proportion \( \lambda \), of total post tax labour income, \( \Omega_t \). Constrained consumers thus receive a proportion \( (1 - \lambda) \) of total post tax labour income. Since they consume their current income,

\[ C_t^c = (1 - \lambda) \Omega_t \]  

(2.26)

If the value of \( \lambda \) is estimated to be unity, then one can conclude that all consumers are forward looking. The aggregate consumption function is thus a generalisation which includes the permanent income hypothesis as a special case.

The consumption of unconstrained consumers may be defined following (2.7) as

\[ C_t^u = \alpha + \beta C_{t-1}^u + e_t \]  

(2.27)

where the error term \( e_t \) is assumed to be normally distributed and uncorrelated to any information available to the consumer in period t-1 including consumption in period t-1. Since changes in current income signal changes in future income, the error term
may include changes in consumption expenditure which occur due to the revision in expectation of future income.

Aggregate consumption may be defined using (2.25) and (2.27) as

\[ C_t = \alpha + \beta C_{t-1} + C^e_t + e_t \]  

(2.28)

Adding and subtracting \( \beta C_{t-1} \) on the right hand side we get

\[ C_t = \alpha + \beta (C^u_{t-1} + C^e_{t-1}) + C^e_t - \beta C^e_{t-1} + e_t \]  

(2.29)

Lagging (2.26) by one time period and substituting in (2.29) and using (2.25) we obtain

\[ C_t = \alpha + \beta C_{t-1} + (1 - \lambda)(\Omega_t - \beta \Omega_{t-1}) + e_t \]  

(2.30)

\( \lambda \) can be interpreted as the degree of excess sensitivity of consumption to current income. If there exist no credit constraints \( \lambda \) should be one.

2.5. Evidence for India

To test the hypothesis for India we estimate (2.27), the constrained model, and (2.30), the unconstrained model. The model is estimated using annual data for India for the period 1960 to 1989. The data source is International Financial Statistics published by the IMF (various issues). Variables are measured in real per capita terms. Per capita GDP is used as an instrument for \( \Omega_t \), the current disposable income. Since the error term may be correlated with \( \Omega_t \), we estimate the model by using instrumental variables. NLIV estimates using one period lagged values of consumption, income, private sector investment and government spending are presented in Table 2.1. We compute the Wald statistic to test the restriction.
Table 2.1: Excess Sensitivity of Consumption

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate [p values in parentheses]</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>15.09 [0.039]</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.30 [0.111]</td>
</tr>
<tr>
<td>$1-\lambda$</td>
<td>0.547 [0.000]</td>
</tr>
</tbody>
</table>

Durbin Watson Statistic: 1.93
LM test for first order Serial Correlation: 0.12 [0.727]
LM test for functional form: 1.64 [0.201]
LM test for Heteroscedasticity: 2.39 [0.122]
LM test for Normality: 2.80 [0.247]

Wald test of restriction ($\lambda = 1$) = 142.35

Wald Statistic indicates that the restricted model is not the true model.

This indicates that there is evidence of excess sensitivity of consumption to income. This suggests that the assumption of the Ricardian model that there are perfect credit markets is not true for India. The estimate of excess sensitivity may however be biased because we have not taken into account the effect of other possible violations of the Ricardian model into account. For instance, the presence of finite horizons, rather than infinite horizons as assumed here, would lead to a greater response of permanent income unconstrained consumers to current income than suggested by the model.
above. The would mean that our estimate of the degree of excess sensitivity, \((1-\lambda)\) the proportion of income received by constrained consumers, is higher than what it would be if we took into account finite horizons. In the next chapter we extend the model to include the assumptions of finite horizons and population growth.
Chapter 3

The Aggregate Consumption Function: Finite Horizons, Liquidity Constraints and Population Growth with Income Redistribution

The model presented here is confined to the analysis of a closed economy. Non-Ricardian effects are introduced in the aggregate consumption function by the inclusion of liquidity constraints following Hayashi (1982), finite horizons following Blanchard (1985), population growth following Weil (1989) and allowing for a transfer of consumers from the group of constrained (unconstrained) to the group of unconstrained (constrained) consumers. Any one of these factors leads to a deviation from Ricardian Equivalence. Time is discrete following Frenkel and Razin (1992).

3.1. Liquidity Constraints

As described in Section 2.5 the economy is assumed to comprise of two groups of consumers - the liquidity constrained consumers and the unconstrained consumers. The unconstrained consumers maximise utility subject to the intertemporal budget constraint. Their consumption expenditure can be more than or less than their current income. They have access to the credit market. Hence, they save or dissave. Assuming that a person is born with zero net wealth, they become owners of all the nation's financial and physical wealth. The component of wealth in the portfolio of an unconstrained consumer may be positive or negative.

Aggregate consumption is the sum of the consumption of the constrained and unconstrained consumers.

\[ C_t = C^c_t + C^u_t \]  

(3.1)
where

\[ C_t = \text{Aggregate consumption} \]

\[ C_t^c = \text{Consumption of constrained consumers} \]

\[ C_t^u = \text{Consumption of unconstrained consumers} \]

We assume that unconstrained consumers receive a proportion \( \lambda \), of total post tax labour income, \( \Omega_t \). Constrained consumers thus receive a proportion \( (1 - \lambda) \) of total post tax labour income. Since they consume their current income,

\[ C_t^c = (1 - \lambda)\Omega_t \quad (3.2) \]

If the value of \( \lambda \) is estimated to be unity, then one can conclude that all consumers are forward looking.

### 3.2. Finite Horizons

The group of unconstrained consumers consist of overlapping generations which, apart from age, are identical. To capture the "life-cycle" aspect and to deal with issues in which the change in behaviour over life are important, we would need to allow for differences in propensity to consume across agents. However, this makes aggregation impossible. To allow aggregation it is assumed, following Blanchard (1985), that agents face throughout their life, a constant instantaneous probability of death, \( p \). Their expected life \( 1/p \) is constant throughout life. The aggregation problem is solved because though agents are of different ages and have different levels of wealth, they have the same horizon and the same propensity to consume. \((1/p)\) the horizon index lies anywhere between zero and infinity. If we let \( p \) go to zero then we obtain the infinite horizon case as a limiting case.

As noted earlier, it is assumed that each agent is born with zero net wealth. Consumers leave neither assets, nor debt to their children. The model thus assumes the absence of a bequest motive. Because of uncertain life-time and the assumption that debt is
not inherited by the borrower's children who would service it, it is assumed that each loan is associated with a direct surcharge on the loan which is an insurance premium. Perfect competition and the zero profit condition in the market for loanable funds would ensure that at the end of a period, after taking risk into account, each lender earns a return equal to the risk free return \((1 + r)\). Since a proportion \(p\) of the population is expected to die in each period, only a proportion \((1 - p)\) of the population is expected to survive. A competitive lender charges a rate of interest higher than \(r\), the risk free rate of interest, because \(p\) per cent of the population is not going to be alive to repay the loan and pay the interest on it. The competitive lender thus charges \((1 + r)/(1 - p)\) so that the safe return is \((1 - p) \times [(1 + r)/(1 - p)] = 1 + r\).

Alternatively, it can be assumed that the agent owns assets which he lends out. He receives interest on his assets. The borrower pays him a return \(R^*\) that includes a life insurance premium in return for which he inherits the assets if the individual dies. Since only \((1 - p)\) proportion of the population is going to survive, he will end up paying only \((1 - p)\) \(R^*\) and therefore if the secure rate of return is \(1 + r\), the zero profit condition ensures that \((1 - p) \times R^* = (1 + r)/(1 - p)\). The effective cost of borrowing relevant for individual decision making is \((1 + r) / (1 - p)\). To ease aggregation, we also ignore life-cycle aspects of labour income and assume that labour income is constant throughout the consumer's lifetime.

3.3. Population Growth and Income Redistribution

It is assumed that the economy is characterised by population growth and income redistribution. The population of unconstrained consumers is assumed to grow at the rate \(g\). The total population over any period may be divided into four groups:
A. Those who were constrained at the beginning of the period and constrained at the end of the period.

B. Those who were constrained at the beginning of the period and unconstrained at the end of the period.

C. Those who were unconstrained at the beginning of the period and unconstrained at the end of the period.

D. Those who were unconstrained at the beginning of the period and constrained at the end of the period.

Since our definition of unconstrained consumers is one that includes those who save or borrow depending on whether the component of wealth in their portfolio is positive or negative, a change in an individual's position from constrained to unconstrained can come about either by a change in the credit market such that more (or less) people have access to credit or by a redistribution of income. In a country where a credit market is developing or one where a developed credit market is liberalised, one would expect a number of consumers who are constrained at the beginning of the period to become unconstrained by the end of the period if they get access to credit during that time. If there was no change in the credit availability such a change could be the result of a redistribution of income from the rich, who have the capacity to save, to the constrained.

Group D consumers could either be the victims of tighter credit controls or a worsening of income distribution. Agents who were better off at the beginning of the period and could save a part of it, could become incapable of doing so by the end of the period due to a fall in their real income. If the size of groups B and D was zero, both the constrained and the unconstrained groups are assumed to grow at the rate of growth of total population, $g^*$. If in any period group B is larger than group D, then $(g - g^*)$,
where \( \mathbf{g} \) is the growth in the size of the unconstrained group, will be positive. If group \( \mathbf{D} \) is larger than group \( \mathbf{B} \), it suggests a net transfer from the unconstrained to the constrained group and \( \mathbf{(g - g^*)} \) will be negative. In the absence of transfers, the rate of population growth of the unconstrained group would be \( \mathbf{g^*} \). In an economy undergoing structural change we would expect both group \( \mathbf{B} \) and \( \mathbf{D} \) to be non-zero.

### 3.4. Utility Function

The utility function is assumed to be of the constant elasticity of substitution type where the intertemporal elasticity of substitution is unity. A constant elasticity of substitution utility function may be written as

\[
u(C_t) = \begin{cases} 
\frac{1}{1 - 1/\sigma} C_t^{1/\sigma} & \text{if } 1/\sigma > 0, 1/\sigma \neq 1 \\
\ln(C_t) & \text{if } \sigma = 1
\end{cases}
\]

The single period utility function of the consumer is thus logarithmic. \( \sigma \) is the intertemporal elasticity of substitution. Consider the unconstrained consumer born in period \( s \). The unconstrained consumer's intertemporal utility function at time \( t \geq s \), in the absence of any uncertainty apart from death is given by

\[
U_{i,s} = \sum_{i=t}^{\infty} \left[ \frac{1 - \delta}{1 + \delta} \right]^{i-t} \left[ \gamma_1 \log C_{i,s} + \gamma_2 \log G_{i,s} \right] 
\]

where \( \delta \) denotes the rate of time preference and \( C_{i,s} \) and \( G_{i,s} \) denote the consumption of private and public goods respectively over period \( (i, i+1) \).

Wealth of an individual consists of two components: non-human wealth that includes physical and financial assets and human wealth which consists of the present value.
of the expected future stream of labour income. Real net financial and physical wealth at the end of period \( i \) is given by \( V_{i,s} \). At this stage we omit taxation of non-labour income. The budget constraint of an individual may be defined as

\[
V_{i,s} = \left[ \frac{(1+r)/(1-p)}{1+r} \right] V_{i+1,s} + \Omega^u_{i,s} - C^u_{i,s} \tag{3.4}
\]

where unconstrained consumers receive \( \Omega^u_i \) which is a part of total post tax labour income, \( \Omega_u \), and \( r \) is the risk free real rate of interest. \( r \) is assumed to be constant. Rewriting (3.4) as,

\[
V_{i+1,s} = \frac{1 - p}{1 + r} \left( V_{i,s} + C^u_{i,s} - \Omega^u_{i,s} \right)
\]

Solving forward in time and substituting we have

\[
V_{i-1,s} = \frac{1 - p}{1 + r} \left( C^u_{i-1,s} - \Omega^u_{i-1,s} \right) + \left( \frac{1 - p}{1 + r} \right)^2 \left( C^u_{i+1,s} - \Omega^u_{i+1,s} \right) + \ldots
\]

Combining with the transversality condition that wealth does not grow at a rate faster than the rate of interest i.e. \( \lim_{i \to \infty} \frac{V_{i+1,s}}{(1+r)^{i+1}} = 0 \), we arrive at the consolidated budget constraint over the individual's lifetime:

\[
\sum_{t=0}^{\infty} \left[ \frac{1 - p}{1 + r} \right]^{t} C^{u}_{i+t,s} = \sum_{t=0}^{\infty} \left[ \frac{1 - p}{1 + r} \right]^{t} \Omega^{u}_{i+t,s} + \frac{1 + r}{1 - p} V_{i-1,s} \tag{3.5}
\]

The consumer maximises utility defined by (3.3) subject to the intertemporal budget constraint (3.5). The resulting Euler equation is linear as in (2.9) and of the form:

\[
C^u_{i+1,s} / C^u_{i,s} = (1+r) / (1+\delta) \tag{3.6}
\]

Combining (3.5) and (3.6) leads to

\[
C^u_{i,s} = \mu \left[ (1+r)/(1-p)V_{i+1,s} + H^u_{i,s} \right]
\]
where \( \mu = (p + \delta)/(1 + \delta) \) and \( H^u_{i,s} \) is human wealth of unconstrained consumers defined by

\[
H^u_{i,s} = \sum_{t=0}^{\infty} \left( \frac{1 - p}{1 + \delta} \right)^t \Omega^u_{i,s} \tag{3.7}
\]

In the infinite horizon case we found \( \mu = \delta/(1 + \delta) \) which corresponds to \( p=0 \) here. \( \mu \) is again interpreted as the marginal propensity to consume out of lifetime wealth.

The amount an individual consumes out of an additional unit of lifetime wealth at any point of time depends on how he weighs present consumption relative to future consumption and upon his probability of being alive to consume it later. If the degree of impatience was infinitely high, the rate of time preference \( \delta \) would be very high and \( \mu \) would be nearly unity. In other words, he would consume every extra unit of wealth right away. The lower the degree of impatience, the more the individual would be prepared to wait to consume his wealth and the lower would be the value of the marginal propensity to consume out of lifetime wealth. If the rate of time preference was zero, the marginal propensity to consume out of lifetime wealth would be equal to \( p \), the reciprocal of the life expectancy of the individual. In that case it can be shown that if the individual expected to live for \( n \) years he would smooth his consumption out such that he consumes an equal amount in each year. Since here the marginal propensity is equal to the average propensity he would consume \( 1/n \) amount of his wealth in each year.

In terms of the probability of survival, the higher is the probability of survival, the lower is the marginal propensity to consume out of lifetime wealth because of the need to spread consumption over a longer period. If \( p \) is very high and the individual expects to live for a very short period he will consume a very high proportion of his wealth. If \( \delta \) and \( p \) are both low then \( \mu \) will be low as well.
3.5. Aggregate Behaviour

We now look at the aggregate behaviour of unconstrained consumers to incorporate the effect of population growth and income redistribution. If \( L_{s,t} \) is the size of the cohort born during the period \([s,s+1]\) who are still alive at the end of period \(t\) then \( L_{s,t} = (1-p)^t L_{s,s} \). The unconstrained group can increase or decrease in size both due to natural birth and transfer to and from the constrained group. Let \( \beta \) be the 'birth rate' (assumed constant) that includes both birth and migration during a period such that \( L_{s,t} = \beta(1-p)L_{s,t-1} \) where \( L_{s,t} \) is the population born in period \(t\) and still alive in period \(t\) and \( L_t \) is the population size at the end of the period. If \( g = \) population growth (assumed constant), then \( L_t = (1+g)L_0 \). Hence we must have that

\[
L_t = (1+g) L_0 \\
\]

\[
= \beta \sum_{s=0}^t L_{s,t} = \beta A_0 \sum_{s=0}^t (1+g)^{t-s} (1-p)^{t-s-1} 
\]

Performing the summation leads to \( \frac{1}{1+\beta} = \frac{(1-p)}{p + g} \) which determines the 'birth rate' \( \beta \). For small \( p, g \) we have \( \beta \approx p + g \).

Aggregate variables are defined as:

\[
C_{t}^u = \sum_{s=0}^t L_{s,t^u} C_{t^u}^{u_{s,t}} \quad (3.9)
\]

\[
H_{t}^u = \sum_{s=0}^t L_{s,t^u} H_{t^u}^{u_{s,t}} \quad (3.10)
\]

etc. Taking first differences of (3.10) we have

\[
H_{t}^u - H_{t-1}^u = L_{t,t^u} H_{t^u}^{u_{t,t^u}} + \sum_{s=0}^{t-1} \left[ L_{s,t^u} H_{t^u}^{u_{s,t^u}} - L_{s-1,t^u} H_{t^u-1,t^u} \right] 
\]

The first term on the right hand side of (3.11) is equal to \( \beta(1-p)L_{t,t^u} H_{t^u}^{u_{t,t^u}} = \beta[(1-p) / (1+g)]L_{t,t^u} H_{t^u}^{u_{t,t^u}} \). But \( L_{t^u} H_{t}^{u_{t,t^u}} = H_{t}^u \) since human wealth of all age groups is equal according
to our 'perpetual youth' or constant probability of death assumption. Using (3.7) human wealth of cohort $s$ accumulates according to:

$$H^u_{t,s} = [(1+r)/(1-p)](H^u_{t+1,s} - \Omega^u_{t+1,s})$$

(3.12)

Using (3.12) and the definition of aggregate human capital, the summation on the right hand side of (3.11) can be shown to be $(1+r)(H^u_{t+1} - \Omega^u_{t+1})$.

Hence aggregate human wealth of the unconstrained group accumulates according to

$$[1-\beta(1-p)/(1+g)]H^u_t$$

$$= [(1-p)/(1+g)]H^u_t = (1+r)(H^u_{t+1} - \Omega^u_{t+1}) + \varepsilon_t$$

$$\varepsilon_t \sim iid(O, s^2_\varepsilon)$$

(3.13)

$\varepsilon_t$ represents the revisions in the expectation of human wealth that are made in period $t$.

Under the assumption that expectations are rational, it is orthogonal to the set of information available to the household at $t-1$ and is serially uncorrelated. Aggregate human wealth of unconstrained consumers may be expressed as

$$H^u_t = \sum_{t=0}^{\infty} \left( \frac{1-p}{(1+r)(1+g)} \right)^t \Omega^u_t + \varepsilon_t$$

The presence of the growth rate of population in the expression for aggregate human wealth is indicative of the fact that the future expected labour income of those yet to join the unconstrained group (by birth or by transfer) is not owned by current households.

Aggregate future labour income is discounted by the real rate of interest augmented by the probability of survival and the rate of growth of population.

$V_t$, total non-human wealth, is defined as the sum of physical and financial wealth. Ignoring consumer durables physical wealth is assumed to be the total private capital stock $K_t$. Financial wealth is assumed to consist of $D_t$, the government debt held by households. Since households constitute the private sector and own all the private
capital stock, the sector as a whole does not have any other financial assets or liabilities in a closed economy apart from public debt. Individual household financial assets and liabilities in the private sector will balance out. We thus assume that the only financial wealth of the household sector as a whole is government debt. Thus

\[ V_t = D_t + K_t. \]

If \( V_t \) is the sum of capital stock and financial assets in period \( t \), we assume that the return earned on it is equal to \( r \). If the net rate of return on capital stock was different from that on government debt then households would sell government debt and buy physical capital, assuming that no risks are involved in either. In equilibrium, therefore, the marginal rate of transformation which is the net return on capital is equal to the real risk free rate of interest.

Aggregating financial and physical wealth, the first term in the summation \( \sum_{t+1}^{t+n} V_{t+1} = 0 \) because the newly born consumers born in period \([t, t+1]\) inherit no financial or physical wealth which can only start accumulating from \( t+1 \) onwards. Hence, corresponding to (3.13) we have

\[ \begin{align*}
V_t &= (1+r) V_{t-1} + \Omega^u_t - C^u_t \\
&= (1+r) V_{t-1} + \Omega^u_t - C^u_t \\
\end{align*} \]

where \( V_t \) is non-human wealth at the end of period \( t \).

The aggregate consumption function of unconstrained consumers is now

\[ C^u_t = \mu((1+r) V_{t-1} + H_t) + u_t; \ u_t \sim iid (0, \sigma^2_u) \]

where the random error term \( u_t \) has been added to capture shocks to the consumer's utility function. (3.13), (3.14) and (3.15) present our model of aggregate consumption of unconstrained consumers.

The aggregate consumption function may be summarised as follows:
\[ C_t = C_t^c + C_t^u \]
\[ C_t^c = (1 - \lambda)\Omega_t \]
\[ C_t^u = \mu((1+r)V_{t+1}^u + H_t^u) + \omega_t; \ u_t \sim iid (0, \sigma_u^2) \]
\[ V_t = (1+r)V_{t+1} + \Omega_t^u - C_t^u \]
\[ H_t^u = [(1+r)\ (1+g)/(1-p)](H_{t+1}^u - \Omega_{t+1}^u) + \epsilon_t; \ \epsilon_t \sim iid (0, \sigma^2) \]

where

- \( C_t \) = Aggregate consumption
- \( C_t^c \) = Consumption of constrained consumers
- \( C_t^u \) = Consumption of unconstrained consumers
- \( \Omega_t \) = post tax labour income
- \( \Omega_t^u \) = post tax labour income of unconstrained consumers
- \( V_t \) = Non human wealth
- \( H_t^u \) = Human wealth of unconstrained consumers
- \( \lambda \) = proportion of total post tax labour income received by unconstrained consumers
- \( p \) = constant instantaneous probability of death
- \( r \) = the risk free rate of interest
- \( g \) = rate of growth of population of unconstrained consumers
- \( \mu \) = marginal propensity to consume out of lifetime wealth
- \( (\mu = \frac{p + \delta}{1 + \delta}) \) where \( \delta \) = rate of time preference
Chapter 4

Estimation and Results

In this chapter we estimate for India the aggregate consumption function defined in the previous chapter. We discuss the difficulties encountered in estimation and present our methodology and results.

4.1. Eliminating Human and Non-human Wealth

Aggregate consumption is expressed as a function of human and non-human wealth and this creates difficulties for estimation. Human wealth $H_t$ cannot be observed. There are two standard ways of dealing with this problem. The first method proposed by Hansen and Sargent (1980), seeks to obtain a closed form expression for $H_t$ in terms of observable variables. They assume that labour income is a part of an $n$-variate autoregressive process and derive an explicit formula for $H_t$ which is linear in the current and lagged values of the $n$ variables and non-linear in the discount term and the coefficients in the autoregression. Estimates of parameters are obtained by estimating the consumption function and the $n$-variate autoregressive process jointly by maximum likelihood. To make the number of parameters finite, it is necessary to assume that the order of autoregression is finite and known a priori. The second method which we adopt follows Hayashi (1982) who avoids an explicit treatment of human wealth by eliminating human wealth from the function.

Non-human wealth is held by households in many forms apart from financial assets. These may be gold, houses etc. accurate measures for which are not easy as not only does their value fluctuate but they are also not always declared by households as part of their wealth. We can avoid this problem by eliminating non-human wealth from the equation. To
eliminate human and non-human wealth from the consumption function of unconstrained consumers let us define \( \alpha = (1+r)(1+g)/(1-p) \); \( R = 1+r \). The lag operator is defined such that \( LX_t = X_{t-1}; \ L^2 X_t = X_{t-2} \) and so on for any variable \( X \).

Ignoring the superscript \( u \) for unconstrained consumers for the time being, and rewriting the equations using the lag operator and rearranging,

\[
C_t = \mu [H_t + RLV_t] + u_t \quad (4.1)
\]

\[
[1-\alpha L] H_t = -\alpha L \Omega_t + \varepsilon_t \quad (4.2)
\]

\[
RLV_t = \Omega_t - C_t - V_t \quad (4.3)
\]

We multiply (4.3) by \( [1-\alpha L] \) and subtract the resulting equation from (4.2). Substituting the expression \( (C_t - u_t)/\varepsilon_t \) from (4.1) for \( H_t + RLV_t \) we express the consumption function as

\[
[1-\alpha L] (C_t - u_t)/\mu = [1-\alpha L] (C_t - V_t) - \Omega_t + \varepsilon_t \quad (4.4)
\]

The above expression does not contain the unobservable term human wealth and can be simplified and estimated along with (3.14) as a system of equations similar to the one in Hayashi (1982). However, the system of equations contains the variable non-human wealth, an accurate measure of which does not exist for India. Rearranging (4.2) gives us

\[
V_t = [\Omega_t - C_t]/[1-RL]
\]

Substituting in (4.4) we arrive at

\[
[1-\alpha L] (C_t - u_t)/\mu = ([1-\alpha L]/[1-RL]) [\Omega_t - C_t] - \Omega_t + [1-\alpha L] C_t + \varepsilon_t
\]

We have now eliminated human and non-human wealth from the consumption function of unconstrained consumers. This expression is equivalent to
\[ C_t = (1 + r) \left( \frac{1 + g}{1 - p} + \frac{1 - p}{1 + \delta} \right) C_{t-1} - (1 + r)^2 \frac{1 + g}{1 + \delta} C_{t-2} - \]

\[ - (1 + r) \left( \frac{p + \delta}{1 + \delta} \right) \left( \frac{p + g}{1 - p} \right) \Omega_{t-1} \]

\[ - (1 + r) \left( \frac{p + \delta}{1 + \delta} \right) \epsilon_{t-1} + \left( \frac{p + \delta}{1 + \delta} \right) \epsilon_t \]

\[ + (1 + r)^2 \frac{1 + g}{1 - p} \rho_{t-2} - (1 + r) \left( \frac{1 + g}{1 - p} \right) \mu_{t-1} + \mu_t \]

(4.5)

The above defines the consumption function of unconstrained consumers.

From (3.1) and (3.2) we have

\[ C_{t} = C_t - (1 - \lambda ) \Omega_t \]

(4.6)

Lagging (4.6) and substituting for \( \Omega_{t}, C_{t-1} \) and \( C_{t-2} \) in (4.5) we get

\[ C_t = (1 + r) \left[ \frac{1 + g}{1 - p} + \frac{1 - p}{1 + \delta} \right] C_{t-1} - (1 + r)^2 \frac{1 + g}{1 + \delta} C_{t-2} - \]

\[ + (1 - \lambda ) \Omega_t - (1 + r) \left[ \frac{1 + g}{1 - p} + \frac{1 - p}{1 + \delta} \right] \left( 1 + \frac{1 + g}{1 + \delta} \right) \lambda \Omega_{t-1} \]

\[ + \left( 1 - \lambda \right) (1 + r)^2 \frac{1 + g}{1 + \delta} \Omega_{t-2} + \rho_t \]

where \( \rho_t = -(1 + r) \left( \frac{p + \delta}{1 + \delta} \right) \epsilon_{t-1} + \left( \frac{p + \delta}{1 + \delta} \right) \epsilon_t \]

\[ + (1 + r)^2 \frac{1 + g}{1 - p} \rho_{t-2} - (1 + r) \left( \frac{1 + g}{1 - p} \right) \mu_{t-1} + \mu_t \]

(4.7)

The above defines the aggregate consumption function in terms of lagged values of consumption and current and lagged values of post tax labour income. Both variables are observable and data can be obtained for them, so it is possible to estimate this equation. But before we do so, we look at some of its properties.

4.2. Non-Linearity

A preliminary examination of the above equation suggests that it may be rewritten as
\[ C_t = \alpha_1 C_{t-1} + \alpha_2 C_{t-2} + \alpha_3 \Omega_t + \alpha_4 \Omega_{t-1} + \alpha_5 \Omega_{t-2} + \rho_t \]

where

\[
\begin{align*}
\alpha_1 &= (1 + r) \left[ \frac{1 + g}{1 - p} \right] \\
\alpha_2 &= -(1 + r)^2 \frac{1 + g}{1 + \delta} \\
\alpha_3 &= (1 - \lambda) \\
\alpha_4 &= -(1 + r) \left[ \frac{1 + g}{1 - p} \right] \left( 1 + \frac{1 + g}{1 + \delta} \right) \\
\alpha_5 &= (1 - \lambda)(1 + r)^2 \frac{1 + g}{1 + \delta}
\end{align*}
\]

Therefore, \( \alpha_5 = -\alpha_2 \alpha_3 \) and \( \rho_t \) is the error term.

The model is then of the form of an autoregressive distributed lag model with two lags of income and consumption and a moving average error term. However, if the model is estimated as a linear model we fail to take into account the non-linear restriction that \( \alpha_5 = -\alpha_2 \alpha_3 \).

If the five parameters \( \alpha_1, ..., \alpha_5 \) could be written as five one-to-one functions of the set of five underlying parameters \( r, g, \delta, \lambda \) and \( p \) then the model could have been defined as being intrinsically linear. However, here due to the non-linear restriction \( \alpha_5 = -\alpha_2 \alpha_3 \) the 'one-to-one' or identification condition is not met. If we were to estimate (4.8) by Non-Linear Least Squares method and solve the resulting 4 independent equations for the 5 underlying parameters \( r, g, p, \delta \) and \( \lambda \), there would be no unique solution.

**4.3. Properties of the disturbance term**

We have defined the disturbance term as

\[
\begin{align*}
\rho_t &= -(1 + r) \left( \frac{p + \delta}{1 + \delta} \right) \varepsilon_{t-1} + \left( \frac{p + \delta}{1 + \delta} \right) \varepsilon_t \\
&\quad + (1 + r)^2 \frac{1 + g}{1 - p} u_{t-1} + (1 + r) \left( \frac{1 + g}{1 - p} \right) u_{t-2} + u_t
\end{align*}
\]

where \( u_t \sim \text{iid}(0, \sigma_u^2) \) independent of \( \varepsilon_t \sim \text{iid}(0, \sigma_e^2) \).
\( \rho_t \) is thus a sum of two moving average processes, an MA(1) and an MA(2) process. Both \( u_t \) and \( \varepsilon_t \) are identically and independently distributed with mean zero and constant variance. They are uncorrelated with each other at all leads and lags.

Since the above error term is fairly non-standard we analyse it in some detail. We derive it’s variance and autocovariance and define the variance-covariance matrix. Let us simplify it by redefining \( \rho_t \) as

\[
\rho_t = u_t + \theta_1 u_{t-1} + \theta_2 u_{t-2} + \varepsilon_t + \lambda \varepsilon_{t-1}
\]

where \( \varepsilon_t = \frac{p+\delta}{1+\delta} \varepsilon_t \)

\[
\theta_1 = -(1+r) \left( \frac{1+\frac{1+g}{1-p}}{l-p} \right)
\]

\[
\theta_2 = (1+r)^2 \frac{1+g}{1-p}
\]

\[
\lambda = -(1+r)
\]

Since \( \varepsilon_t \sim iid(0, \sigma^2) \), we have \( \varepsilon_t \sim iid(0, \sigma^2) \) where \( \sigma^2 = \text{Var}(\varepsilon_t) = \frac{(p+\delta)^2}{1+\delta} \sigma^2 \).

Since the \( u_t \)'s and \( \varepsilon_t \)'s are uncorrelated with each other at all leads and lags and are white noise processes it can be shown that

\[
E(u_t u_j) = E(\varepsilon_t \varepsilon_j) = 0, \quad \text{if} \quad j
\]

\[
E(u_t u_t) = \sigma_u^2, \quad E(\varepsilon_t \varepsilon_t) = \sigma^2
\]

\[
E(u_t \varepsilon_t) = 0 \quad \text{for all} \quad j.
\]

Using the above results we can derive the mean and variance of \( \rho_t \) as

\[
E(\rho_t) = 0
\]

\[
\text{Var}(\rho_t) = (1+\theta_1^2+\theta_2^2)\sigma_u^2 + (1+\lambda^2)\sigma^2
\]

\[
= \sigma_u^2 \left[ (1+\theta_1^2+\theta_2^2) + (1+\lambda^2)\frac{\sigma^2}{\sigma_u^2} \right]
\]

\[
= \sigma_u^2 \gamma_0, \quad \text{say}
\]

The first autocovariance of \( \rho_t \) is
The second autocovariance is
\[ E(\rho_t \rho_{t-2}) = \sigma_u^2 [\theta_1(1+\theta_2) + \lambda \sigma_e^2/\sigma_u^2] \]
\[ = \sigma_u^2 \gamma_2, \text{ say} \]

The variance-covariance matrix of the error term may be written as
\[
\begin{pmatrix}
\gamma_0 & \gamma_1 & \gamma_2 & 0 & 0 & 0 & 0 \\
\gamma_1 & \gamma_0 & \gamma_1 & \gamma_2 & 0 & 0 & 0 \\
\gamma_2 & \gamma_1 & \gamma_0 & \gamma_1 & \gamma_2 & 0 & 0 \\
0 & \gamma_2 & \gamma_1 & \gamma_0 & \gamma_1 & \gamma_2 & 0 \\
0 & 0 & \gamma_2 & \gamma_1 & \gamma_0 & \gamma_1 & 0 \\
0 & 0 & 0 & \gamma_2 & \gamma_1 & \gamma_0 & \gamma_1 \\
0 & 0 & 0 & 0 & \gamma_2 & \gamma_1 & \gamma_0 & \gamma_1 \\
\end{pmatrix}
\]

where \( T \) is the number of observations.

\[ \Sigma = \text{V}(\rho_t) = \sigma_u^2 \gamma 
\]

Substituting for the expressions for \( \theta \)'s and \( \lambda \), we have
\[
\gamma_0 = 1 + (1 + r)^2 \left( 1 + \frac{1 + g}{1 - p} \right)^2 + (1 + r)^4 \left( \frac{1 + g}{1 - p} \right)^2 + \left( 1 + (1 + r)^2 \right) \frac{\sigma_n^2}{\sigma_u^2} \]

\[
\gamma_1 = -(1 + r) \left( 1 + \frac{1 + g}{1 - p} \right) \left[ 1 + (1 + r)^2 \left( \frac{1 + g}{1 - p} \right) \right] - (1 + r) \frac{\sigma_e^2}{\sigma_u^2} \]

\[
\gamma_2 = (1 + r)^2 \frac{1 + g}{1 - p} \]

The error term is thus a moving average process of order two.

4.4. Generalised Method of Moments

In a single equation dynamic model with serially correlated disturbances, a lagged endogenous variable on the right hand side acts as a source of inconsistency for OLS or NLS estimators. If lagged values of consumption are not independent of the error term \( \rho_t \), they do not satisfy the conditions for pre-determinedness. From the definition of the revision of expectations of human wealth we can see that labour income will be correlated with \( e_t \), which is included in \( \rho_t \). The error term is thus correlated with the regressors.

In the classical linear regression model

\[ y_t = x_t \beta + u_t \]

for \( x_t \) a \((k \times 1)\) vector of explanatory variables. The value of \( \beta, \beta_0 \) is assumed to satisfy the condition

\[ E(x_t u_t) = 0 \]

The consumption function we want to estimate contains lagged values of consumption and current and lagged values of the post tax labour income. It can easily be shown that \( \text{Cov}[C_{t+1}, \rho_t] \neq 0 \) and \( \text{Cov}[C_{t+2}, \rho_t] \neq 0 \). Further, since the error term contains \( e_t \), the revision in the expectation of human wealth, we would expect the disturbance term to be correlated with current income as well. If current labour income changes, households...
may revise their expectations of future labour income. Since the disturbance term $\rho_t$ contains $e_t$ and $e_{t-1}$, income and its first lag are correlated with $\rho_t$.

Thus $x_t$, which in our case is a $(5 \times 1)$ vector of the explanatory variables that include lagged values of consumption and income, is not orthogonal to the error term. Or, $E(x_t \rho_t) \neq 0$. Suppose there exist a set of $r$ variables that are uncorrelated with $\rho_t$, but correlated with $x_t$. If $z_t$ is an $(r \times 1)$ vector of such explanatory variables then $E(z_t \rho_t)=0$ are the $r$ orthogonality conditions.

If we define $\beta$ as an $(a \times 1)$ vector of parameters we can define consumption as the function $h(x_t, \beta)$.

In our case defining $\beta$ as a $(5 \times 1)$ vector of $r, p, g, \delta$ and $\lambda$ we have

$$h(x_t, \beta) = (1 + r) \left[ \frac{1 + g}{1 - p} + \frac{1 - p}{1 + \delta} \right] c_{t-1} - \left(1 + r\right) \left[ \frac{1 + g}{1 + \delta} \right] c_{t-2} - (1 - \lambda) \lambda O_t - (1 + r) \left[ \left( \frac{1 + g}{1 - p} + \frac{1 - p}{1 + \delta} \right) - (1 + \frac{1 + g}{1 + \delta}) \right] O_{t-1} + \left[ (1 - \lambda)(1 + r)^2 \frac{1 + g}{1 + \delta} \right] O_{t-2}$$

so that $\rho_t = C_t - h(x_t, \beta)$

If $\beta_0$ denotes the true value of $\beta$ then the population orthogonality conditions are

$E(z_t (C_t - h(x_t, \beta_0))) = 0$

If the number of observations in the sample are $T$, the corresponding sample average is

$$g(\beta) = \frac{1}{T} \sum_{t=1}^{T} (z_t (C_t - h(x_t, \beta)))$$

Identification requires an order condition ($r > a$) and the rank condition that the columns of the plim of $D'_t$ be linearly independent where
\[
\hat{D}_r = \left. \frac{\partial g(\beta)}{\partial \beta'} \right|_{\beta = \hat{\beta}_r}
\]

(Hamilton (1995), p.422). A solution exists only if there are as many orthogonality conditions as there are co-ordinates in the parameter vector to be estimated. The attempt is to make the above sample version of the population orthogonality conditions as close as possible to zero. This is done by choosing a weighing matrix which selects the particular linear combination of orthogonality conditions that are to be used in estimation.

It is required that the number of linear combinations of the sample orthogonality conditions are equal to the number of parameters to be estimated. A model is over-identified when the number of orthogonality conditions exceeds the number of parameters to be estimated or \( r > a \). In this case more orthogonality conditions are used than are needed to estimate the parameters. Hansen (1982) suggested a test of whether all sample moments represented by \( g(\beta) \) are as close to zero as would be expected if the corresponding population moments \( E(z_t(C_t-h(x_t,\beta))) \) were truly zero. If the true population moments are zero this gives us the test of over-identifying restrictions. If the sample moments that we obtain, using a linear combination of the instruments, is significantly different from zero, then our sample average does not represent the true population moments. \( T Q \), where \( T \) is the number of observations and \( Q \) is the criterion function as defined below, has a \( \chi^2 \) distribution with \((r-a)\) degrees of freedom. If \( T Q \) is not significantly different from zero then we cannot reject the hypothesis that the sample moments are as close to zero as would be expected if the corresponding population moments were truly zero. The model is then said to be over-identified in the set of instruments.

Hansen (1982) showed that the minimum asymptotic variance of the estimator \( \hat{\beta} \) was obtained when \( \beta \) was chosen to minimise
\[ Q = g(\hat{\beta})W^{-1}g(\hat{\beta}) \]

where

\[ W = \frac{1}{T^2} \sum_i \sum_j \text{Cov}[z_i \rho_i, z_j \rho_j] \]

\[ = \frac{1}{T^2} Z' \Sigma Z \]

where \( Z \) is an \((r \times T)\) matrix of the \( T \) observations of each of the \( r \) instruments. \( \Sigma \) is the variance-covariance matrix of the error term.

\( \hat{\beta} \) that is chosen to minimise the criterion function

\[ Q = g(\hat{\beta})\left[ \frac{1}{T^2} Z' \Sigma Z \right]^{-1} g(\hat{\beta}) \]

is known as the Generalised Method of Moments estimator and is both consistent and asymptotically efficient.

An estimate of \( Z' \Sigma Z \) can be obtained by the Newey-West (1987) estimator as \( \hat{S}_T \) where

\[ \hat{S}_T = \hat{S}_{0,T} + \sum_{v=1}^{q} \{1 - [v / (q + 1)]\} (\hat{S}_{v,T} + \hat{S'}_{v,T}) \]

where

\[ \hat{S}_{v,T} = \frac{1}{T} \sum_{t=v+1}^{T} \left( z_t (c_t - h(x_t, \hat{\beta})) \right) \left( z_{t-v} (c_{t-v} - h(x_{t-v}, \hat{\beta})) \right) \]

where \( \hat{\beta} \) is a consistent estimator of \( \beta_0 \). \( q \) is the maximum lag length. Since we have shown that \( \rho_\tau \), a sum of an MA(1) and an MA(2) process, is an MA(2) error process we set \( q \) to 2.

To summarize, the estimation procedure we adopt is Hansen’s (1982) Generalised Method of Moments. A set of instruments with at least as many instruments as the number of parameters to be estimated is chosen. An estimate of the variance-covariance matrix of
the error term is obtained by the Newey-West (1987) procedure. The moving average process is specified to be of order two. If the system is overidentified in the set of instruments as shown by Hansen's (1982) test of overidentifying restrictions then the sample moments are expected to represent the true population moments. Estimated parameters can be shown to be both consistent and asymptotically efficient.

4.5. Approaches to Estimation

It is pertinent at this stage to look at some of the existing studies to examine how they have approached the estimation of a similar consumption function. As far as I know, g, the measure of population growth and income distribution has not been explicitly estimated in any empirical work. Some other studies have estimated the consumption function under the assumption that p, the probability of death and/or 1-λ, the proportion of liquidity constrained consumers are zero.

Hayashi (1982) estimates the model for the US assuming infinite horizons. Non-human wealth is not deleted and the model is estimated as a two equation system comprising of the consumption function and the dynamics of non-human wealth. To begin with, he disregards the moving average process in the error term and estimates the system by NLIV intending to use GMM if the residuals indicate the presence of serial correlation. He, however, finds no indication of significant autocorrelation and hence does not have to correct for it.

Leiderman and Razin (1988) test for the Ricardian restriction that p=0, λ=1 for monthly data for Israel. The evolution of gross income and taxes is assumed to be governed by an autoregressive process of order one. The system is estimated by a non-linear least squares procedure. The rate of interest is imposed. Though the authors mention that some parameter estimates seem to be different from what is commonly accepted, the problem is
not dealt with. However, it is indicative of potentially severe misspecification. The estimates are beyond the feasible limits and do not satisfy the inequality restrictions imposed by common sense. The proportion of unconstrained consumers is estimated to be 209 per cent of the total population. The rate of time preference is estimated to be negative. While the likelihood ratio statistic fails to reject the Ricardian hypothesis these results are obtained in a potentially misspecified model. Estimates could be biased as a consequence of correlation between the error term and the regressors or the presence of serial correlation.

Haque (1988) estimates the model for 16 developing countries assuming the absence of liquidity constraints. Both human and non-human wealth are eliminated from the function. His estimate rejects the hypothesis of finite horizons and thus supports the Ricardian model. This model was improved upon by Haque and Monteil (1989) who estimate it for a set of developing countries allowing for both liquidity constraints and finite horizons. The model is first estimated in linear form. It is reported that the signs of some of the coefficients were contrary to what was expected. For instance, they report that the sign of the estimated coefficient was at variance with theory most frequently for $\alpha$. The equation is then estimated using NLIV to extract estimates of the underlying parameters. Values of $1+r$ are imposed ranging from 1.01 to 1.10 (with increments of 0.01), choosing the value that minimised the weighted sum of squared residuals. On the basis of the above tests it is concluded that the Ricardian hypothesis can be rejected for 15 of 16 countries for which the model has been estimated but due only to the effect of liquidity constraints and not finite horizons. The authors report that they uncover no evidence that households exhibit short time horizons.

Darby and Ireland (1994) and the ESRC Macromodelling Bureau (1993) (to re-estimate the Weale (1990) model) employ the Generalized Method of Moments for
estimating a consumption function for the UK. The system of equations consists of regressors that are correlated with the error term and there is a moving average process in the error term. However, non-human wealth is included as a regressor. In our case, we eliminate wealth from the consumption function.

4.6. Data

All variables were measured in real terms. Gross Domestic Product was used as a proxy for labour income as there are no accurate series available for labour's share of income. The only accurate series on wages and salaries are for those employed in the organised sector who are about 8 per cent of the labour force. In other words, accurate series for more than 90 per cent of the work force are not available. Since labour income is correlated with the revision in expectations in both the current and the following periods, which is a component of the error term, income and its one period lag are correlated with the error term and cannot be used as instruments. We use the second and third lag of income as instruments. Other instruments used were private and public investment, exports, imports, taxes, government consumption spending and fiscal deficit lagged by two time periods.

A measure of aggregate consumption was used instead of aggregate non-durable consumption. This is not strictly correct because at any point in time consumption might arise without any act of consumer spending when, for example, a previously purchased consumer durable good is used. Also, consumer expenditure at time t would not correspond to consumption in time t when the expenditure includes the purchase of consumer durable goods. Ideally one should add a flow of services from previously purchased consumer durables to current consumer expenditure and subtract current expenditures on durable goods to obtain a correct measure of consumption. In an empirical
analysis of consumption, the measure of consumption should consist of consumer expenditures on non-durables and services and an imputed flow from the stock of consumer durables.

Since data for durable consumption was not available no adjustment could be made. This might introduce some inaccuracy in our results, especially since the consumption of consumer durables in India has been rising. While total consumption shows an increase, current consumption does not increase as much if the increase is due to an increase in the purchase of consumer durables. If a consumer spends his current income partly on a consumer durable then he has not 'consumed' his entire income as the good gives him a flow of services in the future. If no adjustment is made in the data he may, for example, appear to be constrained when he would not be if consumption was measured accurately.

The source of this data was various issues of the annual Economic Survey published by the Government of India and the Yearbook of International Financial Statistics published by the International Monetary Fund. The full data set was available for the period 1951 to 1989. With two lags our sample period became 1953 to 1989.

4.7. Restrictions

The probability of death, p is assumed to be positive in the finite horizon case and zero in the infinite horizon case. Thus p is non-negative. We would expect the probability of death to lie between zero and one. Or, $0 \leq p \leq 1$.

The real rate of return on physical and financial capital, r, is equal to the marginal rate of product transformation in the economy in the long run. This is again non-negative. $1 + g$, can be assumed to be non-negative as long as population grows at a rate higher than
-100 percent. If all labour income was earned by constrained consumers $\lambda$ would be equal to zero. And if there were no constrained consumers in the economy at all, $\lambda$ would be equal to one. We would thus expect $0 \leq \lambda \leq 1$. We assume that the rate of time preference is non-negative or, $\delta > 0$. There is either some impatience or none but it cannot be that consuming tomorrow is preferred to consuming today.

We choose a sample period over which the underlying parameters were expected to be relatively stable since we are assuming that the value of the parameters we are estimating does not change over time. This assumption implies, for instance, that even if income distribution is changing and $g$ is different from the rate of growth of the population, $\lambda$ the proportion of income received by the proportion of unconstrained consumers does not change significantly over this period. Unless the parameters could be estimated as time-varying, the model would be valid only for short time periods over which our assumption of the constancy of parameters is approximately true. We, therefore, need to choose a sample period which we believe would approximate these conditions better than any other.

The 1950's was the decade immediately after independence and saw a rapid transformation of the Indian economy. The 1980's witnessed substantial external borrowing and balance of payment deficits. In terms of government policies the beginning of the sixties to the end of the seventies was a relatively stable period as it did not see major changes.

4.8. Estimation and Results

The model cannot be estimated as defined by (4.7) because the rank condition for identification is clearly not satisfied. We therefore impose the value of $p$ as a restriction. Assuming that the average planning horizons is 50 years the value of $p$ is imposed at 0.02. The results obtained are presented below.
Estimate of (4.7) with the restriction $p = 0.02$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1+r$</td>
<td>1.14163</td>
<td>1.14768</td>
</tr>
<tr>
<td>$1+g$</td>
<td>0.933232</td>
<td>1045.47</td>
</tr>
<tr>
<td>$1/1+\delta$</td>
<td>0.969000</td>
<td>1083.99</td>
</tr>
<tr>
<td>$\lambda$</td>
<td>0.696562</td>
<td>100177</td>
</tr>
</tbody>
</table>

$R$-squared = .822669 \quad \text{Durbin-Watson statistic} = 2.55465

The rank condition still appears to be unsatisfied since the condition number (the ratio of the maximum to the minimum eigenvalue) of the correlation matrix of the parameter estimates is very high. The model may therefore still not identified. Restricting the model further by imposing a value of 0.7 for the proportion of income received by unconstrained consumers, we obtain the following results.

Estimate of (4.7) with the restriction $p = 0.02; \ \lambda=0.7$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1+r$</td>
<td>1.14163</td>
<td>1.11733</td>
</tr>
<tr>
<td>$1+g$</td>
<td>0.933232</td>
<td>1045.47</td>
</tr>
<tr>
<td>$1/1+\delta$</td>
<td>0.969000</td>
<td>1080.20</td>
</tr>
</tbody>
</table>

However, again the rank condition still appears to be unsatisfied by the same criterion. We impose the values of $r$ and $\delta$ to achieve identification. $r$, the real rate of return on physical and financial capital may be understood to be the marginal rate of product transformation since it is the return on capital. Rates of return of around 15 per cent are reported by the World Bank. At 3.2 per cent the value of $\delta$, the subjective rate of time preference of the unconstrained consumer, satisfies the non-negativity constraint imposed
by the assumption of rationality. If we impose \( r \) at 14.16 percent as above and the rate of
time preference at 3.2 per cent we obtain the following results:

**Table 4.1: An estimate of the rate of growth of population of unconstrained consumers**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Error</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1+g</td>
<td>0.884747</td>
<td>0.059429</td>
<td>14.8875</td>
</tr>
</tbody>
</table>

R-squared = 0.830332, Durbin-Watson statistic = 2.56419

\( Q = 0.265764 \), \( TQ = 5.57 (\chi^2 = 19.0 \text{ at } 5\% \text{ significance level}) \)

The data is trending and given the small sample size it is difficult to reject the
hypothesis that it is trend stationary in which case the t-statistics can still be assumed
to be valid. Andrews and McDermott (1995) provide a justification for the use of
standard asymptotic approximations in models with deterministically trending
variables. The asymptotic distribution of generalised method of moment estimators and
corresponding test statistics of deterministically trending variables are shown to be
normal and chi-square respectively, the same as with non-trending variables.

Our results may be summarised as follows:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( r )</td>
<td>0.14</td>
</tr>
<tr>
<td>( p )</td>
<td>0.02</td>
</tr>
<tr>
<td>( g )</td>
<td>-0.12</td>
</tr>
<tr>
<td>( \delta )</td>
<td>0.032</td>
</tr>
<tr>
<td>( \lambda )</td>
<td>0.7</td>
</tr>
</tbody>
</table>
\( \lambda \), the proportion of post tax labour income received by the group of unconstrained consumers is assumed to be 70 per cent. Though the 'constrained' group is not observable, it would not be unreasonable to suggest that the officially classified 'poor' who live below the poverty line and constituted nearly 50 per cent of the population in 1977-78, might be included in this group. This group receives nearly 18 per cent of household income. Further, nearly 70 per cent of the households who have an annual income below the national average receive about 35 per cent of total household income. We would consequently expect that the constrained group would constitute around 50 to 70 per cent of the total population and receive between 18 to 35 per cent of household income. A value of 0.7 of \( \lambda \) suggests that \( 1 - \lambda \) is 0.3 or the group of constrained consumers receives 30 per cent of labour income. Since labour income constitutes the major component of household income, the figure seems reasonable.

An interesting result which has emerged in this estimate is the value of \( g \) which is estimated to be -0.12. The negative value suggests a net transfer from the unconstrained to the constrained group. Since this is likely to be more country specific that the values of the other parameters, we need to look towards changes taking place in the Indian economy over that period to see if the evidence supports our results.

4.9. Supporting Evidence

A developing economy undergoing structural change, as it witnesses growth, is likely to find some sectors growing and others, like agriculture, declining. Within each sector as well, those in a position to adapt to the changing environment are able to maintain or improve their living standards, while others become worse off. As India witnessed
economic growth led by a capital intensive manufacturing sector, the share of agriculture in GDP fell faster than the share of the population dependent on it.

Table 4.2 Share of Agriculture in National Income

<table>
<thead>
<tr>
<th>Year</th>
<th>Share of Agriculture and Allied Activity in National Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-51</td>
<td>54.04</td>
</tr>
<tr>
<td>1960-61</td>
<td>56.05</td>
</tr>
<tr>
<td>1970-71</td>
<td>49.19</td>
</tr>
<tr>
<td>1975-76</td>
<td>46.76</td>
</tr>
<tr>
<td>1984-85</td>
<td>37.91</td>
</tr>
</tbody>
</table>


Table 4.3: Per Capita NDP in Agriculture

<table>
<thead>
<tr>
<th>Year</th>
<th>Per capita NDP in Agriculture 1970-71 prices (in Rs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1954-58</td>
<td>421.95</td>
</tr>
<tr>
<td>1958-67</td>
<td>401.91</td>
</tr>
<tr>
<td>1968-77</td>
<td>398.83</td>
</tr>
<tr>
<td>1976-83</td>
<td>415.61</td>
</tr>
</tbody>
</table>


The share of agriculture in employment has remained about 70 percent. As Table 4.3 shows, per capita NDP in agriculture fell. The effect of this decline was not evenly spread over the entire rural population as agriculture itself was undergoing both technical and institutional change. At the time of independence Indian agriculture was characterised
by subsistence farming, antiquated methods of production and land tenure systems. Land and labour productivity were miserably low. Agricultural holdings were small and uneconomical. The pattern of land tenure, where the cultivator often did not own the land, had to pay high rents and had no security of tenancy, failed to provide incentives for improvement. Techniques of production were old and inefficient. Use of both farm yard manure and chemical fertilisers was little. Seeds were often of poor quality. Less than 20 percent of the cultivated land was irrigated. 70 per cent of the population depended on agriculture and as the pressure on land grew, disguised unemployment increased. There was little scope for raising yields because of the lack of necessary infrastructure like modern inputs, irrigation, finance and marketing.

In the 1960s the government adopted a policy of promoting modern agricultural techniques. The Green Revolution was characterised by the availability of high yield variety and disease resistant seeds, fertilisers, pesticides, credit, marketing, storage facilities, agricultural machinery etc., in certain selected areas at first and then later provided to other areas. These modern techniques, however, required substantial investment and only a small minority of farmers were able to undertake such expenditure (Rudra (1969)).

The overwhelming majority of cultivators with small holdings were unable to reap the full benefits of modernisation. The cost of inputs rose faster than the price of output and there was a decline in their net income. (Swamy and Gulati (1986)). In cases where small farmers also leased in part of their holdings, rising rentals and the tendency of landowners to resume land for self cultivation due to the high profitability of modern techniques, there was an absolute deterioration in the economic condition of the small-owner-cum-tenant cultivator.
As demographic pressure increased and techniques of production changed, small and medium peasants experienced a deterioration in their economic condition. While some were able to cope with this adverse environment, there is evidence that a large proportion of them became very poor. A significant proportion of those who could be described as 'unconstrained' slipped below the poverty line thus becoming qualified for what we might call 'constrained'.

We assume that rural households belonging to the top four per capita income deciles who account for nearly 90 per cent of rural savings (NCAER (1980), p.27) can be called 'unconstrained'. In a longitudinal study where a very large sample of families identified in 1970-71 were followed through into 1981-82, it was found that there was significant evidence of large scale impoverishment of small and medium farmers. Table 4.4 indicates that there was a significant decline in the income of those rural households who were in the top four income deciles in 1970-71.

Table 4.4: Change in income distribution in Rural India 1970-80

<table>
<thead>
<tr>
<th>Per capita income decile (1970-71)</th>
<th>Mean level of income per earner (Rs. per annum 1980-81 prices)</th>
<th>Percentage change over 1970-80 (Follow through)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>4360.16</td>
<td>-15.50</td>
</tr>
<tr>
<td>8</td>
<td>4360.57</td>
<td>-4.80</td>
</tr>
<tr>
<td>9</td>
<td>6464.98</td>
<td>-21.01</td>
</tr>
<tr>
<td>10</td>
<td>12615.11</td>
<td>-46.07</td>
</tr>
</tbody>
</table>

Source: Change in household income, interclass mobility and income distribution in rural India - A longitudinal study, New Delhi, NCAER, 1986, Table 3.9.
On examining the evidence on household saving and income distribution we could identify at least one set of consumers who may be called constrained. This was the population officially identified 'poor'. The poverty line definition calls those people poor who cannot afford to meet a certain daily requirement of food and the associated level of non-food items. The Planning Commission estimated that in 1979-80 about 317 million persons (48.4 per cent of the total population) lived below the poverty line which was defined as the mid-point of the monthly per capita expenditure class having a daily calorie intake of 2,400 per person in rural areas and 2,100 in urban areas. At 1979-80 prices these mid-points were Rs. 76 in rural areas and Rs. 88 in urban areas. 50.7 per cent of the rural population and 40.3 per cent of the urban population was identified as poor (Planning Commission (1981)). Since these consumers accounted for hardly 5 per cent of household savings (NCAER (1980), p.27), they fit into our definition of constrained.

Though we would expect many of those earning more than this low level of income, to be constrained, we do not attempt to identify the entire group of constrained consumers. It would suffice to say that we assume that persons living below the poverty line form a subset of the set of constrained consumers.

If a group of persons who formally belonged to the set of unconstrained consumers, slipped below the poverty line we could say that they migrated from the unconstrained to the constrained group. This could be said for a significant proportion of small and medium peasants who become 'poor'. By 1981-82, a large proportion of the top four 1970-71 deciles were officially 'poor'.

Table 4.5: Changes in Poverty in Rural India, 1970-80

<table>
<thead>
<tr>
<th>Per capita income decile</th>
<th>Percentage below poverty line</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>27.09</td>
</tr>
<tr>
<td>7</td>
<td>0.00</td>
</tr>
<tr>
<td>8</td>
<td>0.00</td>
</tr>
<tr>
<td>9</td>
<td>0.00</td>
</tr>
<tr>
<td>10</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Source: Changes in poverty and consumption pattern in Rural India between 1970-71 and 1981-82 - A longitudinal analysis, NCAER, New Delhi, 1986, Table 2.1.

Let us now look at another subset of the group of unconstrained consumers. Organised sector workers are the richest class of workers whether in terms of per capita consumption or incidence of poverty. They form only 8 per cent of the work force. In the organised sector employment grew rapidly up to 1965-66 and has only kept pace with population thereafter. During this time, very impressive increases occurred in per worker incomes in the organised sector. Public sector workers more than doubled their real income between 1960-61 and 1984-85. The real incomes of private organised sector workers rose by more than 60 percent. In the unorganised sector, where workers employed are amongst the lowest paid, there was no trend increase at all in the income per worker either of those who were wage workers or those who worked in agriculture (Sen (1988)).

If we identify organised sector workers as a subset of the set of unconstrained workers, the above evidence suggests that the size of this group was not expanding faster
than population growth. Real incomes of those we may consider constrained who were employed in the unorganised sector were not rising and the ratio of their average incomes to organised sector workers fell from about a third in the sixties to a fifth in the eighties (Sen (1988)). There is no evidence of a net transfer to the 'unconstrained' group.

The ratio of Gross Domestic Savings to GDP increased from 6.8 percent in 1953-54 to 23.7 percent in 1990-91. Even over the period of estimation the savings ratio changed substantially. It increased from 11.9 percent in 1959-60 to 23.2 percent in 1978-79. This is in conformity with the hypothesis of a worsening income distribution.

The following decade of the eighties witnessed a surprisingly large build up of unsold food stocks in the Indian economy. This happened at a time when per capita NDP in agriculture remained stagnant and per capita food production for the population as a whole increased only marginally. The food surplus has been attributed to underconsumption of large sections of the rural population whose purchasing power was limited by declining income (Patnaik, 1987).

To summarise, our estimate suggests that a transfer has been taking place from the group of 'unconstrained' consumers to the group of 'constrained' consumers. The causes of this transfer can be located in the nature of India's development process - the pattern of industrial and agrarian growth. The growth of a capital intensive manufacturing sector has not created adequate employment and 70 per cent of India's population continues to depend on agriculture. Only about 8 per cent of the work force is employed in organised industry and this proportion has not risen since 1964-65. Modernisation of agriculture has been accompanied by large scale impoverishment of the mass of small peasants and about 40 per cent of the population still lives below the 'poverty line'. As India develops from a predominantly agrarian to a modern industrial nation, the traditional
peasant is the most likely to be displaced first. Unless other sectors grow sufficiently fast to absorb the labour force released by agriculture, the impoverishment of a large section of the population is likely to continue.
Chapter 5

Policy Evaluation in an Endogenous Growth Model

Recent developments in growth theory have shifted the focus of attention from the effects of fiscal policy on the levels of saving and consumption to those on growth. In traditional growth models the long-run rate of growth was determined by the rate of exogenous technical progress. Growth rates across economies with access to this technology were expected to converge. Failing to observe such convergence across the world, attempts have been made to explain the differences in long-run growth rates in terms of economic activity within each economy. In the new theory growth rates are determined by endogenous factors like the accumulation of knowledge and human capital (Romer (1986), Lucas (1988)), R&D (Romer (1990)), or public infrastructure (Barro (1990)). Output displays increasing or constant returns to these factor inputs in the aggregate production function because of the externalities involved.

As we have seen earlier, the representative agent Barro-Ricardian model with infinite horizons predicts debt neutrality. If government financing policy does not affect aggregate consumption and investment, it has no effect on growth in either exogenous or endogenous growth models given government spending and its composition. However, in an exogenous growth, overlapping generations model with Yaari-Blanchard-Weil consumers, financing policy affects the levels of consumption, saving and investment. The growth rate, being determined by the rate of technical progress that is exogenously given, is not affected.

In an endogenous growth overlapping generations model with Yaari-Blanchard-Weil consumers and distortionary taxes, financing policy affects both the level of
consumption, saving and investment and the rate of growth. In this chapter we shall adopt such a model of endogenous growth and analyse the effect of budgetary policy in India. The driving force behind economic growth is assumed to be a combination of R&D, learning by doing, human capital and public infrastructure.

5.1. Traditional Models of Growth

In the traditional model of growth the assumption of diminishing returns to capital in the production of output leads to a decreasing rate of return on investment and rate of growth of output. In the absence of technological change per capita, output converges to a steady state value with no per capita growth. Sustained economic growth is possible when technological progress takes place. It is assumed that this technological progress is a function of time and is exogenous to the production function. The production function which relates output to the stock of accumulated physical capital goods and labour displays decreasing returns with respect to each of these factors of production. Given the amount of labour employed, an increase in the stock of capital yields a less than proportionate increase in output. Technical change, however, can prevent this tendency towards a zero rate of profit. In its absence, capital and output would grow at the rate of growth of population such that the per capita growth rate is zero; but in the presence of labour augmenting technical change, capital and output can grow at the sum of the rate of growth of population and the labour augmenting technical progress. The long-run growth rate is thus imposed on the model and not determined by economic activity within it.
5.2. Endogenous Growth

Extending the work of Arrow (1962) and Uzawa (1965), Romer (1986) rekindled the debate on what determines long-run growth questioning models of exogenous growth and convergence. He proposed an alternative view for prospects of long term growth where per capita output can grow without bound and even at a monotonically increasing rate. With increases in the stock of capital, the rate of investment and the rate of return on capital may increase rather than decrease. This is essentially due to the departure from the assumption of diminishing returns that is made in traditional models (Ramsey (1928), Cass(1965), Koopmans (1965)). The model endogenises knowledge or technological progress that drives long-run growth. Investment produces knowledge. It is not merely the firm creating the knowledge that benefits; other producers benefit from it as well. Knowledge as an input has positive external effects on the production possibilities of other firms. In the aggregate production function for consumption goods, the stock of knowledge as an input exhibits increasing returns, so it will not be optimal to stop acquiring knowledge at any stage. This is in contrast to a situation where it is optimal at some stage not to use an additional unit of capital because its marginal product is diminishing. The production of knowledge is assumed to be subject to diminishing returns, doubling investment in research and development will not double the stock of knowledge. The assumption of diminishing returns in the production of knowledge is required to ensure that consumption does not grow too fast.

Romer's (1986) model departs essentially from earlier models in the assumption that knowledge is assumed to be an input with increasing or at least constant marginal product. Production of the consumption good is assumed to be
globally convex, not concave as a function of the stock of knowledge when all other inputs are held constant. Without upsetting the basic argument the definition of this input can include the know-how acquired through learning by doing, R&D, the accumulation of human capital through education, public infrastructure and other factors of production that have a public good character and exhibit externalities.

Barro (1990) defines the production function to include the input of public services which raise the productivity of private capital. The government invests in both the material infrastructure like public highways, railways, telecommunications and the immaterial infrastructure like education and training, and health. He incorporates a public sector into an endogenous growth model where he assumes constant rather than diminishing returns to a broad concept of capital which encompasses both human and non-human capital. The role of public services as an input to private production creates a potentially positive linkage between government and growth. In other words, Barro assumes that even with a broad concept of private capital that includes physical capital, human capital and aspects of privately owned knowledge, production displays decreasing returns to private inputs if complementary infrastructure does not expand in a parallel manner. Constant returns apply to this broad measure of reproducible capital as long as the public service input changes in the same proportion as private capital.

The effect of finite horizons is incorporated in an endogenous growth model by Alogoskoufis and van der Ploeg (1990) who show that fiscal policy is not neutral when the probability of death is positive. Alogoskoufis and van der Ploeg (1991) and Buiter (1991) include the effect of both finite horizons and population growth in a model of endogenous growth and reach similar conclusions. Tax distortions in the form of a flat
rate income tax is incorporated by Barro (1990) who does not include the above
Blanchard-Weil non-Ricardian effects but assumes externalities arising from the flow
of public services. Externalities arising from the stock of public capital have been
incorporated in Jappelli and Meana (1994). Our specification provides a generalisation
of the above models and incorporates the various mechanisms by which fiscal policy
can affect the long-run growth rate. In this model fiscal policy has both a supply side
and a demand side effect.

5.3. The Model

We develop an endogenous growth model which draws upon early chapters
capturing non-Ricardian Blanchard-Weil effects due to finite horizons and population
growth and includes tax distortions and externalities due to public capital stock as in
Krichel and Levine (1995) and Futagami, Morita and Shibata (1993). We also include
the effect of liquidity constraints on the demand function. The structure of property
rights is such that in equilibrium new generations are born with endowments whose
value rises at the endogenous rate of growth. This way they have a claim to some share
of the capital stock in existence when they are born as it is absorbed in their human
capital (Buiter (1991)). This is ensured in the model by allowing workers to
appropriate the returns created by an economy-wide production externality. In Barro
(1990) the externality arises from the flow of public services while we include the
effect of past government spending on education, health, infrastructure, etc. by
assuming that the externality arises from the stock of public capital. Behaviour of
consumers, producers and the government determine the output equilibrium
conditions.
We present a closed economy model driven by capital externalities arising from public and private capital. The closed economy assumption may not be strictly true for India today but considering the technical difficulties involved in an open economy endogenous growth model, we keep the analysis simple by assuming a closed economy. Further, since imports account for about 10 per cent of GDP and the current account deficit stands at 0.1 per cent of GDP, our results should not be significantly affected by this assumption.

5.3.1. Households

The aggregate consumption function is as defined in Chapter 3. We include distortionary taxes at the rate \( \tau \). Capital is assumed to earn a rate of return \( r_t \) in period \( t \) and depreciate at the rate \( \pi \). Defining the consumption of unconstrained consumers as a function of \( W^u_t \), the total wealth of unconstrained consumers at the beginning of period \( t \) and ignoring the error terms we have,

\[
C^u_t = \mu W^u_t \tag{5.1}
\]

\[
W^u_t = H^u_t + (1 + r_t(1 - \tau))V_{t-1} \tag{5.2}
\]

Human wealth in period \( t \) can be shown to be

\[
H^u_t = \frac{(1 + r_t(1 - \tau))(1 + g)}{1 - p} \left[ H^u_{t-1} - \Omega^u_{t-1} \right] \tag{5.3}
\]

Labour income earned by unconstrained consumers is
\[ \Omega_t = \lambda(Y_t - (\tau_t + \pi)K_t)(1 - \tau_t) \]  
(5.4)

Since aggregate consumption of unconstrained consumers depends on the value of lifetime wealth, the evolution of consumption depends on the evolution of wealth. We therefore turn to the evolution of aggregate wealth which is a combination of human and non-human wealth.

(3.14) may be redefined in the presence of distortionary taxes as

\[ V_t = (1 + \tau(1 - \tau))V_{t-1} + \Omega_t - C_t \]

Using the above, (5.1) and (5.2) we obtain

\[ W_t = \left( \frac{p + g}{1 + g} \right) H_t^u + \left[ 1 + \tau(1 - \tau) \right] \frac{1 - p}{1 + \delta} W_{t-1} \]  
(5.5)

The value of wealth in period \( t \) is expressed in terms of its value in period \( t-1 \) and in terms of human wealth in period \( t \). The evolution of aggregate wealth thus depends upon its composition. It reflects the asymmetry between human and non-human wealth. If the probability of death were zero and there was no population growth, we would have

\[ W_t^u = \left[ 1 + \tau(1 - \tau) \right] W_{t-1} \]  
(5.6)

The asymmetry thus disappears with the removal of uncertainty regarding the length of life and the evolution of wealth no longer depends on the magnitude of human wealth in the current period. It depends on its aggregate value rather than its composition.

From (5.1 and (5.5) it follows that

\[ C_t^u = \left( \frac{p + \delta}{1 + \delta} \right) \left( \frac{p + g}{1 + g} \right) H_t^u + \left[ 1 + \tau(1 - \tau) \right] \frac{1 - p}{1 + \delta} C_{t-1} \]  
(5.7)
If \( g = 0 \), \( p = 0 \), \( \tau = 0 \), and for a constant rate of interest, \( C_i^u = \frac{1 + r}{1 + \delta} C_{i-1}^u \) which corresponds to the Euler equation in the representative agent model with infinite horizons. In addition if there are no liquidity constraints then aggregate consumption \( C_t = \frac{1 + r}{1 + \delta} C_{t-1} \). This shows that non-Ricardian behaviour of aggregate consumption arises from four sources: finite horizons, population growth, distortionary taxes and liquidity constraints. Effect on growth on each of these sources will be explored later.

Using (5.1), (5.2) and (5.5) we have

\[
C_i^u = \left[1 + \delta (1 - \tau)\right]\frac{1 + g}{1 + \delta} C_{t-1}^u - \left(\frac{p + \delta}{1 + \delta}\right) \left(\frac{p + g}{1 - p}\right) \left[1 + \delta (1 - \tau)\right] V_{t-1} \tag{5.8}
\]

which describes the consumption behaviour of the unconstrained consumers in terms of lagged consumption and lagged non-human wealth. This may be referred to as the discrete time Yaari-Blanchard consumption function.

### 5.3.2. Private Sector Output and Investment.

The representative firm \( f \) produces homogeneous output with the following Cobb-Douglas constant returns to scale production function at time \( t \)

\[
Y_{t,f} = F(K_{t,f}, J_{t,f}) = K_{t,f}^\alpha J_{t,f}^{1-\alpha} \tag{5.9}
\]

where \( K_{t,f} \) is private physical capital and \( J_{t,f} \) is labour input in efficiency units. Or,

\[
J_{t,f} = \varepsilon_{t,f} L_{t,f} \tag{5.10}
\]

where \( \varepsilon_{t,f} \) is a measure of the efficiency of raw labour input \( L_t \). The crucial assumption that drives endogenous growth in this model is that this efficiency measure is a function of the economy-wide capital-labour ratio. Let \( K_t \) be aggregate private

---

1 For small \( r, g, p, \lambda \) and \( \delta \) this corresponds to the \( \dot{C} = (r - \delta)C - (p + g)(p + \delta)V \) in continuous time.
capital. In addition to the externality from private capital, the government affects labour efficiency by providing physical capital in the form of infrastructure which may be broadened to include education, health, etc., accumulated out of the economy's single output. This is captured by

\[ e_{t,r} = A_t \left( \frac{(K_i^G)^{\gamma_1} (K_i)^{1-\gamma_1}}{L_i} \right) \]  

(5.11)

where \( K_i^G \) is public capital and \( \gamma_1 \) is the contribution of public capital to the economy-wide efficiency of labour. This way workers inherit the benefits of past investment. Assuming identical firms that are constant in number, and aggregating, we arrive at the aggregate production function

\[ Y_t = B(K_t)^{\gamma_2} (K_i^{G_i})^{1-\gamma_2} \]  

(5.12)

where \( \gamma_2 = 1 - (1-\alpha)\gamma_1 \) and \( B \) depends on the constant number of firms in the economy.

It is assumed that the government does not produce. It buys output, including roads, dams, canals, hospitals, schools etc., from the private sector. This infrastructure is made available to the private sector without any user charges. Private capital has a diminishing marginal product given by \( \frac{\partial^2 Y_t}{\partial K_t^2} = -\gamma_2 (1-\gamma_2) \frac{Y_t}{K_t^2} < 0 \). However, if the ratio of public to private investment remains constant, i.e. with every increase in private investment there is a corresponding increase in public investment, then the marginal product of private capital is constant and is equal to its average product. The average product of capital may be expressed as

\[ \frac{Y_t}{K_t} = B \left( \frac{K_i^G}{K_t} \right)^{1-\gamma_2} \]  

(5.13)
If the ratio \( \frac{K_{1t}^G}{K_t} \) is a constant then the production function displays constant returns to the input private capital and technology is linear. Also, if \( \gamma_1 = 0 \) i.e. public expenditure has no role to play in raising the efficiency of labour then \( \gamma_2 = 1 \) and the production function can be expressed as \( Y = BK_t \) as in Romer (1986) where \( B > 0 \) is the constant net marginal product of private capital. Technology in this case is linear.

We assume that firm \( f \) ignores the externality in choosing capital stock. The marginal product of capital is \( MP_K = \frac{\partial Y}{\partial K} = \alpha K^{\alpha - 1} J^{1 - \alpha} = \alpha Y / K \). The marginal cost of capital (including depreciation at a rate \( \pi ) = r_t + \pi \). Equating the private marginal product of capital to the cost of capital gives

\[
\frac{K_t}{Y_t} = \frac{\alpha}{r_t + \pi} = K(r)
\]

Net private investment is then given by the addition to capital stock less the depreciation in period \( t \)

\[
I_t = K_t - (1 - \pi)K_{t-1}
\]

5.3.3. The Government

The government provides an amount \( G_c^t \) of public consumption goods using the same technology as for the privately produced good, and purchases an amount \( G_I^t \) of the latter to invest in infrastructure. Total government expenditure is then \( G_t = G_c^t + G_I^t \) which is financed by a combination of taxation \( (T_t) \) and borrowing \( (D_t) \) where \( D_t \) are single period bonds. (We ignore or rule out seigniorage). The government borrowing identity is given by
\[ D_t = (1 + r)D_{t-1} + G_t - T_t \quad (5.16) \]

and public sector capital accumulates according to
\[ K_t^G = (1 - \pi)K_{t-1}^G + G_t^I \quad (5.17) \]

assuming the same depreciation rate as in the private sector. Since the definition of capital is broad, public sector investment \( G_t^I \) is assumed to include public expenditure on health, education, etc. Since only profits net of depreciation are taxed at the rate \( \tau \) total receipts are
\[ T_t = \tau (Y_t - \pi K_t). \quad (5.18) \]

5.3.4. Output Equilibrium.

We assume that the market always clears. Equilibrium in the output market gives
\[ Y_t = C_t + I_t + G_t \quad (5.19) \]

Thus, given the government choice of fiscal policy variables \( G_c^c, G_t^I \) and \( \tau \), the supply and demand sides of the economy are now fully determined.

5.3.5. The Steady-State

We seek a balanced growth steady-state in which all stocks and flows are growing at the same endogenous rate \( n \), the steady-state value of \( n \). The debt/GDP ratio is assumed to be constant which is the strong solvency condition. It is assumed that \( r_t \) is constant at the rate \( r \). If we express all macroeconomic stock and flow variables as ratios of GDP then in steady state balanced growth the ratios remain unchanged. We retain the same notation without the subscript \( t \) to denote these ratios to ease notational burden.
Consumption of constrained consumers who receive only labour income and consume their entire income is given by
\[ C^*_i = (1 - \lambda) (Y_i - (r + \pi)K_i)(1 - \tau) \tag{5.20} \]

We can substitute for the expression for non-labour income from (5.14) where \( K_i(r+\pi) = \alpha Y_i \). Post-tax labour income of unconstrained consumers can be now defined in terms of total income. Consumption of constrained consumers defined as a ratio of GDP in the steady state is
\[ \frac{C^*_i}{Y_i} = C_e = (1 - \lambda)(1 - \alpha)(1 - \tau) \tag{5.21} \]

We can now obtain the consumption of unconstrained consumers in the steady state from
\[ (r(1-\tau)+g(1+r(1-\tau))-\delta-n(1+\delta))C^u=(p+g)(p+\delta)[1-r(1-t)]/(1-p)(D+K) \tag{5.22} \]

The capital output ratio may be expressed as a ratio of GDP as
\[ K(r) = \frac{\alpha}{r+\pi} \tag{5.23} \]

Given that the rate of depreciation for public capital is the same as that for private capital we obtain public capital in the steady state as a ratio of GDP as
\[ K^p = \frac{(1+n)G^i}{(n+\pi)} \tag{5.24} \]

where \( G^i \) is the share of public investment in GDP.

The aggregate production function can be expressed as a ratio of GDP as
\[ \log B + \gamma_1 \log K + (1 - \gamma_2) \log \frac{G^i}{(n+\pi)} = 0 \tag{5.25} \]
In the steady state public and private capital grow at the same rate \( n \) and depreciate at the same rate \( \tau \). Thus the ratio of public to private capital is constant and so production is linear in private capital.

In a steady state public debt grows at the rate \( n \). Thus the government budget constraint may be expressed as

\[
(1+n)D_t = (1+r)D_{t-1} + G_t - T_t \tag{5.26}
\]

Rearranging, we express the solvency condition in the steady state as

\[
[(r-n)/(1+n)]D = T - G = [1-\pi K] \tau - G \tag{5.27}
\]

The market equilibrium in the steady state may be defined as ratios of GDP as

\[
1 = C^u + C^l + I + G
\]

\[
C^u = 1 - (\lambda)(1-\alpha)(1-\tau) - [(n+\pi)/(1+n)]K(r) - G \tag{5.28}
\]

To summarise the steady-state form of the model may be expressed as

\[
(r(1-\tau) + g(1+r(1-\tau)) - n(1+\delta))C^u = ((p+g)(p+\delta)[1-r(1-\tau)]/(1-p))(D+K) \tag{5.22}
\]

\[
[(r-n)/(1+n)]D = T - G = (1-\pi K(r)) \tau - G \tag{5.27}
\]

\[
K = \alpha / r + \pi = K(r) \tag{5.23}
\]

\[
\log B + \gamma_2 \log(K(r)) + (1-\gamma_2)\log(\gamma G/(n+\pi)) = 0 \tag{5.25}
\]

\[
C^u = 1 - [(n+\pi)/(1+n)]K(r) - G - (1-\lambda)(1-\alpha)(1-\tau) \tag{5.28}
\]

\[
C^u = (1-\lambda)(1-\alpha)(1-\tau) \tag{5.21}
\]

(5.22) defines the aggregate consumption of the group of unconstrained consumers. (5.27) is the solvency condition of the government in the steady state. It is the strong solvency condition which implies that the debt/GDP ratio is constant. (5.23) and (5.25)
describe the supply side of the model. (5.23) defines the steady state capital output ratio. (5.25) defines the production function. (5.28) is the market equilibrium condition. Together these define consumption, the government budget constraint, production and market equilibrium in the steady state.

Futagami, Morita and Shibata (1993) who assume externalities arising from the stock of public and private capital on the supply side and from distortionary taxes on the demand side find that the steady state equilibrium path is unique and exhibits saddlepath stability. In a model of overlapping generations and endogenous growth where externalities on the supply side arise from the stock of capital and on the demand side due to finite horizons, Alogoskoufis and van der Ploeg (1991) also find that the steady state equilibrium is saddlepath stable. The condition of solvency of the public sector is sufficient to ensure saddlepath stability. Corresponding to this boundary condition there is a single value of the forward looking variable - consumption at some initial time for which the system converges to a steady state. For all other initial values of consumption we have explosive behaviour. Strictly speaking, the stability of the steady state equilibrium in our model can be examined by linearizing around the steady state and investigating the transitional dynamics. However, since our model is later shown to be near Ricardian, it is very close to Futagami, Morita and Shibata (1993) and so we can draw upon their results and assume that the system will exhibit saddlepath stability.

5.4. Fiscal Policy and Long-Run Growth

This section studies the steady-state of the economy defined above. Given fiscal instruments, \( \tau \), \( G^C \) and \( G^I \) we have five equations in five endogenous variables
r, C, D, K and growth n. Since we wish to focus on the effects of government debt D, the distortionary tax rate τ, and the mix of government spending as between consumption and investment, we will characterise fiscal policy in terms of D and τ making total government spending endogenous. Let G = γG making the third fiscal instrument the proportion γ.

To compute an "order of magnitude feel" for their effects on long-run growth we derive multipliers for estimating the change in the rate of growth when there is a change in fiscal policy variables.

Substituting the value of consumption and eliminating G we arrive at the Yaari-Blanchard consumption relationship.

\[
f(n, r, D, \tau) = (1 + \gamma_1 (1 - \tau)) \gamma_2 \log K(r) + (1 - \gamma_2) \log(1 + \gamma_1 - \gamma_2) \log(1 - \gamma_2) \log(1 + \gamma_2) - \gamma_2 \log(1 + \gamma_2) + \log(1 + n) - \log(n + \pi) + \log B = 0
\]

The production function may be derived as

\[
g(n, r, D, \tau, y) = \gamma_2 \log K(r) + (1 - \gamma_2) \log(1 + k(r) - \gamma_2) \log(1 + n) - \gamma_2 \log(1 + n) - \gamma_2 \log(1 + n) + \log(n + \pi) + \log B = 0
\]

The two relationships determine r and n given D, τ and γ.

The relationship \( f(n, r, D, \tau) = 0 \) describes the locus of interest and growth rates consistent with Yaari-Blanchard consumption behaviour, output equilibrium, private sector investment and the government budget constraint. We term this locus the Yaari-Blanchard (YB) curve. The relationship \( g(n, r, D, \tau, y) = 0 \) is the locus consistent with balanced growth and our linear technology, private sector investment and the
government budget constraint. We call the relationship the **linear technology (LT)**

curve.

Consider incremental changes in the exogenous fiscal variables $dD$, $dT$, $dY$ and the
corresponding incremental changes $dn$ and $dr$ along the YB and LT curves.
Differentiating, these incremental changes satisfy

\[ f_n dn + f_r dr + f_D dD + f_T dT = 0 \]

\[ g_n dn + g_r dr + g_D dD + g_T dT + g_Y dY = 0 \]

where it can be shown that under very lax conditions we expect $f_n, g_n, g_Y > 0$;
$f_n, f_D, g_n, g_D < 0$ (Details are presented in Appendix B). Keeping fiscal policy and
income distribution fixed, the slope of the YB curve is given by $(\partial n/\partial r)_{r=0} = -f_r/ f_n$.
Since $f_n < 0$ and $f_r > 0$ therefore $-f_r/f_n > 0$. In other words, $(\partial n/\partial r)_{r=0} > 0$ or the YB
curve is upward sloping. Turning to the LT curve when fiscal policy is given, its slope
is given by $(\partial n/\partial r)_{r=0} = -g_r/ g_n$ where we expect $g_n < 0$ and $g_r < 0$ and so, the LT curve
is downward-sloping. In the case when public investment is irrelevant and $\gamma = 1$ as in
Romer (1986) we have $K(r) = B$ and the LT curve is vertical. In an exogenous growth
model the rate of growth is not affected by the rate of interest and the LT curve is
horizontal.

We now look at the effect of fiscal variables on the YB and LT curves. To look at
the effect of a change in the ratio of debt to GDP let $dr = dT = 0$. We then have
$f_n dn + f_D dD = 0$. Given $dn/dD = -f_D/f_n$, if $f_n, f_D < 0$, $dn/dD < 0$. Thus growth decreases as a
result of the rise in debt everything else remaining constant. The YB curve shifts down.
Similarly, keeping $r$, $\tau$, and $\gamma$ fixed, $dr=d\tau=d\gamma=0$, we have $g_d dn + g_D dD = 0$ and so $dn/dD = -g_D/g_n$. If $g_D, g_n < 0$ then $dn/dD < 0$ and the LT curve shifts downwards when debt increases. The combined effect of an increase in debt is a reduction in long-run growth.

The Yaari-Blanchard and Linear Technology Curves:

Effect of a rise in the Debt/GDP ratio

![Diagram](image)

Figure 5.1

We can derive the debt/GDP ratio multiplier

$$\left[ \frac{\partial N}{\partial D} \right]_{\tau, \gamma} = g_r f_r - g_D f_D / f_r g_n - g_f f_f$$

where $f_g n - g_f f_f < 0$. From the expected signs of the partial derivatives we can expect $\left[ \frac{\partial N}{\partial D} \right]$ to be negative. This implies that an increase in the steady state ratio of public debt to GDP reduces long-run growth given the ratio of government consumption to government spending and the tax ratio. This effect is not contrary to our expectations.
in a non-Ricardian world. Since public debt is considered net wealth in such a world, an increase in debt would raise consumption spending and reduce private savings available for investment. It should thus have a growth reducing effect if long-run growth depends on the level of investment.

Let us now look at the effect of a change in the tax rate. We assume that \( \frac{dr}{dD} = 0 \).

Now, \( f_n \frac{dn}{dT} + f_t \frac{dT}{dT} = 0 \) or \( \frac{dn}{dT} = -\frac{f_t}{f_n} \). If \( f_n, f_t < 0 \) as expected, \( \frac{dn}{dT} < 0 \). In other words when the tax rate increases less is available for private sector saving and investment and when investment is lower, the growth rate is lower in an endogenous growth model. Hence the YB shifts down.

To look at what happens to the LT curve, let \( \frac{dr}{dD} = \frac{dy}{y} = 0 \). We have \( g_n \frac{dn}{dT} + g_t \frac{dT}{dT} = 0 \).

So, \( \frac{dn}{dT} = -\frac{g_t}{g_n} \). If \( g_t > 0 \), \( g_n < 0 \) then \( \frac{dn}{dT} > 0 \). The LT curve shifts upwards when the tax rate increases. This is because more can be invested by the government while satisfying its intertemporal budget constraint. The total effect of the change in tax rate is not clearly in any one direction. We can derive the tax rate multiplier as

\[
\left[ \frac{\partial N}{\partial T} \right]_{D, \gamma} = \frac{g_t f_n - g_n f_t}{f_n g_t - g_n f_t}.
\]

While the denominator is negative, the numerator can be either positive or negative. An increase in taxes thus has an ambiguous effect on growth. The reason for this is that as the tax rate increases, given the debt/GDP ratio, a higher government spending-GDP ratio consistent with the government budget constraint can be reached. Part of this additional spending goes on infrastructure which enhances growth. However, taxes are distortionary and, for a given real interest rate \( r \), an increase in the tax rate reduces savings as a proportion of GDP which depresses private investment and hence growth.

Let us now look at the effect of the third fiscal policy variable \( \gamma \). Since YB is not a function of \( \gamma \), it does not shift due to a shift in \( \gamma \). On the LT curve we assume that the
tax rate and debt/GDP ratio remaining constant we will have $\frac{dn}{dy}=-g_y/g_n$. If $g_y>0$ and $g_n<0$ then $\frac{dn}{dy}>0$. The LT shifts upwards. An increase in the proportion of government spending on infrastructure raises the growth rate. We can show

$$[\phi N/\phi y]_{D,r} = -\frac{g_y f_r}{f g_n-g f_n} > 0$$

The result that an increase in the proportion of government spending on investment and development purposes raises growth is again in accord with the basic characteristics of the growth model presented here.

5.5. Calibration and estimation for India

In this section we present the data used and the results obtained. We use the values of parameters on the demand side as in the previous chapter to calibrate the above model. Other observed variables are those reported in the Economic Survey 1993-94, Government of India and Yearbook of the International Financial Statistics published by the International Monetary Fund.

We assume that $r$, the implicit risk free real interest rate relevant for consumption decisions, is 14.16 per cent, the proportion of labour income received by unconstrained households is 70 per cent, the probability of death, $p$, is 0.019 and $\delta$, the rate of time preference, is 0.032.

The Economic Survey 1993-94 reports a rate of growth of population over 1981-91 to be 2.14 per cent. GDP grew at an average rate of approximately 4.5 per cent over this decade. Gross Domestic Private Investment as a percent of GDP for 1991-92 is reported to be 14.0 per cent. Consumption as a percent of GDP is calculated to be 64 per cent from the figures provided by the IMF. Government spending constitutes 22 per cent of GDP. The total outlay of the government - Central and State Governments
and Union Territories is categorised as development and non-development expenditure. Non-development expenditure includes defence, tax collection charges, police, etc. To analyse the impact of government spending on productivity, we choose $\gamma$ to be development expenditure as a proportion of total government expenditure. This includes public investment in infrastructure, education and health. Table 1.5 shows that development spending as a proportion of total government expenditure has declined by about 10 per cent in the last decade and was 54.3 per cent in 1993-94.

Table 5.1: Summary of Calibration.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depreciation Rate = $\pi$</td>
<td>0.05</td>
</tr>
<tr>
<td>Real Rate of Interest = $r$</td>
<td>0.14</td>
</tr>
<tr>
<td>Rate of time preference = $\delta$</td>
<td>0.032</td>
</tr>
<tr>
<td>Consumption/GDP = $C$</td>
<td>0.64</td>
</tr>
<tr>
<td>Gov. Exp./GDP = $G$</td>
<td>0.22</td>
</tr>
<tr>
<td>Gov. Debt/GDP = $D$</td>
<td>0.60</td>
</tr>
<tr>
<td>probability of death = $p$</td>
<td>0.019</td>
</tr>
<tr>
<td>liquidity parameter = $\lambda$</td>
<td>0.70</td>
</tr>
<tr>
<td>rate of growth of population = $g$</td>
<td>0.0214</td>
</tr>
<tr>
<td>GDP growth = $n$</td>
<td>0.045</td>
</tr>
<tr>
<td>Development Exp./Gov. Exp. = $\gamma$</td>
<td>0.543</td>
</tr>
<tr>
<td>Capital Externality = $\gamma_1$</td>
<td></td>
</tr>
<tr>
<td>$\gamma_2 = 1-(1-\alpha)\gamma_1$</td>
<td></td>
</tr>
</tbody>
</table>


$\pi$, the rate of depreciation, is chosen to be 5 per cent. Depreciation of physical capital through technological obsolescence as well as wear and tear may be expected to be roughly 10 per cent. Our concept of capital is broader and includes human as
well as physical capital. Since we expect a much lower depreciation rate for human
capital we choose the average depreciation rate for our broad concept of capital to be
5 per cent.

g_1 is the contribution of public capital to the production externality i.e., it is the
contribution of public capital to the economy-wide efficiency of labour. As g_1 is neither
estimated nor observed, it is imposed. Since we do not know its value, we impose
different values of g_1 and calibrate the model. To each level of g_1 corresponds 1-g_2 = g_1
(1-\alpha), the elasticity of aggregate output to public capital stock. The value of \alpha, the
share of income accruing to private capital, was revealed to be approximately 29 per
cent. So the higher is g_1 the higher is the elasticity 1-g_2.

The marginal products of private and public capital can be shown to be g_2(Y/K) and
(1-g_2)(Y/K^G). Since the ratio of both public and private investment to GDP is each
approximately 11 per cent, the marginal product of private and public capital may be
compared by comparing the value of g_2 to (1-g_2). If g_2 =1-g_2 i.e. g_2=0.5, the two
marginal products are equal and output cannot be increased by reallocating resources
from the public to the private sector or vice versa. Our calibration shows that \alpha=0.29
and g_2=1-g_2 when g_1=0.7. Allocation of capital between public and private sectors is
then efficient. If (1-g_2)< 0.5 output can be raised by reallocating investment from the
public to the private sector then size of the public sector is too large. The Table 5.2
shows the values of the multipliers when the model is calibrated at different values of
g_1.
Table 5.2: The Multipliers for selected values of $\gamma_1$

<table>
<thead>
<tr>
<th>$\gamma_1$</th>
<th>$\partial n/\partial \gamma$</th>
<th>$\partial n/\partial \delta D$</th>
<th>$\partial n/\partial \delta \tau$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>0.03232</td>
<td>-0.00497</td>
<td>-0.0625</td>
</tr>
<tr>
<td>0.5</td>
<td>0.07678</td>
<td>-0.01202</td>
<td>0.06384</td>
</tr>
<tr>
<td>0.7</td>
<td>0.10404</td>
<td>-0.02174</td>
<td>0.14130</td>
</tr>
<tr>
<td>0.9</td>
<td>0.12960</td>
<td>-0.02772</td>
<td>0.21393</td>
</tr>
</tbody>
</table>

5.5.1. The Development Expenditure Multiplier

The development expenditure multiplier, $(\partial n/\partial \gamma)$, measures the change in long run steady state growth rate corresponding to a change in the proportion of development expenditure in total government spending when the tax rate and the debt /GDP ratio are unchanged. For $\gamma_1 = 0.2$ a one per cent increase in the proportion of development expenditure in government spending leads to an increase in the long-run growth rate by 0.03 per cent. Similarly if $\gamma_1$ were 0.7 the rise in the long-run growth rate would be 0.1 per cent. A ten per cent reduction in the proportion of development expenditure then implies a 1 per cent decline in the long run growth rate.
Any increase in the proportion of public investment to total government spending raises the long-term growth rate whatever the efficiency of the public sector. However, when $\gamma_1$ is higher, a reduction in the ratio of development expenditure to total government expenditure reduces growth to a larger extent. This can be seen in Figure 5.2. The higher is $\gamma_1$, the contribution of the public sector to raising the economy-wide efficiency of labour, the greater is the effect on long-term growth of a reduction in the proportion of public investment to total government spending.

5.5.2. The Tax Multiplier

While growth rates unambiguously increase as debt declines or as government spending on infrastructure increases, other things remaining the same, the change in growth brought about by a change in the tax rate is not so well defined. The tax multiplier, $(\partial n/\partial \tau)$, measures the change in long-run steady state growth due to a change in $\tau$, the tax rate, when $D$ and $\gamma$ are unchanged. Given the government budget
constraint a rise in the tax rate allows higher public spending and thus investment. When \( \gamma_1 \) is high, then a rise in the tax rate which reallocates resources to the public sector raises long-term growth rate. The tax multiplier is therefore positive. However, when \( \gamma_1 \) is low, higher taxes imply an increase in public investment at the cost of private saving which leads to a reduction in private investment. An increase in tax rate reduces long-run growth rate when the contribution of the public sector to the growth potential of the economy is relatively lower.

\[ \gamma_1 \text{ and the tax multiplier} \]

![Figure 5.3](image)

Figure 5.3 shows how the value of the tax multiplier rises with an increase in \( \gamma_1 \). We see that the sign of the tax rate multiplier changes from negative to positive as \( \gamma_1 \) rises.

5.5.3. The Debt Multiplier

The debt multiplier, \( \frac{\partial n}{\partial D} \), measures the change in long-run steady state growth due to a change in \( D \), the debt/GDP ratio, when \( \tau \) and \( \gamma \) are unchanged. Table 5.2
shows that if $\gamma_1$ were 0.2, a one per cent increase in the debt/GDP ratio leads to a reduction in the long run growth rate by 0.005 per cent. Or, a hundred per cent increase in the debt/GDP ratio would reduce growth rate by 0.5 per cent. At $\gamma_1=0.7$ a hundred per cent increase in $D$ would reduce the growth rate by 2.17 per cent.

![Graph showing $\gamma_1$ and the debt multiplier](image.png)

**Figure 5.4**

We observe in Figure 5.4 that the absolute value of the multiplier rises when $\gamma_1$ is higher and a rise in the debt ratio reduces long-term growth to a larger extent. If taxes remain unchanged, then a reduction in debt is achieved by reducing government spending. Since development expenditure constitutes nearly half of total government spending, the higher is $\gamma_1$, the larger will be the effect of a reduction in debt on long-term growth rate.

As discussed in detail earlier, the ratio of development expenditure in the government’s total expenditure is rapidly declining in the face of the commitment to
reduce public borrowing under the SAP. Our calibration suggests that the effect of the
decline in the ratio of development expenditure on the growth rate is quite significant.
Assuming a mean level of $\gamma_1$, reducing the proportion of development spending from
the present $\gamma = 54.3$ per cent say by another 10 per cent to 44.3 per cent, keeping the
tax rate and the debt/GDP ratio unchanged, will reduce growth by more than 0.7 per
cent. The pattern of government spending therefore has a significant effect on the long-
run growth rate of the economy. For instance, if half of defence expenditure, which is
about 20 per cent of total government spending, was diverted to development
purposes $\gamma$ would increase from 54.3 to 64.3 and the long-run growth rate would rise
by about 0.76 per cent.

A 0.5 per cent increase in growth could be achieved either by a less than 10 per cent
rise in the ratio of development expenditure in total expenditure or by a 50 per cent
reduction in the debt/GDP ratio from the present 0.6. The second is much larger in
magnitude. Since total government expenditure stands at about 22 per cent of GDP
and slightly more than half of it is development expenditure, development expenditure
stands at about 12 per cent of GDP. Thus higher growth to the same extent could be
achieved by a small increase in development expenditure rather than a large reduction
in debt.

The effect of small changes in more than one fiscal variable can be analysed as
follows. Since we have $n = n(D, \gamma, \tau)$, the total effect is given by
\[ \frac{\partial n}{\partial D} \frac{dD}{dD} + \frac{\partial n}{\partial \gamma} \frac{d\gamma}{d\gamma} + \frac{\partial n}{\partial \tau} \frac{d\tau}{d\tau}. \]
If the fiscal deficit is reduced by raising the tax rate, $\tau$, while the proportion of infrastructure spending to total government spending remains
unchanged, then the total effect on long term growth rate can be measured by
\[ \frac{\partial n}{\partial D} dD + \frac{\partial n}{\partial \tau} d\tau. \]

On the other hand, the tax rate could be kept constant and the fiscal deficit could be reduced by cutting public spending. Government expenditure can be reduced either by a reduction in both consumption spending and investment such that \( \gamma \) remains unchanged, or by a reduction in one such that \( \gamma \) changes. If, say, the reduction is brought about by a cut in the expenditure on infrastructure, because of which \( \gamma \) changes, the total effect on growth would be \( \frac{\partial n}{\partial D} dD + \frac{\partial n}{\partial \gamma} d\gamma \). Here the first term is positive since debt has been reduced and the second term is negative since there is a fall in \( \gamma \) which reduces growth. The total effect on growth depends on which effect is larger.

5.6. Non-Ricardian Effects

In this section we examine some of the implications that arise from the violation of Ricardian assumptions. We first look at the values the tax and debt multipliers would take on if the planning horizons of the unconstrained consumers were different. We next look at the effect of liquidity constraints.

5.6.1. Finite horizons

If the probability of death is higher the effect of the shorter time horizon on the consumption of unconstrained consumers is revealed as larger non-Ricardian effects on growth rates. Figure 5.5 shows that the absolute value of the debt multiplier increases as the probability of death approaches unity. This accords well with our expectation
that if consumers have shorter planning horizons then public debt is treated as net wealth and consumption rises crowding out private investment and reducing the rate of growth in our model. When \( p = 0 \) the value of the multiplier is non-zero because of other non-Ricardian effects, namely distortionary taxes, population growth and liquidity constraints and the public capital externality.

\[
\text{Finite horizons and the debt multiplier}
\]

![Graph showing the debt multiplier vs. p](image)

\( p = \text{the probability of death} \)

Similarly the value of the tax multiplier would be higher if the probability of death were higher. Shorter time horizons represented by a higher value of \( p \), other parameters remaining the same, imply small changes in the tax rate would have much larger effects on growth. Again the multiplier is non-zero when \( p = 0 \) because of other non-Ricardian effects. This can be seen in Figure 5.6.
5.6.2. Liquidity constraints

We now examine the effect of liquidity constraints on the tax multiplier. As Figure 5.7 shows the value of the tax multiplier falls as we approach the Ricardian case ($\lambda=1$). This is because if a higher proportion of income is received by forward looking consumers then the effect of a change in the tax rate on consumption will be lower and the magnitude of crowding out is smaller. Hence the effect of a change in the tax rate on the growth rate is smaller.
5.6.3. Distortionary Taxes

To examine the effect of distortionary taxes we assume that $p=g=0$ and $\lambda=1$ as in the Ricardian case. Now the deviation from Ricardian Equivalence is due only to distortionary taxes and the public capital externality. We re-estimate the multipliers at the mean value of $\gamma_1 = 0.5$. Table 5.3 shows us how these ‘quasi-Ricardian’ multipliers compare with the non-Ricardian case when there exist finite horizons, population growth, liquidity constraints and distortionary taxes. Since the development expenditure multiplier is determined on the supply side of the model we look at the tax and debt multipliers which would be affected by non-Ricardian effects on demand.
Table 5.3: The Multipliers for the Quasi Ricardian and Non-Ricardian Cases

<table>
<thead>
<tr>
<th>Multiplier</th>
<th>Quasi Ricardian</th>
<th>Non-Ricardian</th>
</tr>
</thead>
<tbody>
<tr>
<td>$c_1 \gamma D$</td>
<td>-0.0154</td>
<td>-0.0153</td>
</tr>
<tr>
<td>$c_1 \gamma c$</td>
<td>0.0599</td>
<td>0.0638</td>
</tr>
</tbody>
</table>

The tax and debt multipliers in the Quasi Ricardian case are only marginally lower than in the non-Ricardian case. Clearly the effect of finite horizons, population growth and liquidity constraints is not very large. We examine the relation between the tax rate and the long-run growth rate in Figure 5.8, 5.9, 5.10 and 5.11. We also look at the choice of the tax rate that maximises growth. This is considered to be the 'optimal' tax rate.

We first examine the relationship between the tax rate and the growth rate in Figure 5.8. $\gamma_1$ is assumed to be the mean level of 0.5. Figure 5.8 shows the optimal tax rate for different levels of $\gamma$, the ratio of development to total government spending. Given the level of $\gamma$ at 0.54 growth rate can be raised by raising the tax rate to about 40 per cent. If $\gamma$ were higher by 10 or 20 percentage points, growth rates achieved would be relatively higher at any tax rate.
As discussed earlier the effect of distortionary taxes on the long-run growth rate depends on the contribution of public capital stock to the economy wide efficiency of labour. We see that the optimal tax rate is different at different values of $\gamma_1$. Figure 5.9 indicates that if $\gamma_1 = 0.25$ the maximum growth rate is achieved when the tax rate is around 25 per cent. The higher is $\gamma_1$, the higher is the optimal tax rate. When $\gamma_1 = 0.75$ the optimal tax rate is around 57 per cent.
Figure 5.9

Figure 5.10 shows growth rates at different levels of the tax rate corresponding to the debt/GDP ratio. $\gamma_1$ is assumed to be the mean level of 0.5. Again growth rate can be increased from its present level by raising the tax rate up to about 40 per cent. If the debt/GDP ratio is lower then growth rates are relatively higher for all $\tau$. 
Finally Fig. 5.11 shows the optimal tax rate for different values of the liquidity parameter $\lambda$. It also shows that the effect on growth of changing the proportion of income received by unconstrained consumers. It can be seen that this effect is quite small. Increasing the proportion of income earned by the rich will not increase growth substantially even though they save and the poor don’t. If all post-tax labour income was to be received by unconstrained consumers ($\lambda = 1$), the long run growth rate would be about 0.2 per cent higher. For the present value of the liquidity parameter of 70 per cent, the optimal tax rate is about 40 per cent. This is not significantly affected by the value of $\lambda$. 

Figure 5.10
5.7. Reducing Debt

The effect of a reduction in debt has been examined above by looking at the change in the growth rate induced by small changes in the debt/GDP ratio. The multipliers were derived at the current level of the debt/GDP ratio of 0.6. In Figure 5.12 and Figure 5.13 we observe that if the debt/GDP ratio was considerably reduced then the development expenditure and the tax multiplier acquire much higher values. A small increase in the proportion of development expenditure in total government spending or an increase in the tax rate can raise the long-run steady state growth rate more effectively at lower levels of the debt/GDP ratio.
The debt/GDP ratio and the tax multiplier

Figure 5.12

The debt/GDP ratio and the development expenditure multiplier

Figure 5.13
5.8 Effects of Demand and Supply Side externalities

In this section we impose restrictions on the parameters $p$, $g$, $\lambda$, $\tau$ and $\gamma_1$ to evaluate the relative importance of the non-Ricardian effects for empirical analysis and obtain a range of specifications including the ‘pure’ Ricardian, and models similar to Alogoskoufis and van der Ploeg (1990) and Buiter (1991) among others. The endogenous growth character of the model is retained throughout by the assumption that there are externalities arising from private capital.

In the ‘pure’ Ricardian case we assume that there are no public capital externalities, no liquidity constraints, no population growth, horizons are infinite and taxes are non-distortionary. So $p = g = 1 - \lambda = \tau = \gamma_1 = 0$.

The aggregate consumption function can be shown to be

$$ C_t = \frac{1+r}{1+\delta} C_{t-1} $$

as in (2.9) which defined the consumption function of a representative agent. In the steady state expressing consumption as a ratio of GDP

$$ (1+n)(1+\delta)(1+r)C = 0 $$

Since taxes are lump-sum, the government budget constraint is

$$ G = T - (r-n)/(1+n)D $$

The market equilibrium condition is

$$ C = 1 - ((n+\pi)/(1+n))K - G $$

The ‘Ricardian’ equivalent of the ‘Yaari-Blanchard’ consumption function is

$$ f(n,r,D) = ((1+n)(1+\delta)-(1+r))(1-((n+\pi)/(1+n))K-T+(r-n)/(1+n)D) = 0 $$
Assuming that $\gamma_1 = 0$ as in Romer (1986) i.e. public capital has no externalities then the LT curve becomes

$$\log B + \log K(r) = 0$$

The debt multiplier has been defined as

$$\left[ \frac{\partial N}{\partial D} \right]_{\tau, \gamma} = g_p f_n - g_D f_r / f_r g_n g_r f_n$$

In this case $g_D = 0$ and if $n = r - \delta$, $f_D$ approaches zero and the debt multiplier approaches zero. The tax and development expenditure multipliers are also both zero. In other words, when consumers have infinite horizons, there are no liquidity constraints, no population growth, taxes are lump sum, public capital has no externalities and the growth rate is equal to the real interest rate minus the pure rate of time preference, fiscal policy is neutral.

In the Yaari-Blanchard case when only $p \neq 0$, and we assume that there are no liquidity constraints, population growth or externalities associated with public capital and $n = r - \delta$, non-Ricardian effects arise as the probability of death is positive. Due to finite horizons public debt is considered net wealth and this raises consumption and reduces saving which in turn reduces net investment and hence reduces the long run growth rate. The restrictions that $g = 0$, $\lambda = 1$, $\tau = 0$, $\gamma_1 = 0$ and $n = r - \delta$, reduce our model to the Alogoskoufis and van der Ploeg (1990) specification. As can be seen in Table 5.4 if $p = 0.02$ we find that when taxes are lump sum, the value of the debt multiplier is -0.0013. Thus a 100 percent decrease in the debt/GDP ratio leads to a 0.13 percent rise in the growth rate. Our result that in the presence of finite horizons, a change in the debt/GDP ratio affects the long-run growth rate, corresponds with their conclusions. When finite horizons and population growth are both included in the model as in Alogoskoufis and van der Ploeg (1991) and Buiter (1991) the debt
multiplier becomes -0.0018. In other words, if in addition to finite horizons we include the population growth rate the absolute value of the debt multiplier rises by 0.0005. This suggests that the effect of Blanchard-Weil demographics are significant when taxes are lump sum and there arise no externalities due to public capital.

The model incorporates tax distortions in the form of a flat rate income tax imposed on all labour and non-labour income as in Barro (1990) and Futagami, Morita and Shibata (1993), Jappelli and Meana (1994) and Krichel and Levine (1995). When none of the other Ricardian assumptions are violated the debt multiplier is found to be non-zero at -0.001. The non-zero effects of government borrowing on long-run growth are entirely due to distortionary taxes. We can again look at how the multipliers would be affected if there one or more of the other assumptions of the Ricardian theorem were violated as well.

When finite horizons and population growth are incorporated in the model with tax distortions the absolute value of the debt multiplier becomes higher. At $p = 0.02$, $g = 0$ the value of the debt multiplier is -0.0027 and at $p = 0.02$, $g = 0.02$ it is -0.0030. In comparison with the lump sum tax case these values are nearly double indicating the importance of tax distortions. These results suggest that models like Alogoskoufis and van der Ploeg (1990, 1991) and Buiter (1991) while taking into account effects of finite horizons and population growth on the demand side, ignore more important demand side non-Ricardian effects due to distortionary taxes.

When the stock of public capital affects the economy-wide efficiency of labour, the effect of fiscal policy on the long-run growth rate is due not only to non-Ricardian demand side effects but due to the direct effect of public spending on infrastructure, education, health and other development expenditure which creates physical and
human capital. We see that the multipliers are much larger in magnitude when the externality arising from public spending is taken into account. Our results are summarised in Tables 5.4, 5.5 and 5.6. At $\gamma_1 = 0.5$ the tax multiplier is now positive which indicates that higher taxes that finance public investment serve to raise growth, outweighing negative demand side effects.

Table 5.4: The Debt Multiplier$^2$

<table>
<thead>
<tr>
<th>Case</th>
<th>Distortion</th>
<th>Lump sum Taxes</th>
<th>Distortionary Taxes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure Ricardian</td>
<td>None</td>
<td>0</td>
<td>-0.001</td>
</tr>
<tr>
<td>Finite Horizons</td>
<td>$p = 0.02$</td>
<td>-0.0013</td>
<td>-0.0027</td>
</tr>
<tr>
<td>Finite Horizons and Population Growth</td>
<td>$p = 0.02$</td>
<td>-0.0018</td>
<td>-0.0030</td>
</tr>
<tr>
<td>Public Capital Externality</td>
<td>$\gamma_1 = 0.5$</td>
<td>-0.0065</td>
<td>-0.0061</td>
</tr>
<tr>
<td>Finite Horizons and Public Capital Externality</td>
<td>$\gamma_1 = 0.5$</td>
<td>-0.0074</td>
<td>-0.0074</td>
</tr>
<tr>
<td>Finite Horizons, Population Growth and Public Capital Externality</td>
<td>$\gamma_1 = 0.5$ $p = 0.02$ $g = 0.02$</td>
<td>-0.0078</td>
<td>-0.0079</td>
</tr>
<tr>
<td>Liquidity Constraints, Finite Horizons, Population Growth and Public Capital Externality</td>
<td>$\gamma_1 = 0.5$ $\lambda = 0.7$ $p = 0.02$ $g = 0.02$</td>
<td>$^3$</td>
<td>-0.0088</td>
</tr>
</tbody>
</table>

$^2$ We set $r = 0.077$ so that $n = r - \delta$. All other parameters retain their previous values.

$^3$ In the case when we have lump sum taxes and liquidity constraints we need to determine the share of taxes paid by the two groups of consumers. Since there is no evidence for this we avoid imposing an arbitrary value and so do not calculate this multiplier.
### Table 5.5: The Tax Multiplier

<table>
<thead>
<tr>
<th>Case</th>
<th>Distortion</th>
<th>Distortionary Taxes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure Ricardian</td>
<td>None</td>
<td>-0.0478</td>
</tr>
<tr>
<td>Finite Horizons</td>
<td>p = 0.02</td>
<td>-0.0481</td>
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<tr>
<td>Finite Horizons and Population Growth</td>
<td>p = 0.02 g = 0.02</td>
<td>-0.0764</td>
</tr>
<tr>
<td>Public Capital Externality</td>
<td>$\gamma_1 = 0.5$</td>
<td>0.1267</td>
</tr>
<tr>
<td>Finite Horizons and Public Capital Externality</td>
<td>$\gamma_1 = 0.5$ p = 0.02</td>
<td>0.1305</td>
</tr>
<tr>
<td>Finite Horizons, Population Growth and Public Capital Externality</td>
<td>$\gamma_1 = 0.5$ p = 0.02 g = 0.02</td>
<td>0.1168</td>
</tr>
<tr>
<td>Liquidity Constraints, Finite Horizons, Population Growth and Public Capital Externality</td>
<td>$\gamma_1 = 0.5$ $\lambda = 0.7$ p = 0.02 g = 0.02</td>
<td>0.1196</td>
</tr>
</tbody>
</table>
Table 5.5: The Development Expenditure Multiplier

<table>
<thead>
<tr>
<th>Case</th>
<th>Distortion</th>
<th>Lump sum Taxes</th>
<th>Distortionary Taxes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure Ricardian</td>
<td>None</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Finite Horizons</td>
<td>p = 0.02</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Finite Horizons and Population Growth</td>
<td>p = 0.02</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Public Capital Externality</td>
<td>γ₁ = 0.5</td>
<td>0.0850</td>
<td>0.0710</td>
</tr>
<tr>
<td>Finite Horizons and Public Capital Externality</td>
<td>γ₁ = 0.5</td>
<td>0.0858</td>
<td>0.0726</td>
</tr>
<tr>
<td>Finite Horizons, Population Growth and Public Capital Externality</td>
<td>γ₁ = 0.5, p = 0.02, g = 0.02</td>
<td>0.0874</td>
<td>0.0754</td>
</tr>
<tr>
<td>Liquidity Constraints, Finite Horizons, Population Growth and Public Capital Externality</td>
<td>γ₁ = 0.5, λ = 0.7, p = 0.02, g = 0.02</td>
<td>0.0765</td>
<td></td>
</tr>
</tbody>
</table>

When we include only the externality due to public capital then the value of the debt multiplier is -0.0065, while if we include all the non-Ricardian demand side effects due to finite horizons, population growth, tax distortions and liquidity constraints it is -0.0088. This means that the effect of a ten per cent reduction in growth rate would raise the long run growth rate in the first case by 0.065 per cent and in the second by 0.088 per cent. By ignoring non-Ricardian demand side effects, though they have been found to exist, the anticipated change in the long run growth rate would not be very different. From the current level of 4.5 per cent it is anticipated to rise to 4.5088, when demand side effects are included and 4.5065 when they are ignored. Even in the case
of development expenditure and the tax rate, there is only a marginal change in the value of the multiplier when these effects are ignored.

The strongest effects arise from public capital externalities, and in their absence from tax distortions. Our results thus appear to suggest that in an endogenous growth model which takes into account strong supply side effects caused by externalities arising from public investment, ignoring non-Ricardian effects on the demand side would not significantly affect our results. Ignoring Blanchard-Weil demographics may on the one hand lead to loss of generality and perhaps reduce the accuracy of our results, but more may be gained by the analytical simplicity achieved by making Ricardian assumptions on the demand side.

5.9. Conclusion

Our analysis reveals the significance of the violations of Ricardian assumptions. Our results indicate that though non-Ricardian effects are potentially significant the effect of population growth, finite horizons and liquidity constraints does not change our results drastically.

The major policy implications that arise from the above results are that the growth rate of the Indian economy can be raised most effectively by either raising the tax rate or by raising the proportion of development expenditure. The tax rate can be raised effectively by bringing into the fold of the tax structure those sectors that at present enjoy exemption. Rationalising the tax system while widening the tax base could be more effective in raising the proportion of income that is paid as taxes. As we have discussed earlier, there is an attempt to streamline, restructure and rationalise the tax structure under the SAP.
On the other hand, there is no attempt to raise development expenditure. On the contrary, $\gamma$ has declined in this period. Cutting public investment is going to reduce the long term growth potential of the economy. Such a policy is counter-productive and though there seems to be a general awareness of the implications of reducing public investment, it is still being followed to meet the government’s commitment under the SAP to cut deficit. Clearly, the emphasis needs to shift from simply cutting the deficit, to cutting it by reducing non-development expenditure and to diverting spending from government consumption to public investment. Unless the policy framework of the SAP clearly defines the role of public investment and takes into account the effect of government policies on long-run growth, borrowing countries concerned might continue to follow such counter-productive policies. A clear definition of the role of public investment and its contribution to the economy wide efficiency of labour can prove to be a step towards raising the long-run steady state growth rate in the economy.
Conclusion

In this thesis we examine the effects of fiscal policy on the long-run steady state growth rate in the framework of an endogenous growth model of India. We first examine the Ricardian hypothesis that predicts that fiscal policy has no effect on consumption and private investment in an economy. Next we estimate non-Ricardian effects on the demand side and calibrate our model which has public capital externalities on the supply side to determine the impact of changes in tax rate, debt /GDP ratio and the proportion of government spending on development on the long-run steady state growth rate of the economy.

Since Ricardian Equivalence predicts that fiscal policy is neutral we first examine the Ricardian model for India. Underlying the Ricardian equivalence theorem is the permanent income hypothesis and the assumption that there are no credit market imperfections. Liquidity constraints magnify the response of current consumption to current income. Our results suggest an 'excess sensitivity' of consumption to disposable income in India. This implies that the Ricardian assumption of perfect credit markets is violated for India.

The representative agent model prevents us from analysing the effect on consumption of a transfer of population between the forward looking permanent income consumers whom we call “unconstrained” and those who consume their current income the “constrained”. We, therefore, describe an aggregate consumption function that allows for both groups of consumers to exist in one population and for there to be a transfer between the groups. The unconstrained consumers have a constant probability of death that can lie
between zero and one. They own all the physical and financial wealth in the economy, have access to credit and they smooth consumption over their lifetimes. If we define their probability of death \( p \) as zero then they would represent Barro's infinite horizon consumers.

The liquidity parameter, \( \lambda \), represents the fact that in an economy, especially in a poor developing country not all consumers can be described as unconstrained as they do not have access to credit. The transfer of consumers from one group to another can come about, for instance, by a liberalisation of the credit market or by a redistribution of income and wealth. The parameter of population growth of unconstrained consumers, \( g \), captures the change in the consumption pattern of an economy undergoing structural transformation.

An interesting result that emerged from our results was the value of \( g \) that was estimated to be -0.12. The negative value suggests a net transfer from the unconstrained to the constrained group for the period under consideration. Our estimate indicates income redistribution that is unfavourable to some sections of the population in the period 1960-80. Figures for rural income distribution and poverty levels suggest that India's process of development, with its emphasis on large-scale capital-intensive industry and modernisation of agriculture in selected pockets of the country, has been accompanied by pauperisation of a section of the peasantry. This hypothesis is also supported by the evidence of a rise in the aggregate savings ratio and the build-up of food stocks.

Production externalities in our model arise from the effect of public and private capital on the economy-wide efficiency of labour. Capital is defined in a broad sense to include infrastructure and human capital. Public spending on education, health, irrigation, transport, telecommunications, etc., is part of government spending on capital formation. In India the public sector was envisaged to have a crucial role in the planning process that aimed to speed up the rate of economic growth. Fiscal policy was regarded by planners and
Policy makers as an important tool in India’s development strategy. Public investment intended to provide both the physical infrastructure and the human capital required for economic growth. In recent years, however, the rising burden of government consumption expenditure and higher interest payments has squeezed the resources available for development expenditure. The government’s commitment to development expenditure has been further undermined under the Structural Adjustment Programme. Since on the one hand, there is no clearly defined role for public investment, and on the other there is pressure to cut total spending and reduce deficits, we observe that in recent years there has been a reduction in the proportion of development expenditure in total government spending.

We analysed the effect of fiscal measures - changes in the debt/GDP ratio, the tax rate and the proportion of development expenditure in total government spending on the objective of economic growth in a steady state model of endogenous growth. The significance of the non-Ricardian effects observed earlier is examined in our analysis of the effect of fiscal changes. Our results indicate that though potentially the effect of finite horizons, liquidity constraints and population growth can be important, the effect of these non-Ricardian assumptions is marginal. The strongest non-Ricardian effects arise from distortionary taxes. When fiscal policy has a strong impact on growth, due the externalities arising from public investment, the only significant demand side non-Ricardian effect originates from tax distortions. The multipliers are relatively insensitive to the presence of finite horizons, population growth and liquidity constraints in the model. In terms of modelling strategy this suggests that while achieving analytical simplicity by ignoring them we will not lose much in terms of empirical application. Although we detect the presence of finite horizons at the estimated value of the parameter it has very minor implications for
growth. This suggests that in future research we can assume that Barro's assumptions for household behaviour hold without a loss of generality. In other words, the contribution of this study in terms of modelling strategy lies in not just imposing the demand side effects but estimating the consumption function to determine them, to assess the impact of the non-Ricardian effects for fiscal policy analysis and show which of them have important implications for growth.

The multipliers derived suggest that a reduction in the debt/GDP ratio leads to an increase in the long-run growth rate. The effect of the tax rate is ambiguous. When the contribution of public capital to the economy-wide efficiency of labour is high an increase in the tax rate increases the long-run rate of economic growth. If, however, the contribution of the public sector is low compared to that of private investment then an increase in the tax rate which reduces private investment, has a negative effect on the long-run growth rate. When the contribution of public capital to the economy-wide efficiency of labour is greater than that of private capital, then reducing the tax rate will decrease the growth rate. The effect of reducing the proportion of public investment in government spending on the long-run growth rate is always found to be negative. In our calibration for India we find that the magnitude of the development expenditure multiplier is nearly six times the value of the debt/GDP ratio multiplier. Whatever the contribution of public capital to the economy-wide efficiency of labour, the effect of a change in public investment is positive. If the objective is to achieve a higher rate of long-run economic growth in India, a reduction in public investment is clearly contrary to this objective.

The explanation of why the proportion of public investment in total government spending is falling sharply under the SAP despite its negative effect on growth, could be that the emphasis in a SAP is on short-term macroeconomic balance rather than growth. As
distinct from the IMF, the World Bank, whose horizon for an adjustment programme is usually longer, emphasises supply side measures. Recently, it has also been emphasising the role of human capital. To take account of this, government spending on health and education in India has been increased in the last two years. Also, it is proposed that a Policy Framework Paper be drafted jointly by the borrowing government, the IMF and the World Bank. The objective is to achieve a better balance between and short term goals of the IMF and the objective of long-run growth.

The major limitation of the framework adopted in this study is that it is a closed economy model. While this may be acceptable for India at the present level of development, such a model may not approximate reality for another country or for India in the future. A closed economy model prevents us from analysing the effect of inflow and outflow of capital to and from the country. Since capital is not homogenous, this is not a trivial issue. For example, the inflow may be of foreign capital which comes with new technology and contributes significantly to the economy-wide efficiency of labour. The outflow may be of highly educated technical and scientific personnel like engineers and doctors (‘brain drain’) whose training has involved significant investment.

Research in endogenous growth theory is opening up many avenues. For instance, we could follow Barro and Sala-i-Martin (1995) in analysing the effect of technology diffusion through imitation and/or foreign investment. Intellectual property rights could be granted by a government to foreign investors if spill-over effects on growth of the profit flow were higher than of technology diffusion through imitation of designs. Though many issues relating to open economy models have not been settled satisfactorily, there are attempts to solve them. Barro and Sala-i-Martin (1995)
introduce credit constraints on international borrowing, variations in the time
preference parameter and adjustment costs to deal with some issues.

We could also explore the possibility of extending the above model to examine
the impact of military expenditure on growth rate. In a similar model Berthelemy et.
al. (1995) analyse the interrelationships between military expenditure and growth in a
model where investment in education creates skilled labour which increases the
endogenously determined rate of growth. Since both education and defence are non-
rival in use, they are public goods and have to be financed by taxation. Therefore there
is a trade-off between them. By raising security defence contributes to social welfare.
But if it leads to lower civilian spending which is also assumed to contribute to welfare
then the total effect may be either way. There is thus a case for analysing both
economic growth and welfare in a framework that incorporates defence and
development expenditure. In our model development expenditure (which includes
education) serves to raise the overall efficiency of labour in the economy and therefore
contributes to growth. We could also take into account spill-over effects from
investment in military R&D and defence related infrastructure in the aggregate
production function. Both development expenditure and defence expenditure then
contribute to growth. Since here externalities would arise from private capital and
public infrastructure as well as education and defence spending the model would be
broader in its analysis. Also, if it is assumed that public investment in health, education,
infrastructure, etc. raise the quality of life of the population then it could be included in
the social welfare function. We could then study the impact of military expenditure on
growth and welfare as in Berthelemy et. al. (1995) but incorporating a wider range of
phenomena.
In this study we have demonstrated the applicability of recent developments in macroeconomics to issues of growth and development in LDCs in just one aspect - that of fiscal policy. The scope of our study is however much larger - for example, endogenous growth theory has a bearing on many issues relating to technology diffusion, intellectual property rights, the migration of labour, and so on. No doubt, the next few years will witness a boom in research in many of these aspects of development within the framework of endogenous growth models.
Appendix A

The Yaari-Blanchard and Linear Technology Curves

Here we examine the slope of the The Yaari-Blanchard and Linear Technology curves. Consider incremental changes in the exogenous fiscal variables dD, dt, dy and the corresponding incremental changes dn and dr along the YB and LT curves. Differentiating, these incremental changes satisfy

\[
f_n dn + f_r dr + f_{\delta} d\delta + f_d dD = 0
\]

\[
g_n dn + g_r dr + g_{\delta} d\delta + g_d dD + g_{\gamma} d\gamma = 0
\]

Hence keeping fiscal policy and income distribution fixed, the slope of the YB curve is given by

\[
\left(\frac{\partial n}{\partial r}\right)_{f=0} = -\frac{f_r}{f_n}
\]

\[
f_n = -(1+\delta)C-\phi(K+D)<0
\]

From (5.29) \(\phi C-\eta(D+K)=0\)

since \(C>0, K+D>0,\) and \(\eta = (p+g)(p+\delta)(1+r(1-\tau))/(1-p) > 0,\) so

\(\phi = r(1-\tau)-\delta-n(1+\delta)>0.\) Note that if \(p+g=0\) then \(\phi = 0.\) Also from (5.29) we have

\(f_r = \phi(D-[n+\pi]/(1+n))(1-\tau)K'(\tau)+C(1+g)(1-\tau)-\{(p+\delta)(p+g)(1-\tau)/(1-p)\}(D+K(\tau))-\eta
\]

\(K'(\tau)>0\)

Since \(f_n < 0\) and \(f_r > 0\) therefore \(-fr/fn > 0.\) In other words, \(\left(\frac{\partial n}{\partial r}\right)_{f=0} > 0\) or the YB curve is upward sloping.

Turning to the LT curve when fiscal policy is given, its slope is given by

\[
\left(\frac{\partial n}{\partial r}\right)_{g=0} = -\frac{g_r}{g_n}
\]

\[
g_n = (1-\gamma_2)[(1+r)D/(1+n)^2 G]-(1 / (n+\pi))+1/(1+n)]
\]
\[
g_r = \gamma_2 \{K(r)\} / \{K(r)\} - (1-\gamma_2)(D/G + \tau \pi K'(r)) / G
\]

Hence \(g_r < 0\) and \(g_t < 0\) if \(D < G/n + \pi\) and \(\tau \pi < G K(r) \gamma_2/(1-\gamma_2)\). For \(G=0.3\) and \(n + \pi < 0.1\) the first of these conditions is satisfied if \(D < 3\) (i.e., a debt/GDP ratio less than 300%). We expect \(\gamma_2 > 1/2\), \(\tau < 0.5\) and \(\pi < 0.1\) (on an annual basis). If \(G=0.3\) again, the second condition is satisfied if \(K < 6\), not a stringent condition. From these considerations we deduce that, under very lax conditions, the LT curve is downward-sloping.

The remaining partial derivatives are

\[
f_D = \phi(r-n)/(1+n) - \eta
\]

\[
f_t = -(1+g)C - \phi(1-\pi K + \lambda(1-\alpha)) + \{(p+g)(p+\delta)/(1-p)\}r(D+K)
\]

\[
g_t = \{(1-\gamma_2)(1-\pi K)\} / G
\]

\[
g_D = -(1-\gamma_2)(r-n)G/(1+n)
\]

\[
g_\gamma = (1-\gamma_2)/\gamma
\]

From these results we can unambiguously sign \(g_D < 0\) and \(g_\gamma > 0\). We require \(1-\pi K(r)) > 0\) to obtain positive consumption which gives \(f_t < 0\) and \(g_t > 0\). Finally along \(f=0\) we have that \(f_D = \eta V/C(r-n) - \eta\). Hence \(f_D < 0\) if \(r-n < C/V\) which requires extraordinarily large capital/GDP and debt/GDP ratios to violate. To summarise we expect \(f, g_\gamma, f, g, g_D < 0\).
# Appendix B
## The Data Set

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CONS      Private household Consumption
GDP       Gross domestic Product
GOVC      Government Consumption Expenditure
POP       Population
CPI       Consumer Price Index
EX        Exports
IM        Imports
DEBT      Domestic Public Debt
DEF       Fiscal Deficit
PSI       Private Sector Investment
GSI       Public Investment

At current prices
Bibliography and References


Bardhan, Pranab (1989), The Political Economy of Development in India, Oxford University Press, Delhi.


Barro, R.J. (1990), Government Spending in a Simple Model of Endogenous Growth',


International Monetary Fund, 'International Financial Statistics', Various issues.


Weale, Martin(1990), 'Wealth constraints and consumer behaviour', Economic Modelling, 165-178.

