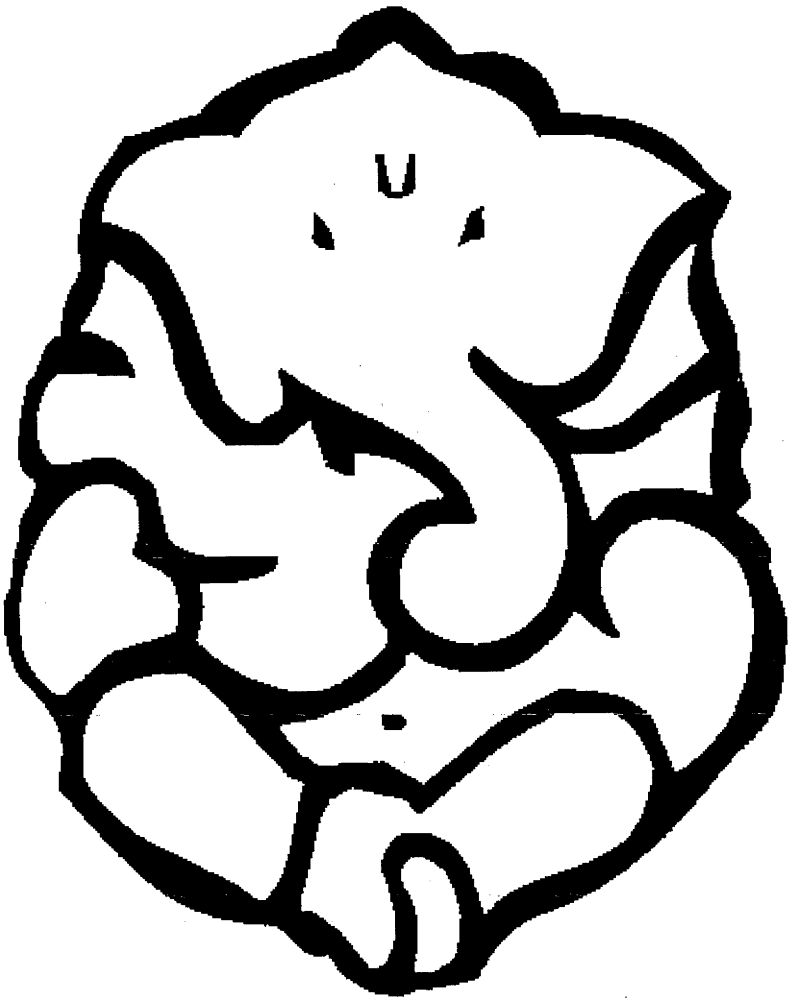

वक्रतुण्ड महाकाय सुर्यकोटि समप्रभः।
निर्विघ्नं कुरूमेदेव सर्वकार्येषु सर्वदा।

FISCAL DEFICITS, BANKING CRISES AND ADJUSTMENT POLICY IN A SEMI-OPEN ECONOMY

by

Anurag Sharma

A thesis submitted for the Degree of Doctor of Philosophy
of the Australian National University

Division of Economics
Research School of Pacific and Asian Studies
The Australian National University
July, 2004

I declare that this thesis contains no material which has been previously published or written by another person, except where due acknowledgement is made in the text of the thesis.

Signed: Anurag Sharma
Anurag Sharma

Date: 12/07/2004

ABSTRACT

This dissertation combines the role of credit market distortions in monetary policy transmission and the impact of government policy on the financial sector, which have to date been studied separately in the literature. The thesis argues simultaneous interaction between these two sectors can lead to an endogenous policy reversal attached to any government stabilization effort. Policy reversal can be described as a situation where government policies of sound fiscal management or financial restructuring so adversely affect the banking sector (due to underlying inefficiencies) that it is subsequently forced to revive the sector with policies such as recapitalization of public sector banks, honoring contingent liabilities or explicit bail-out packages that serve to undermine the initial stabilization efforts and adversely affect the government exchequer. The dissertation provides an overview of the Indian banking sector (Chapter 2) emphasizing the possibility of policy reversal and concludes financial sector reform in India is incomplete. The banking sector remains inefficient due to several factors viz. high reserves and liquidity requirements, a poor regulatory and supervisory framework and the presence of implicit government guarantees and high transaction costs.

The dissertation formally models and quantifies partial policy reversals subsequent to the introduction of stabilization programs particularly in developing countries, in a general equilibrium set up. The theoretical model predicts the offsetting effect attached to stabilization policy can only be eliminated by adopting loose monetary policy thereby undermining any initial stabilization measures. Using data from India, it then provides empirical support for the model's prediction. Subsequently the dissertation empirically tests two assumptions underlying endogenous policy reversals viz. government satisfies its intertemporal budget constraint and banks play a significant role in monetary policy transmission.

Satisfaction of the government's intertemporal budget constraint is related to the broader question of debt sustainability. The dissertation argues the debate on debt sustainability should be examined in the light of recent advances on endogenous structural breaks in the cases of unit root analysis and cointegration, since revenue and expenditure series

are susceptible to structural breaks in response to sharp economic shocks. The empirical analysis discovers that structural breaks or regime shifts play a crucial role in time series analysis of revenue and expenditure series, in the case of India. The contributions of this analysis are in providing a basis for testing for debt sustainability even in the absence of data on debt; and a methodology for inducting unknown structural breaks in the analysis of the sustainability of public debt at both the unit root testing and cointegration stages. In the particular case of India, it is discovered that the debt is not unsustainable, in sharp contrast to the widely prevalent view in extant literature and policy discussions. However this result is supportive of an assumption made in the context of the general equilibrium model developed here.

The dissertation further empirically justifies the importance of the bank lending channel in India. The empirical analysis uses aggregate data to establish a long run relationship between the interest rate spread and bank credit (using cointegration). The analysis further reveals that bank credit does adjust significantly in the direction of equilibrium in the short run confirming the role of banks in transmitting monetary shocks.

ACKNOWLEDGEMENTS

I take this opportunity to express my gratitude to my supervisor Prof. Raghbendra Jha, for his invaluable guidance, innovative ideas and suggestions on my research. I have yet to see the limits of his wisdom, his patience, and his selfless concern for his students. I would also like to thank my dissertation committee members, Dr. Satish Chand and Dr. Prasanna Gai for their support and constructive comments on my work. I gained a lot from the academic discussions and comments from Prof. Warwick Mckibbin and thank him for his time and help.

I am thankful to GOD almighty and my parents for giving me the courage, strength and encouragement that I needed to complete my goals. I thank my wife Kompal for her motivation and constant academic and mental support throughout the writing of my dissertation. Without her backing and help, the progress of the dissertation would have been considerably delayed at various stages. My little daughter Krittika's arrival during the writing of my thesis and her presence made the difficult phases of my research into merrier ones. I thank my brother Avinash for his constructive queries on my dissertation which motivated me to finish it soon.

I wish to thank my department for the excellent work culture and the helpful academic and computer center staff. Many thanks to Ms. Carol Kavanagh for careful editing of my thesis. My research has immensely benefitted from feedback I received during my presentations at regular departmental PhD workshops, the Econometric Society Australasian Meeting, 2003 and the Ten Years of Australia South Asia Research Center (ASARC) Conference, 2004.

I am especially grateful to the Australian National University for providing me with financial support through the ANU PhD scholarship. I would also like to thank my friend Arvind Jha for providing part of the data used in this dissertation.

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey Fuller
CD	Certificate of Deposit
CRR	Cash Reserve Ratio
FDI	Foreign Direct Investment
FRBMA	Fiscal Responsibility and Budget Management Act
FRBMB	Fiscal Responsibility and Budget Management Bill
GDP	Gross Domestic Product
GIRF	Generalized Impulse Response Function
IIP	Index of Industrial Production
MIP	Minimum Income Plan
NABARD	National Bank for Agriculture and Rural Development
NAV	Net Asset Value
NBFC	Non Banking Finance Company

NDA	National Democratic Alliance
NGO	Non-Governmental Organization
NPA	Non-Performing Asset
NRI	Non-Resident Indian
PDV	Present Discounted Value
PLR	Prime Lending Rate
PSB	Public Sector Bank
PSU	Public Sector Unit
RBI	Reserve Bank of India
RRB	Regional Rural Bank
SBI	State Bank of India
SCB	Scheduled Commercial Bank
SEBI	Security and Exchange Board of India
SHG	Self-Help Group
SLR	Statuary Liquidity Ratio
UPA	United Progressive Alliance
UTI	Unit Trust of India
VAR	Vector Auto Regression
VECM	Vector Error Correction Model

LIST OF SYMBOLS

δ	Per unit transaction cost of making loans	
ϵ_t	Rate of devaluation	
η_t	Rate of growth of real GDP	%
Γ^b	Government transfer payments to banks in case of default	
π_t	Domestic rate of inflation	%
π_t^*	Foreign inflation	
ψ	Reserve requirement ratio	
ρ_t	Government expenditure inclusive of transfer payments and interest on debt	Rs.
τ_t^L	Lump sum tax on households	
θ	Risk premium of investing in the economy	
φ_t	real interest rate – rate of growth of real GDP	
ς	Fraction of commitment to the banks by the government	
B_t	Government debt	Rs.
bh_t	Banks' bond holdings	Rs.

c_t	Household consumption	
d_t	Domestic demand deposits	Rs.
d_t^*	Foreign borrowing by the banks	$
e_t	Nominal Exchange Rate	Rs/$
G_t	Government expenditure	Rs.
H	Herfindahl Index	
h_t	High powered money	Rs.
i_t	Nominal domestic interest rate	
i_t^*	Nominal world interest rate	%
i_t^{bh}	Yield on government treasury bills	%
i_t^b	Interest to be paid on foreign borrowing	%
i_t^d	Banks' deposit rate	%
i_t^g	Rate of interest payable on government debt	%
i_t^l	Bank lending rate	%
L_t	Bank credit or loans	%
l_t	Labor Supply	
M_t	Domestic money supply	Rs.
P_t	Domestic price level	Rs.
P_t	Domestic price of tradeable good	Rs.

P_t^*	Foreign price of tradeable good	Rs.
q	Probability of devaluation	
R_t	Combined revenue of central and state governments	Rs.
r_t	Real world interest rate	%
T_t	Government tax revenue	Rs.
w_t	Household wage rate	
x_t	Household leisure	
Y_t	Real GDP	
y_t	Output	
z^{**}	Stabilizing primary surplus	Rs.
z_m	Maximum level of government primary surplus	Rs.

CHAPTER 1

Introduction

1.1 Overview

This dissertation investigates the role of the banking sector in affecting the impact of stabilization policies and creating endogenous forces which could lead to partial policy reversal of stabilization measures. A policy reversal can be described as a situation where government policies of sound fiscal management or financial restructuring so adversely affect an inefficient banking sector, that the government is forced to revive the banking sector by using policies such as recapitalization of public sector banks, honoring contingent liabilities or explicit bail-out packages that undermine its initial efforts and adversely affect the government exchequer. Examples of potential policy reversals include stabilization policies in Russia and Brazil when these countries were suffering chronically high inflation pre-crisis. Due to high inflation banks had a huge markup on profits. As soon as inflation fell sharply, banks faced reduced profits or losses forcing the government to bail them out.

A more recent example is the Unit Trust of India (UTI) mutual funds crisis in 2002. The main objective of UTI (which had a monopoly in the funds market until 1985) was to invest retail savings in the capital market and pass the accrued benefits back to small investors. The crisis was caused by the poor regulatory and supervisory framework in India. This

environment encouraged UTI to make imprudent investment decisions which resulted in large losses. As a result the UTI market share dropped from 77 per cent in 1999 to 46 per cent in 2002. Due to intense political sensitivity involved, after initial denials of bailout[1], the government was forced to backtrack and approved a package of over Rs. 145 billion for UTI to meet the liabilities on its returns schemes.[2]

The outline of the present chapter is as follows: Section 2 surveys the literature highlighting the linkages between the banking sector crisis and stabilization policies. Section 3 outlines the structure of this dissertation and summarizes its contributions to the literature.

1.1.1 Stabilization

The dissertation uses the word stabilization broadly in reference to the "orthodox stabilization" (Bruno, 1993) which affects the real fundamentals and are a part of more broader "structural reforms". As Bruno (1993, page 269) points out the objective of such stabilization policy is to achieve internal and external balance in the following ways: For orthodox stabilization: *"(a) Establish permanent budget balance (usually includes substantial cut in direct and indirect subsidies and increase in taxes), (b) Up-front devaluation (usually followed by an initial exchange-rate peg...), (c) Establish or bolster central bank independence, (d) Obtain external stabilization fund (and/or debt rescheduling) and (e) Establish social safety net, within constraint of (a) (to soften immediate distributional costs and facilitate political acceptance)."*

The objective of structural reforms is to remove micro-distortions to enhance efficient growth in following ways: *"(a) External current-account liberalization (remove quotas and licensing with or without pre-announced receding tariff schedule), (b) Fiscal reforms (of tax,*

[1] In a press conference the finance minister Y. Sinha was quoted as saying, "*We cannot go on spending government money for bailouts. A budgetary support is not a desirable option at the moment.*"

[2] UTI crisis has been discussed in detail in Appendix A.

expenditure, and internal transfer systems), (c) Deregulation of domestic financial and capital markets and creation of new institutions for financial intermediation, (d) Deregulation and/or liberalization of labor markets (e) Privatization and de-monopolization of goods and services, and (f) Deregulation of the external capital account."

The government can use fiscal or monetary policies to achieve its objective of stabilization. There are various channels of transmission of stabilization policies (See Mishkin, 1995, for an excellent discussion on these). This dissertation focusses on the bank lending channel of transmission of stabilization policy. The bank lending channel is based on the view that banks play an important role as a financial institution for small firms or bank dependent borrowers. According to this channel real economic activity in the economy can be affected through the supply of loans in the financial sector and keeping interest rates broadly unchanged. Thus banks respond to a monetary contraction by decreasing the supply of loans thereby adversely affecting the aggregate output and inflation in the economy. The basic underlying assumption for the existence of a credit channel is imperfection in the capital markets and it is argued that this channel tends to weaken with financial innovation and liberalization of capital markets (Kashyap and Stein, 1994). The literature argues that as a result of the vastly expanding financial innovation of recent times, banks have a less important role to play in credit markets (Bernanke and Gertler, 1995). While this argument may be true for the developed economies where financial liberalization is advanced, for developing countries with weak financial systems, banks continue to play a crucial role in credit markets.[3]

[3]For a discussion on bank lending channel see Chapter 5.

1.2 Banking Sector and Stabilization

The factors responsible for financial distress in an economy can be grouped under the following headings: unsustainable macroeconomic policies, weakness in financial structure, global financial shocks, exchange rate misalignments, and political instability (Kunt and Detragiache, 1998). In addition, fluctuations in the economy give rise to shifts in market sentiments that contribute to stress in the financial system. Macroeconomic instability has been an underlying factor in many financial crises (e.g. 1997 East Asian currency crisis); expansionary monetary and fiscal policies have spurred lending booms, excessive debt accumulation, and over investment in real assets, which have driven up equity and real estate prices to unsustainable levels. This has often lead to a speculative bubble (Corsetti et al., 1998b) (Kho and Stulz, 1999) (Burnside et al., 2001).

Eventually governments have to tighten policy to contain inflation and promote the adjustment of external positions, and the inevitable correction of asset prices. Such stabilization policies lead to a slowdown in economic activity, debt servicing difficulties, declining collateral values and net worth, and rising levels of non performing loans that threaten banks' solvency (Corsetti et al., 1998a). Lending booms were the major cause of financial crises in Latin American countries (Ter-Minnassian and Schwartz, 1997). Macroeconomic instability has been an important factor in most banking crises experienced by industrial countries in the post war period (Kaminsky and Reinhart, 1998).

A banking crises refers to a situation where actual or potential bank runs or failures induce banks to suspend the internal convertibility of their liabilities or compel the government to intervene to prevent this by extending assistance on a large scale (IMF, 1998). Banking crises can lead to a "credit crunch" (Bernanke and Lown, 1991) causing a reduction in the flow of credit to households and firms thereby adversely affecting investment and consumption. Stress in financial sector can also reduce confidence in the financial insti-

tutional structure leading to reduced domestic savings and large capital outflows (Cerra and Saxena, 2002) (Demirguc-Kunt et al., 2000). Efforts to bail out may involve use of expansionary monetary policy (reflected by, say, recapitalization measures used to rescue banks (Bhattacharya and Patel, 2003)) and public funds which may have an adverse effect on the government budget. Protection of the banking sector allows inefficient banks to stay in business (at the cost of healthy banks) and reduces incentive for adequate risk management (see Shirai, 2002, for discussion on India).

But expansionary monetary policy to prevent banking sector losses can increase inflation and also trigger a speculative attack against the currency in "pegged" exchange rate regimes specific to most developing countries (Rebelo, 1994) (Chang and Velasco, 2000). Banks become insolvent when the value of their liabilities (deposits) exceed the value of their assets (bank credit). Banks in the financial sector of many developing countries face credit risk (Kunt and Detragiache, 1998) and suffer from a high incidence of Non-Performing Assets (NPAs) i.e. those loans on which borrowers default (Bhattacharya and Patel, 2003).[4] The literature argues credit risk can be reduced by screening loan applicants (Sinn, 2001) and, diversifying the loan portfolio by lending to borrowers who are subject to different risk factors (Elyasiani et al., 1995), or asking for collateral.

However, in developing countries it is very difficult to eliminate credit risk. There is an incentive for banks in these countries to invest in somewhat "riskier" projects as returns are higher. Banks behave in this way because of a weak regulatory and supervisory framework and the presence of implicit government guarantees to bail them out of a crisis (Polackova, 1999). Government policy of concessional and directed lending to "priority sectors" also contributes to high NPAs (Ketkar, 1993). The banks also suffer from the high transaction costs of making loans.[5] Though governments encourage group lending to reduce transac-

[4]For example, in 1992-93, NPA's amounted for 24 per cent of total assets of public sector banks in India.

[5]The opportunity cost of high transaction costs is put at 2 to 3 per cent of GDP by the Reserve Bank

tions costs, they remain significantly high (Puhazhendhi, 1995). Thus "non-policy" shocks such as terms of trade deterioration or a decline in asset (equity or real estate) prices which adversely affect bank borrowers (firms and households) can lead to a banking crisis as credit risk diversification is minimal in underdeveloped economies.

However some "policy shocks", such as an increase in short term interest rates caused by adoption of restrictive monetary policy, can adversely affect banks' balance sheets even if they do not have significant NPAs (Kashyap and Stein, 1994). An increase in interest rates may cause banks' returns from lending operations to fall short of the rate that must be paid on liabilities. For example, a rise in savings deposit rates will force banks to pass on the increase to depositors. However, banks' returns on assets will not change as they mostly consist of long term loans on fixed interest rates which cannot adjust quickly in the short run. Banks cannot pass on the higher interest rates to borrowers because of the policy of directed and concessional lending in most developing countries. Even if banks are allowed to increase lending rates there is a risk of a rise in the share of NPAs. Small borrowers will default on loans rather than pay higher interest rates. Thus a policy-based stabilization process may lead to reduced profits or losses in the banking sector. In countries like India where government is the major banks' shareholder[6] the government has to rescue the banks. This action offsets the government's initial stabilization efforts.

Another example of policy shock that leads to banking distress is successful inflation stabilization policy in economies suffering from chronically high inflation. An economy with high inflation is characterized by an overblown financial sector and banks' profit from the float on payments. Therefore a drastic reduction in inflation as a result of stabilization policies results in one of the main sources of banks' revenue disappearing. Recent banking sector difficulties in Russia and Brazil are explained in this way.

of India (RBI) (RBI, 2003a).

[6]In 2003 the public sector banks owned by the government of India accounted for about 80 per cent of deposits, assets and credit in the economy (CII, 2004).

Liberalizing an economy, say, by an easing of capital controls combined with a simultaneous restrictive monetary policy of raising domestic rates to curb inflation, may lead to a period of large inflows of short term capital and expansion of domestic credit. When investors lose confidence or when world interest rate rises relative to domestic rates there is a sudden outflow of short term capital making the banking sector illiquid. The crises in East Asian countries in the late 1990's and Latin American countries in the early 1990's are attributed to this.

Bank profitability can also be threatened when a rate of return mismatch occurs as a result of banks' borrowings in foreign currency and lending in domestic currency (Burnside et al., 2001). In this case, an unexpected depreciation of the domestic currency would threaten bank profitability. The banks in this case can also choose to issue domestic loans denominated in foreign currency in order to hedge but an unexpected devaluation will then result in an increase in NPAs thereby affecting the profitability of the loans. Foreign currency loans were a source of banking problems in Chile in 1981, Mexico in 1995 (Goldberg et al., 2000), the Nordic countries in the early 1990's and in Turkey in 1994.

The crux of the argument here is that the economic implications of a banking crisis can be significant in an economy with an underdeveloped financial sector. A banking crisis restricts the capacity of banks to make domestic loans. Thus bank-dependent borrowers, such as small business, may find it more costly to obtain credit. This may be inefficient and inequitable for an economy where small businesses play an important role in developing product and process innovations (Bernanke and Lown, 1991). A "credit crunch" could also lead to a decline in economic activity, affecting both aggregate demand and supply

Bernanke and Blinder (1988) do a modified $IS - LM$ analysis under the additional assumption that bank loans are imperfect substitutes for other assets (bond and money).[7]

[7]This assumption implies the financial sector is not competitive enough to make the alternative sources of finance easily accessible to small borrowers.

They conclude an exogenous decline in bank lending is a negative IS shock to the economy. This is because at a given interest rate, the net return to investment for a bank dependent borrower depends on the marginal product of investment as well as the *the cost of financial intermediation.* An exogenous decrease in banks' lending capacity will force the bank dependent borrower to either cancel the decision to borrow or opt for some costlier form of credit. In both cases the net return to investment falls at a given interest rate and hence the IS curve shifts down. Ceteris Paribus, the downward IS shift is contractionary. Hence there are two areas where reduction in bank lending can have a serious impact: a direct effect on bank-dependent borrowers and indirect effects on the economy.

Thus a banking crisis may be triggered by policy shocks arising from, for example, monetary targeting (achieved by restrictive monetary policy) which can create a "liquidity crunch" and is recessionary. The onus then is on the financial sector to bail out the economy from recession through the credit channel. In most developing countries where the financial sector is underdeveloped, banks cannot tackle a credit crunch so that the onus is again on the government exchequer to bail out the economy. This may lead to what is called a partial policy reversal by government which offsets its initial efforts of stabilization. The underlying reason behind policy reversals is inefficiency in the financial sector. Chapter 2 of this dissertation highlights the main inefficiencies in the Indian banking sector which can contribute to policy reversals by the government. Chapter 3 formally models the possibility of policy reversal in a general equilibrium setup.

One of the crucial assumptions of a policy reversal mechanism is that government is capable of honoring its contingent liabilities and rescuing the financial sector. The immediate effect of a policy reversal will be an increase in the government's fiscal deficit which will have to be financed by external or internal debt. Thus it is implicitly assumed that government satisfies its intertemporal budget constraint. Chapter 4 tests for the solvency of central

and state government deficits for India.

Another imperative underlying assumption for policy reversal is that banks play a significant role in financial propagation mechanism or in other words the bank lending channel is an important channel of monetary transmission in the economy. It is argued in the literature (Kashyap and Stein, 1993) (Kashyap and Stein, 1994) (Huang, 2003) that financial sector reforms tend to reduce the effectiveness of the bank lending channel as the share of alternative sources of finance from bonds or equity markets increases in the economy. Chapter 5 tests for this in the Indian case.

1.3 Outline of the Dissertation

This dissertation is divided into six chapters. Chapter 2 provides a brief overview of the evolution of the banking sector in India, emphasizing those inefficiencies which can lead to policy reversal.

Chapter 3 proposes a theoretical framework and formally models the possibility of policy reversals in the context of an economy with the broad characteristics discussed in chapter 2. The extant literature focusses either on the "bad market" or "bad policy" while discussing the effectiveness of the credit channel of monetary transmission. This dissertation integrates both credit market distortions and the presence of government policies (such as providing implicit guarantees to the financial sector), contributing to inefficiencies of the financial sector, in a single framework. The theoretical model further reveals that simultaneous interaction between these two sectors can lead to an endogenous partial offsetting effect attached to any stabilization effort by government. There are four groups of competitive agents: banks, households, firms and government. Banks are assumed to be perfectly competitive, borrowing from domestic depositors and foreign creditors. The banks borrow

in dollars from abroad and lend in local currency thereby exposing themselves to exchange rate risk. Three assumptions are introduced in the model which typically characterize developing economies and are key sources of inefficiency in the banking sector. These are: (i) Banks incur transaction costs while generating credit, (ii) Government issues contingent liabilities as a guarantee to foreign creditors in case the bank defaults on foreign borrowings and (iii) Imperfect capital mobility. Banks determine their optimal strategy given the borrowing rate they face and the guarantees against default provided by government. Households derive utility from consumption and leisure, provide labor, own firms and spend against their deposits held in the banks and face a cash-in-advance constraint when making purchases. Firms produce the only output in the economy by a single factor of production (labor) using constant returns to scale technology. The government satisfies its intertemporal budget constraint. The empirical analysis tests the transmission mechanism of the model using Indian data. A reduced form Vector Auto Regression (VAR) approach and generalized impulse response functions are used to investigate the impact of an exogenous shock in the economy. The chapter demonstrates the empirical evidence is consistent with the prediction of the theoretical model.

This dissertation then asks the question: ***Is the government able to honor its guarantees to the financial sector or, in other words, does the government satisfy its intertemporal budget constraint in the long run?*** This question is answered empirically in chapter 4 for the case of India. The chapter provides a basis for testing for debt sustainability even in the absence of data on debt, by using information on revenue and expenditure. The chapter also argues that since revenue and expenditure of any government are susceptible to sharp shocks (e.g. war, oil price shocks or shocks arising from government's own policy like financial restructuring), debate on debt sustainability should be examined in light of recent advances on endogenous structural breaks in the cases of unit root analysis and cointegration. Hence the chapter provides a methodology

for inducting unknown structural breaks in the analysis of the sustainability of pubic debt at both the unit root testing and the cointegration testing stages. Chapter 4 proposes a methodology to test for debt sustainability which can be used to determine the solvency of government intertemporal budget constraint. If public expenditure and public revenue are $I(0)$ public debt is sustainable but if they are $I(1)$ and not cointegrated public debt is said to be unsustainable. Extant work indicates India's public debt is unsustainable. However, this does not consider the fiscal deficit of the central and state governments combined, nor does it permit the possibility of endogenous structural breaks. Chapter 4 rectifies both shortcomings and thus presents a more complete analysis of the sustainability of fiscal deficit in India and shows that while the burden of the deficit is onerous, public debt is sustainable.

One of the crucial assumptions of the theoretical model discussed in chapter 3 is that banks play a significant role in the transmission of monetary policy. This issue is addressed in chapter 5. The effectiveness of the bank lending channel tends to diminish with financial liberalization (Kashyap and Stein, 1994). The Indian economy has undergone over a decade of financial sector liberalization. In the light of this, chapter 5 asks the following question: ***Has financial liberalization in recent years affected the monetary transmission mechanism by altering the channels through which it operates?*** The chapter tests the importance of the bank lending channel in the monetary transmission mechanism using the Indian data. Cointegration technique allowing for regime change is applied in the empirical analysis and a cointegrating relationship is tested between the interest rate spread (difference between the lending rate and banks return on investment) and bank credit thus indicating the long-run response of bank credit to changes in this spread. The analysis discovers a structurally stable long run relationship for bank credit with significant coefficients on the interest rate spread. The estimation of short run dynamics reveals that once such regime changes are allowed for, bank loans adjust significantly in the direction

of equilibrium after the system is subjected to an exogenous shock. Hence the chapter concludes banks play a critical role in the transmission mechanism and the results of this chapter support an important underlying assumption of the model (i.e. banks play an important role in the credit transmission mechanism) developed in chapter 3, hence further validating the robustness of the theoretical model. Chapter 6 concludes.

CHAPTER 2

Banking Sector in India: An Overview

2.1 Introduction

In the first decade following India's independence in 1947, the banking sector was characterized by low reserve requirements and no control on interest rates (Demetriades and Luintel, 1996). Acting pursuant to its policy of directed and concessional lending to priority sectors (agriculture, exports, small scale industry) the government assumed control of the financial sector in the 1960's by nationalizing the major banks. Liquidity requirements were raised and interest rates on lending and deposits controlled and these became a major source of inefficiencies in the banking sector, through out the 1970's and 1980's. Concessional lending to priority sectors with weak regulatory and supervision framework led to a high incidence of NPAs in the banking sector. In 1992-93 NPAs amounted to 24 per cent of the total assets of public sector banks. The government began a gradual process of financial sector reforms in the mid 1980's. Even though the pace of reform increased following the 1991 financial crisis, they remain incomplete. Demetriades and Luintel (1996) examine the effect of various types of banking controls on financial deepening in India and conclude these controls (with the exception of the lending rate ceiling) are having a negative impact on financial deepening and thus adversely affecting economic growth.

The Indian economy has experienced more than a decade of economic reform following the 1991 financial crisis. The present chapter focusses on a critical analysis of the reforms process with emphasis on the banking sector, to highlight those inefficiencies which can contribute to "policy reversal" by the government. Policy reversal can be described as a situation in which government policies of sound fiscal management or financial restructuring adversely affect the banking sector (due to underlying inefficiencies) so that the government is forced to revive the banking sector by using policies such as recapitalization of public sector banks, honoring contingent liabilities or explicit bail-out packages that serve to undermine its initial efforts and adversely affect the government exchequer. This chapter provides a brief overview of the evolution of the banking sector in India. Particular emphasis is placed on the possibility of policy reversal. The outline of the chapter is as follows: Section 1 describes the structure of the banking sector in India and its main characteristics in the pre-1991 period. Section 2 outlines the causes and impact of the 1991 financial crisis focussing on the changes in exchange rate regime. Section 3 critically analyzes the banking sector reforms after 1991 and summarizes current inefficiencies in the banking sector emphasizing high transaction costs and presence of the contingent liabilities. Section 4 discusses the relevance of policy reversals in India and cites some examples. Section 5 concludes.

2.2 Banking Sector in India

Banks in India are classified under the broad categories of scheduled and non-scheduled (Figure 2.1). Scheduled banks consists of Scheduled Commercial Banks (SCBs) and scheduled cooperative banks. Non Scheduled Banks comprise banks that are not included in the Second Schedule of the Banking Regulation Act of 1965 and thus do not satisfy the following conditions: a) have paid-up capital and reserve of not less than Rs. 500000 and b) Satisfy the RBI that its affairs are not conducted in a manner detrimental to the interests of depositors.

Scheduled commercial banks are further split into Public Sector Banks (PSBs), private sector banks, foreign banks and Regional Rural Banks (RRBs).

Public sector banks consists of nationalized banks and State Bank of India (SBI) group of banks. In 1969 the Indian government nationalized existing large private sector banks under its policy of assisting India's planned development strategy by mobilizing financial resources to strategically important sectors. Fourteen banks were nationalized in 1969 and six in 1980. The Punjab National Bank was merged with the New Bank of India in 1993 thereby reducing the total count of national banks to nineteen. The SBI group comprises the SBI and its seven independently capitalized subsidiaries. The government of India is the major share holder in these banks. Prior to 1991, PSBs accounted for about 90% of all deposits assets and credit in the economy.

Private sector banks are classified as old and new private sector banks. There are 23 old private sector banks. 8 private sector banks opened for business after 1991 and are classified as new private sector banks. Currently there are 42 foreign banks in India, although their share in the holdings of banking sector assets remains negligible due to strict regulatory and entry requirements.

RRBs operate exclusively in rural areas to provide credit to small farmers and entrepreneurs. There are currently 196 RRBs accounting for 4 per cent of the total assets of scheduled commercial banks.

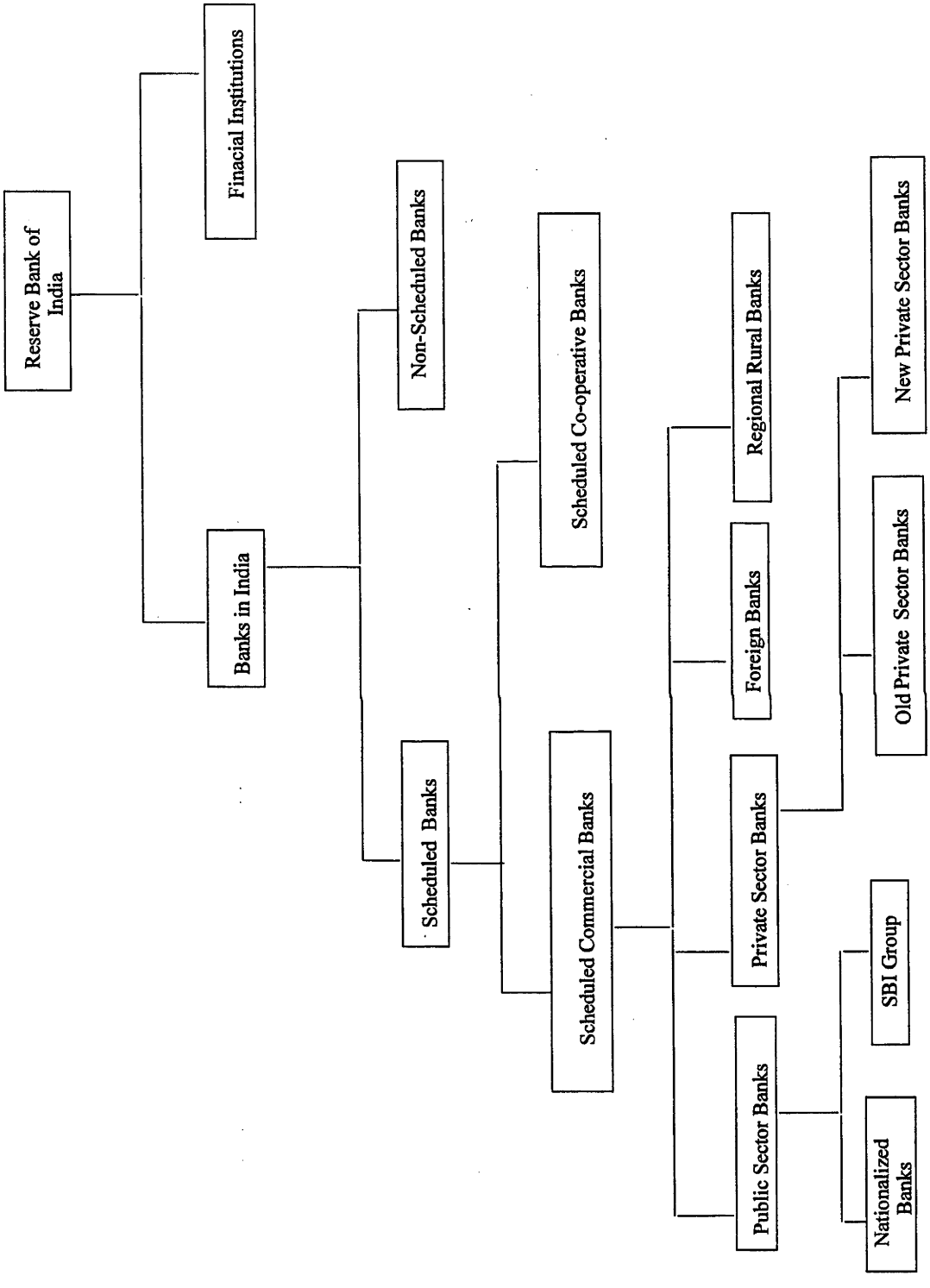


Figure 2.1: Banking Structure in India

India also has specialized financial institutions under the following categories: big industry, investment and credit guarantee, exim trade, capital market, agriculture and housing development. Their geographic reach is classified as all India, state-level and other institutions. All-India financial institutions include (a) development banks (i.e., Industrial Development Bank of India, Industrial Credit and Investment Corporation of India, Small Industrial Development Bank, Industrial Investment Bank of India, and Industrial Finance Corporation of India); (b) specialized financial institutions (such as, Export Import Bank of India, Technology Development and Information Company of India); (c) investment institutions (i.e., UTI, Life Insurance Corporation of India, General Insurance Corporation and subsidiaries); and (d) refinance institutions (i.e., National Bank for Agriculture and Rural Development (NABARD) and National Housing Bank). The role of these financial institutions is to promote economic development in various sectors of the economy. State level institutions include state financial corporations and state industrial development corporations. Other institutions consist of the Export Credit and Guarantee Corporation of India and Deposit Insurance and Credit Guarantee Corporation. (Shirai, 2002).

2.2.1 Pre-reform Period

The banking system in India prior to 1991 was highly regulated and inefficient. The most significant of these distortions were:

- The existence of high levels of Cash Reserve Ratio (CRR) and Statuary Liquidity Ratio (SLR): CRR is a requirement on banks to hold a certain amount of deposits in the form of deposits to RBI. It is calculated as a percentage of reserve liabilities which are defined as a difference between all liabilities exempted from the SLR requirement and net time and demand deposits. The CRR rose from around 15 per cent in 1960-70 to its upper legal limit of 15 per cent in 1991. The high value of CRR led to low

profitability for banks and higher spreads. The RBI uses CRR as a tool for monetary intervention in the economy; e.g. the RBI increased CRR in August 1993 in order to sterilize capital inflows (Shirai, 2002). SLR is a liquidity requirement[1] for banks to hold a certain amount of deposits in the form of government and eligible securities. The upper legal limit of SLR is 40 per cent. SLR increased from 25 per cent in 1970 to 38.5 per cent in 1991. Hence for some time periods overall reserve requirements exceeded 50 per cent.

- Prior to 1991, Indian interest rates were administered by government. These included lending and deposits rates including rates on saving deposits. The administration of rates was politically motivated and adversely affected bank balance sheets. Joshi and Little (1996) report the average return on assets in the second half of the 1980's was just 0.15 per cent.

- Directed and Concessional Lending: The government pursued a policy of allocation of financial resources to the so-called "priority sectors". These included agriculture, small scale industries, small business and self-employed persons. Thus policy set quantitative loan targets[2] on banks and was a major reason behind the NPAs of public sector banks. At the beginning of 1992-93 NPAs amounted to 24 per cent of total credit.[3]

- Lack of competition in the banking sector: The role of foreign and private sector banks remained negligible due to restricted entry regulations and strict branch li-

[1] *"Under section 24 (b) of the Banking Regulation Act, 1949, every bank is required to maintain at the close of business every day, a minimum proportion of their Net Demand and Time Liabilities as liquid assets in the form of cash, gold and un-encumbered approved securities. The ratio of liquid assets to demand and time liabilities is known as Statutory Liquidity Ratio (SLR). Present SLR is 25 per cent. The RBI is empowered to increase the SLR up to 40 per cent"* (RBI Glossary).

[2] In 1974, banks were required to direct 33 per cent of their net bank credit at concessional fixed interest rates to priority sectors. This was raised gradually to 40 per cent in 1980.

[3] NPAs have been defined as those loans for which interest has remained unpaid for four quarters in 1992-93.

censing policies.

These government policies were the main cause of deteriorating bank performances and diminished banks' incentive to operate efficiently. There was lack of a proper regulation and supervision mechanism, which allowed banks to take high risks. This situation was worsened by the presence of implicit government guarantees i.e. the existence of contingent liabilities in the system.

The reform process in the banking sector started in the second half of the 1980's but was only seriously implemented after the 1991 financial crisis. Table 2.1 summarizes salient aspects of the progress of the commercial banking sector in India.

Table 2.1: Progress of Commercial Banking in India

	Jun-69	Dec-80	Mar-91	Mar-95	Mar-99
No. of SCBs	73.0	154.0	272.0	281.0	297.0
Per capita Deposit (Rs.)	88.0	738.0	2368.0	4242.0	8247.0
Per capita Credit (Rs.)	68.0	457.0	1434.0	2320.0	4705.0
Share of Priority Sector advances in Total Non-food credit of SCBs(%)	15.0	40.3	39.2	35.8	35.9
Deposits (% of National Income)	15.5	36.0	48.1	46.4	48.7
Total Assets (Rs. Billion)	68.4	710.8	3275.2	5215.4	11516.2

Source: RBI (2003b)

The evolution of the financial crisis of 1991 and its impact on the Indian economy is now briefly outlined.[4]

[4]For a detailed analysis on financial crisis see Joshi and Little (1996), Cerra and Saxena (2002), Kapila and Kapila (1996) and Rangrajan (1991) among others.

2.3 Financial Crisis in India

Prior to 1991 some important financial characteristics of the Indian economy can be summarized as follows:

- *Restrictive Capital Controls*: Direct Investment was restricted. Capital inflows mainly consisted of foreign aid, commercial borrowings and Non-Resident Indian (NRI) deposits. Indian companies were not allowed to hold foreign equities. The foreign portfolio investment was mainly directed toward a small number of public sector bond issues.

- *High fiscal deficits*: Fiscal deficits were consistently high (combined gross fiscal deficit of state and central government rose by 20 and 24 per cent respectively in 1990 and 1991) and mainly financed by borrowings and financial repression rather than monetization. As a result the inflation rate did not reach extremely high levels and was at a par with India's trading partners.

- *Pegged Exchange Rate*: The exchange rate was officially pegged to a basket of currencies. However the trade-weighted nominal exchange rate depreciated steadily relative to the US$ in the latter half of the 1980's leading to small frequent devaluations. The rate of nominal depreciation was faster than the relative inflation differential leading to falls in the real exchange rate.

- *Trade*: The government strategy was highly interventionist since independence and consisted of import substitution, complex industrial licensing requirements and public ownership of heavy industry. In the second half of the 1980's, the emphasis shifted from import substitution to export-led growth. The government began a process of gradual liberalization of trade, investment, and financial markets. Export growth was rapid due to real depreciation of the rupee. However the value of imports increased

at a faster rate (mainly in the petroleum sector) because of the easing of quantitative restrictions.

2.3.1 1991 Financial Crisis

- Due to a widening gap between exports and imports and downturn of capital flows the current account deficit grew steadily and was financed by external borrowings and remittances of NRIs making the economy extremely vulnerable to external shocks. External debt was $69 billion in 1990-91 compared with $35 billion in 1984-85.

- *Shocks*: The first external shock was the sharp increase in world oil prices due to the Gulf War increasing the value of petroleum imports from $2 billion to $5.7 billion which was quite high compared to 5 per cent increase in non-oil imports. Exports were also adversely affected due to the impact of the Gulf war on India's trading partners. For example, growth of India's single largest trading partner, the US, fell from 3.9 per cent in 1989 to -1 per cent in 1991. This led to a sharp deterioration in the trade account. The Gulf crisis also resulted in a decline in non resident workers' remittances to India.

  Apart from these external factors, political uncertainty in India in 1990 and 1991 led to a fall in investor confidence further widening current account imbalances and causing a loss in reserves. India's credit rating was downgraded by credit rating agencies leading to difficulties in commercial bank financing. The outflows from the economy were quick and as the forex reserves declined, the economy was on the brink of default by January 1991. One of the major policy shifts in response to the financial crisis was a change in exchange rate management. The next section briefly outlines exchange rate policy changes from 1970 to the present.

2.3.2 Exchange rate regime in India

With the collapse of the Bretton Woods arrangement in 1973 most developed economies switched from a fixed exchange rate to a flexible exchange rate regime. Under a fixed exchange rate regime the central bank announces the buying and selling rates of its currency in terms of a foreign currency and commits to trade in unlimited amounts at that rate. Normally the exchange rate is allowed to vary within a narrow band. One major drawback of a fixed exchange rate regime in economies with perfect capital mobility is that monetary stabilization policy becomes ineffective (Obstfeld, 1995). For example if a government attempts to increase money supply by open market purchase of domestic bonds, households will find themselves holding more money than they desire. Since interest rate parity condition holds, household will sell their excess money holdings to the central bank for foreign currency at the fixed exchange rate and invest abroad to buy the desired amount of bonds. Such a mechanism will keep interest rates unchanged and leave the government with more bonds on the cost of forex reserves. One option for government will then be to refuse to buy the excess money supply and allow the currency to depreciate.

In spite of its drawbacks a fixed exchange rate regime is preferred in some developing economies especially those with limited capital mobility. This is due to the following perceptions: a) A fixed exchange rate regime removes exchange rate uncertainty thereby retaining investor confidence and macroeconomic stability; b) The export import industry can be protected from huge swings in exchange rates by keeping it stable and c) If the currency is pegged to a low inflation currency it helps keep domestic inflation low. For example, a government running a very high deficit will be reluctant to adopt an expansionary monetary policy because of its ineffectiveness in a fixed rate regime.

Macroeconomic stability is a priority for any economy and all governments (irrespective of exchange rate regime) tend to intervene in the forex markets in order to influence the

exchange rate. The government can take direct or indirect measures to counter exchange rate movements. Direct measures involve trading in the forex market. The government uses its foreign exchange reserves to affect demand and supply in the forex market. For example, if domestic currency is depreciating the government will buy excess money supply by selling forex reserves to stabilize supply demand imbalances.

The government can further offset this contractionary effect in domestic money supply by a simultaneous and equal purchase of domestic currency bonds. Such intervention is called "sterilized intervention" and is preferred by most governments. Such direct measures of intervention are complemented by some indirect measures like trade and interest rate restrictions to affect the demand and supply of foreign currency. For example, variable interest rates will affect the capacity of importers. One example is an interest rate surcharge on import finance: In order to curb imports and retain forex reserves, the RBI increased the interest rate surcharge on import finance from 15 per cent to 25 per cent in January 1996.

Prior to 1991, the exchange rate regime in India, was pegged to a currency basket. Hence India had a fixed rate regime. Figure 2.2 plots the exchange rate and its annual change, for rupee from 1970 to 1990. A positive change indicates depreciation and a negative change indicates appreciation of the currency.

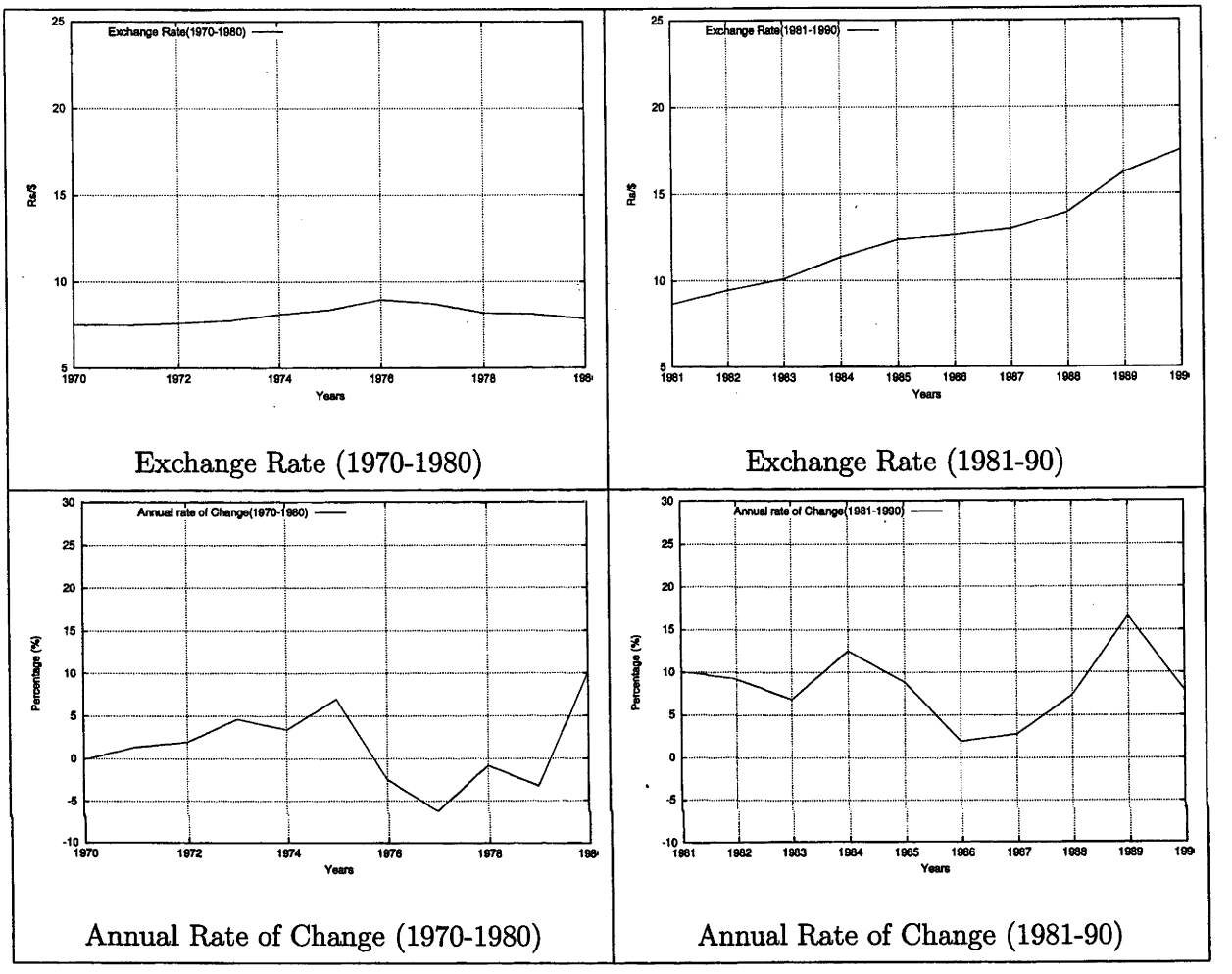
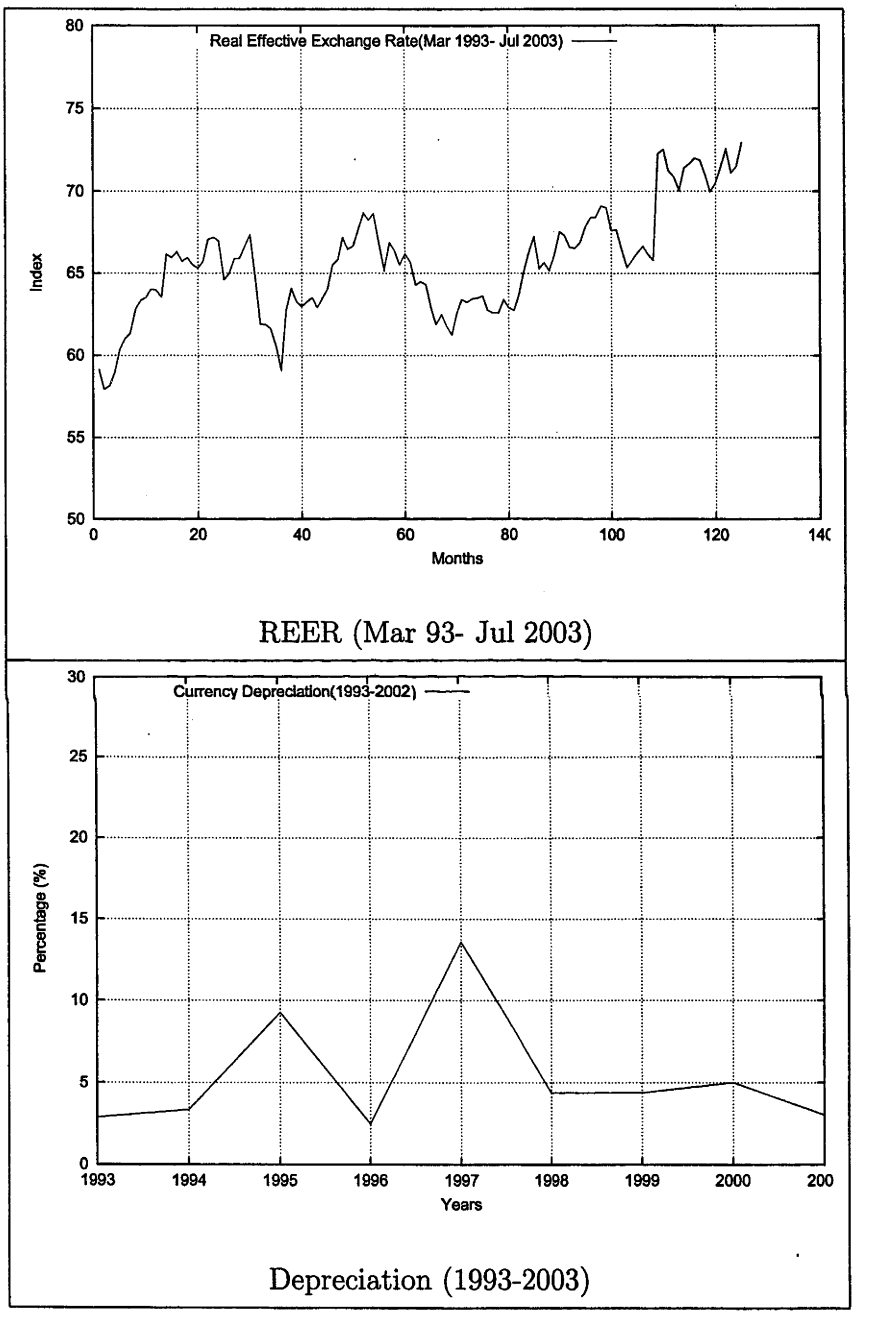


Figure 2.2: Pre- reform Exchange Rate Variability

The plots show the nominal exchange rate remained almost stable during the two decades of the 1970's and 1980's. The rate of change moved in a band of $\pm 6 percent$ in the 1970's except for 1979 when the rupee depreciated by 10 per cent due to the oil price shock.

During the 1991 financial crisis, faced with very low forex reserves the government floated the rupee, though the transition was gradual. Between 1991-93 there was a dual exchange rate regime and the rupee was subsequently floated in early 1993. International experience has shown exchange rate variability increases with a change to a more flexible rate regime.

This has not been the case for India even after a decade of a floating rate regime as evident from the figure 2.3 which plots the real effective exchange rate for the rupee from 1993-2002.



Source: RBI (2003c)

Figure 2.3: Post-reform Exchange Rate Variability

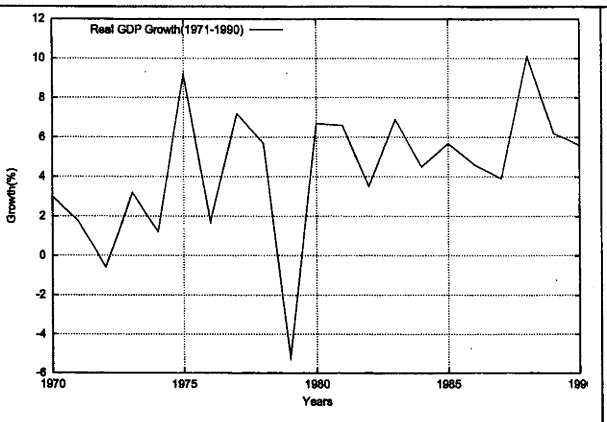
This is essentially because a stable exchange rate remains an important objective of government exchange rate policy. Saggar (1999) notes the RBI's intervention (measured by changes in foreign reserves) has in fact increased in the post 1993 period. The central bank has used both direct and indirect methods of market intervention.[5]

The main objective of government policy is to keep the exchange rate aligned with the fundamentals of the economy like inflation. Thus the exchange rate depreciated by 1.5 per cent in September 1997 and the speed of depreciation was moderated by intervention sales by the RBI. In the central banks' own words "*...the conduct of exchange rate policy was guided by the need to maintain a delicate balance between the considerations of external competitiveness and price stability" (RBI, 1997, page I-9).* This is also confirmed by analyzing the standard deviation of the rate of change in exchange rates, a measure of variability of the exchange rate. The standard deviation was 4.7 from 1970-80, 4.6 from 1980-90 and 4.7 from 1993-2003. This evidence clearly indicates that although the rupee has been floated, the government plays an important role in influencing demand and supply of forex reserves and thereby the exchange rate.

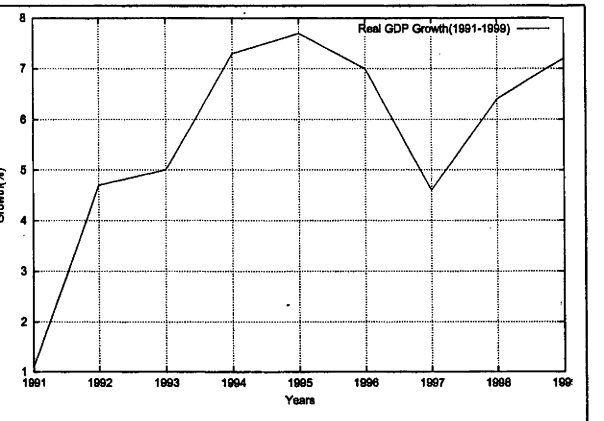
2.4 Post-1991 Banking Reforms

Financial sector reform was launched in 1991, based on the recommendation of the Narsimhan Committee (1991) that was set up by the government. The 1991 financial reforms were based on five fundamentals: Strengthening prudential norms and market discipline, appropriate adoption of international benchmarks, management of organizational change and consolidation, technological upgrading and human resource development. Figure 2.4 compares major macroeconomic variables in the pre-reform and post-reform period.

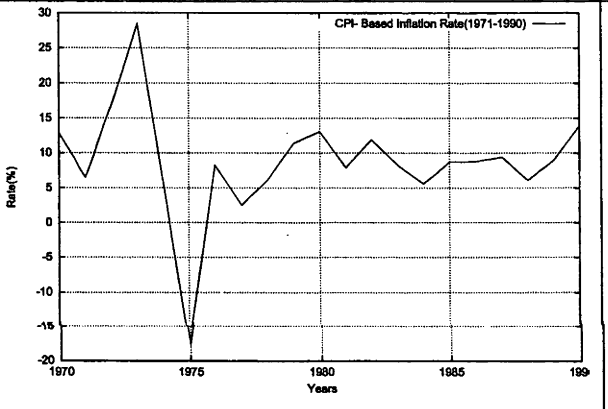
[5]For example (Kohli, 2001) reports the dates of indirect intervention done by RBI as October 1995, January and July 1996, November 1997 and January, June and August 1998.



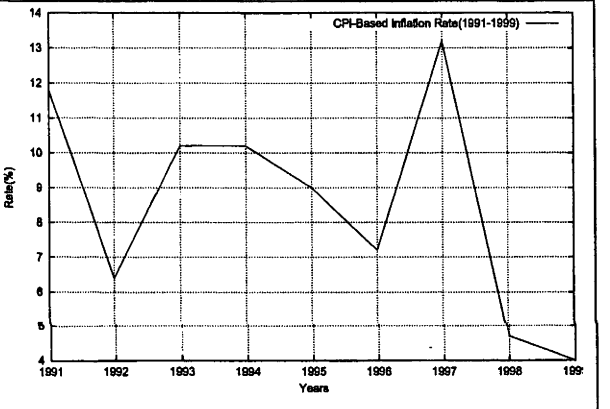
Real GDP Growth (1971-90)



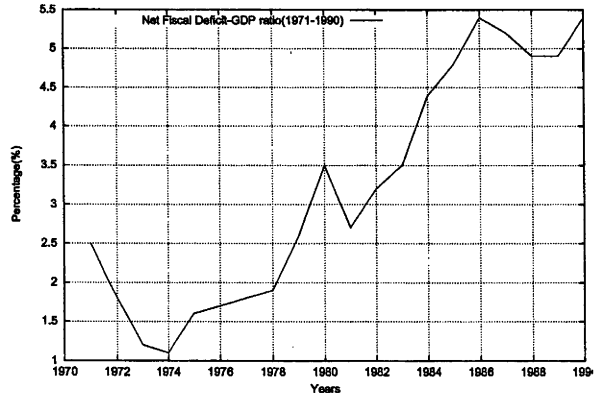
Real GDP Growth (1991-99)



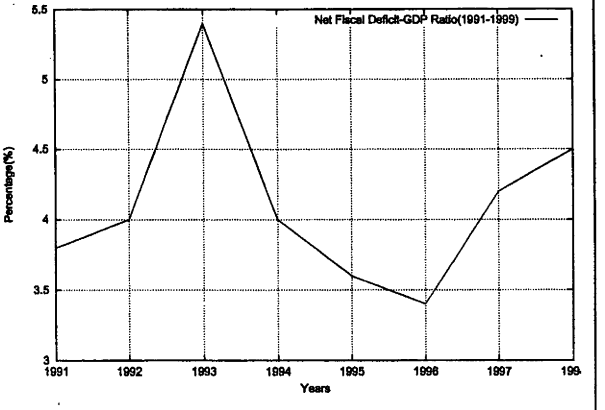
CPI Based Inflation Rate (1971-90)



CPI Based Inflation Rate (1991-99)



Net Fiscal-Deficit GDP ratio (1971-90)



Net Fiscal-Deficit GDP ratio (1991-99)

Figure 2.4: Trends in Major Macroeconomic Indicators (1970-99)

The banking sector reforms specifically included the following measures:

The RBI reduced the CRR from 15 per cent in 1991 to 5.75 per cent in November 2001. The cash reserve ratio was further reduced to 4.5 per cent in May 2004, although it remains higher than its statuary minimum level of 3 per cent. The SLR has been reduced from 38.5 per cent in 1991 to 25 per cent in 2004. The general perception is that if the government reduces SLR the reduced demand for government bonds will lead to a rise in interest rates the government has to pay bond holders. This may adversely affect the fiscal deficit. However, banks have continued to invest around 40 per cent of their deposits in government securities in spite of the reduction in SLR. This is essentially because government bonds are considered to be a risk-free investment for banks.

Interest rates were deregulated in 1992 leading to complete liberalization of all term deposit and lending rates, except for savings deposit rates which remain controlled. The RBI has also begun using the bank rate (the rate at which RBI lends to commercial banks by rediscounting bills or eligible paper) as a reference rate for influencing the direction of interest rates in the economy (Bhide et al., 2001). The flexibility to set lending rates led the banks to use this measure to offset the cost involved in concessional lending to priority sectors.

During the reform period the ceiling of 40 per cent on domestic banks and 33 per cent on foreign banks for priority sector lending remained but banks were allowed to set the lending rates and more profitable sectors like the software industry and venture capital were included in the definition of priority sectors.

The government relaxed the norms for entry in the banking sector in order to increase competitiveness. For example the ceiling of voting rights of an individual shareholder was increased from 1 to 10 per cent in 1994. The relaxed guidelines led to the entry of 8 private sector banks and 26 new foreign banks in the Indian banking sector.

In response to the Narsimhan Committee recommendations, the government gradually started to privatize PSBs. These banks were accumulating large amounts of NPAs due to the pre-reform regulated regime. They made an aggregate loss of Rs. 35 billion and almost half of the public sector banks had negative net worth. Realizing the importance of recapitalization, the government spent in the range of 0.02 to 0.7 per cent of GDP each year to wipe off accumulated NPAs (Table 2.2).

Table 2.2: Cost of Banks' Rescue (Rs. Billion)

	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	2001-2002
Capital Infusion	57.0	52.9	8.5	15.1	27.0	4.0	18.0
Cumulative Infusion	97.0*	149.9	158.4	173.5	200.5	204.5	222.5

*: Includes Rs. 40 billion injected prior to 1993

Source: Bhattacharya and Patel (2003)

This helped the banks clean up their balance sheets and make public issues of equity. As Table 2.3 shows, the central government still continues to hold a large share of holdings in major state-owned banks.[6]

[6]The 1998 committee on banking sector reforms recommended the minimum shareholding by the government or RBI equity in nationalized bank should be brought down to 33 per cent.

Table 2.3: Comparison of central government holdings by major Indian Banks after Public Issue

Bank name	Date of Public Issue	Government Percentage holding after public issue (%) as of 2001
State Bank of India	December 1993	66.34
Sate Bank of Bikaner	November 1997	75.00
State Bank of Baroda	December 1996	66.88
State Bank of Travancore	January 1998	76.00
Bank of India	February 1997	77.00
Corporation Bank	October 1997	66.33
Oriental Bank	October 1994	66.48
Dena Bank	December 1996	71.00

Source: Saez (2001)

Adoption of regulatory and supervision norms: Strengthening of the regulatory and supervisory framework of the banking sector remains a key element of financial sector reform. The policy focus is on streamlining banking operations, upgrading risk management systems and enhancing the level of bank compliance with accounting standards and operationalizing consolidated accounting practices (RBI, 2003c). However, progress in this direction has been gradual. The RBI notes: "*Within the process of convergence with best practices, finetuning is undertaken keeping in view the country specific circumstances.*" (RBI, 2003d). For example, NPAs have been defined as loans in which interest has remained unpaid for four quarters in 1992-93. This period was shortened to three quarters in 1993-94 and two quarters in 1994-95. The central bank now plans to further shorten the period (in March 2004) to match the international norm of one quarter. Thus NPAs were underestimated by Indian accounting standards. The main reason behind such a policy was the political lobbying of borrowers. A summary of some aspects of the regulatory framework used by the RBI is given in Table 2.4.

Table 2.4: Regulatory framework of Banking Sector in India

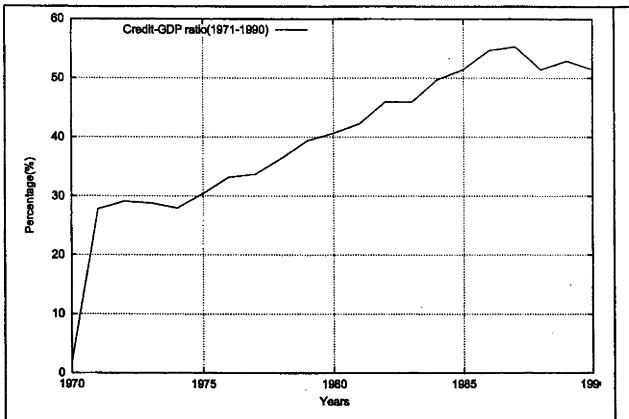
Variable	1992-93	2000-01	2001-02	2002-03
Capital to Risk-weighted Assets Ratio (%)				
Domestic banks with international business	4	9	9	9
Foreign banks	8	9	9	9
Non-performing assets				
(period overdue)				
Sub-standard assets	4 Q	2 Q	180 days	180 days*
Doubtful Assets period for which remained substandard	24 M	18 M	18 M	18 M@
Provisioning requirements (%)				
Standard Assets	-	0.25	0.25	0.25
Sub-standard assets	10	10	10	10
Doubtful Assets (unsecured portion)	100	100	100	100
Loss assets	100	100	100	100

Source: RBI (2003a)

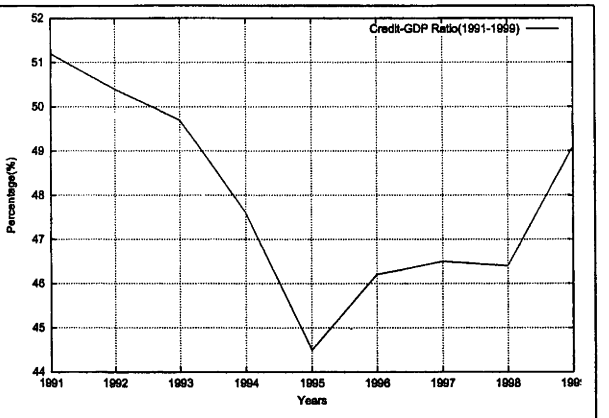
M: Month ; Q: Quarter

*: 90 days after March 31, 2004

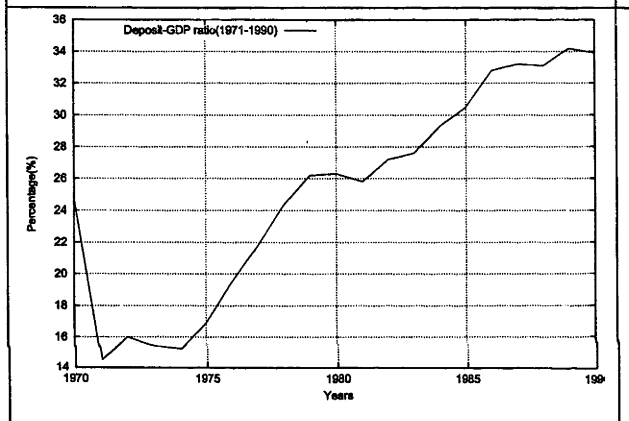
The financial sector reform process in India can be described as a graduated approach in the direction of liberalization. Figure 2.5 plots major banking indicators for the pre-reform and post-reform period.



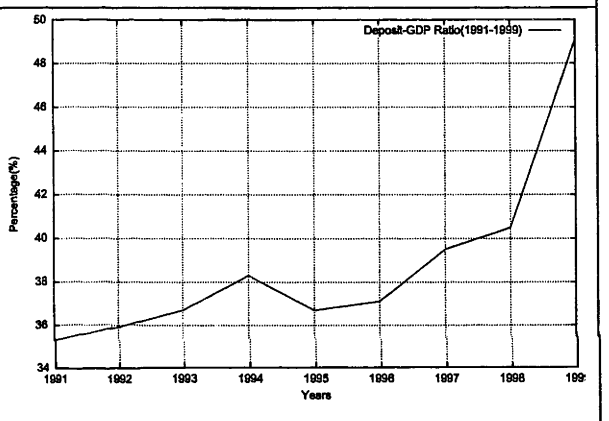
Credit-GDP Ratio (1970-90)



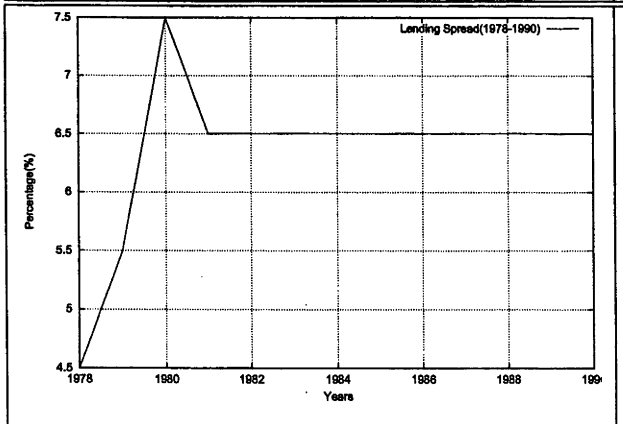
Credit-GDP ratio (1991-99)



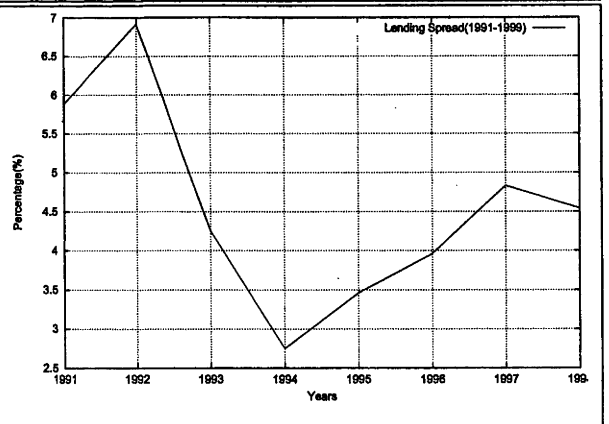
Deposit-GDP ratio (1970-90)



Deposit-GDP ratio (1991-99)



Lending Spread (1970-90)



Lending Spread (1991-99)

Figure 2.5: Trends in Major Banking Variables (1970-99)

There are still some weaknesses in the financial sector which contribute to its inefficiencies. Though reduced from 40 per cent to 25 per cent, the SLR has remained at high levels. Moreover, bank investment in government bonds and securities is still around 40 per cent of their assets (Bhattacharya and Patel, 2003). This is because interest rates paid by the government are more market based due to the auction mechanism of its securities such as Treasury Bills; and also because banks prefer to invest in government securities as they are relatively risk free and more liquid. Banks are reluctant to take risks in alternative markets because of stricter prudential norms and accounting standards. The high investment in government securities is convenient for government which is running high fiscal deficits. However, when economic growth accelerates, high SLR can adversely affect the credit formation role of banks. Banks will be reluctant to lay off their securities in order to satisfy increased demand for credit. The CRR also remains higher than its statuary minimum of 3 per cent.

The deregulation in interest rates is also incomplete. Interest rates on saving deposits and other saving schemes such as National Savings Certificates, public provident funds etc. remain regulated.[7] Such rigidities reduce the effectiveness of the transmission of monetary policy. The lending rate for advances of over Rs. 200000 was subjected to a ceiling of 16.5 per cent in 1987-88. This was eventually removed in 1994. The Prime Lending Rate (PLR) was set as a floor rate and banks are now free to set lending rates without any upper restriction. The lending rates though, officially flexible, are affected by public sector banks which are the dominant players in the banking sector. These banks offer rates below the PLR because of their advantage in market share and quality of borrowers. Therefore other banks' lending rates do not diverge much from the rates set by PSBs thereby making PLR ineffective.

[7]In fact, few allies in the newly formed United Progressive Alliance (UPA) government are demanding a rise in the interest rates on various provident fund schemes.

The banks still have to make some loans based totally on the political agenda of the government. For example banks are forced to provide concessional loans to individuals or firms belonging to scheduled caste or scheduled tribes.

2.4.1 High Transaction Costs

One of the major concerns of the banking sector is the high transaction costs involved in the lending operations of banks. Transaction costs are particularly high in rural sector areas which is one of the priority sectors defined by government. Puhazhendhi (1995) estimated the transaction costs of lending to the rural poor in India. He considered two major commercial banks, one regional rural bank and one private commercial bank from the southern states of Tamil Nadu and Kerala. The estimated transaction cost was 3.68 per cent of the loan amount if the loan was delivered through a direct lending channel. The literature on micro-credit (see (Ghatak, 2000) and (de Aghion and Gollier, 2000)) argues that group lending to the poor through Non-Governmental Organizations (NGOs) and Self-Help Groups (SHGs) may be an efficient method of credit delivery system. In 1991, the RBI initiated the policy of encouraging direct linkages between the banks and NGOs and SHGs due to the presence of high transaction costs. Puhazhendhi (1995) estimated the financial intermediation of NGOs and SHGs reduced transaction costs by between 21 and 41 per cent relative to the direct lending channel. In spite of these efforts transaction costs remain high even after a decade of reform. The estimated opportunity cost of existing high transaction costs in India is still high.[8]

Though heading in the right direction, prudential norms are yet to reach global standards. The pace of restructuring nationalized banks through privatization is slow. This is mainly

[8]To quote RBI Governor Y.V. Reddy:"*The transaction costs are a drag on the economy and it is time to put emphasis on their reduction which can facilitate the growth of GDP by 2 to 3 per cent.* (November 3, 2003, http://www.rediff.com/money/2003/nov/03cred10.htm)

because nationalized banks' balance sheets are weak due to accumulated NPAs over the past three decades. The government needs to clean up balance sheets by recapitalization and other measures in order to make these banks more attractive to investors. Given recent trends on the magnitude of NPAs (Table 2.5) the cost of restructuring appears to be very high, particularly since it is already running very high deficits.

Table 2.5: Non Performing Assets of Commercial Banking Sector: 1997-2003

Year	Public Sector Banks	Old Private Sector Banks	New Private Sector Banks	Foreign Banks in India
1997	17.80	10.70	2.60	4.30
1998	16.00	10.90	3.50	6.40
1999	15.90	13.10	6.20	7.60
2000	14.00	10.80	4.10	7.00
2001	12.40	11.10	5.10	6.80
2002	11.09	11.01	8.86	5.38
2003	9.36	8.90	7.64	5.22

Definition: Gross NPA/Gross Advances (%)
Source: RBI (2003b)

Such liabilities on the government to revive the banking sector (contingent liabilities), are significant in the case of India. The impact of contingent liabilities is now examined.

2.4.2 Contingent Liabilities

The financial sector in transition and developing economies is characterized by poor regulatory and enforcement systems, and inadequate disclosure of information which may lead to a high incidence of NPAs. When the banking sector is in stress, out of legal obligation or political compulsion the central government has to rescue the banks. Such public financing by government represents its contingent liabilities and can potentially lead to a large increase in public debt. Because of their uncertain nature these contingent liabilities

are unbudgeted and, hence, are hidden fiscal risks.

Contingent liabilities are also important because the government cannot achieve its long-run objective of a sound fiscal system without addressing the problem. Explicit contingent liabilities are specific obligations which the government has to settle under a contract or a law. These include obligations issued to state governments and public sector banks, etc. The government can foresee such guarantees and includes them in its budget constraint.[9]

However, contingent liabilities or implicit liabilities are uncertain and their realization is dependent on the probability of particular events. Sometimes, these events could be totally exogenous to government policy, e.g., an earthquake or any other natural disaster. Most of the time, these liabilities are a result of government policy. One interesting example is a guarantee extended by government to foreign creditors of domestic banks. These guarantees may lead to moral hazard problems in the banking sector as banks may take high risks, eventually leading to default on foreign loans, and pressure on the government to bail them out because of public expectations or political compulsion. One relevant case study in this regard is the crisis in the UTI mutual fund discussed in the Appendix A.

Contingent implicit liabilities are normally calculated after the event occurs, as they are dependent on the probability of the triggering event, the actual loss and the amount government pays to bail out the system. (Polackova, 1999) notes the financial systems represent the most serious contingent implicit liability. For example the cost of resolving past banking crises varies from around 1 per cent of Gross Domestic Product (GDP) (Thailand 1983-87) to around 55 per cent of GDP (Argentina 1980-82) depending on the state of the financial system. Standard and Poor's (Polackova, 1999) estimate the fiscal cost of a future banking crisis in India will be around 15 per cent of GDP. This is so high because of the persistent inefficiencies in the banking system even after a decade of financial reform

[9]Australian and New Zealand governments currently report such liabilities in their balance sheets.

(Bhattacharya and Patel, 2003). Bhattacharya and Patel (2003) put the estimate of government guarantees in India as around 12 per cent of GDP. Hence government guarantees are a crucial part of analysis of a financial sector especially in developing economies.

The overview of the reform process brings up the question of policy reversal which is covered in the next section.

2.5 Policy Reversal

Most of the financial reforms in the Indian economy were guided by *".... objectives of increasing operational efficacy of monetary policy...."* (RBI, 1997, page I-9). It is argued that under current inefficiencies (especially high NPAs and the large share of government ownership) in the banking sector, any efforts by government to ensure macroeconomic stabilization (say reduction in fiscal deficit) or restructuring will involve an offsetting effect, adversely affecting the initial policy objectives, which will transmit mainly through the financial sector. This offsetting effect can subsequently cause what can be termed a "policy reversal" by government. Such policy reversals can arise under several conditions some of which are:

- Suppose government is running high deficits and implements a tight monetary policy by increasing interest rates. Due to the inflexibility of the banking sector in passing on interest rates rise this will lead to banking stress. This inflexibility arises mainly because of the government's policy of directed and concessional lending to priority sectors. Because of a regulated interest rate regime, the banks cannot adjust their deposit rates much, say in the, area of savings deposits. Thus stress in the banking sector will be directly reflected in a higher incidence of NPAs in balance sheets. This may force the government to revive the banking sector through measures like

recapitalization which will be a direct burden on government budget. As discussed earlier, the cost of reviving banks is very high in the case of India. The government indeed began a partial privatization of banks as part of its economic reform process initially providing Rs. 40 billion from 1991-92 to 1992-93 to 19 nationalized banks. Subsequently, the government has spent around Rs. 164.5 billion at a rate of between 0.02 and 0.7 per cent of GDP each year from 1993-99. Though there was a decline in NPAs from 17.8 per cent in 1997 to 11.4 per cent in 2002 they are still very high.

- A second reason for policy reversal is the existence of weak regulatory and supervisory framework in the Indian Banking sector. The UTI mutual funds crisis is an example of this (See Appendix A).

2.6 Conclusion

The present chapter has reviewed the financial sector reform process in India focussing on the banking sector. It can be safely concluded that financial sector reform in India is incomplete. The banking sector remains inefficient because of several factors viz. high reserves and liquidity requirements, a poor regulatory and supervisory framework, the presence of implicit government guarantees, high transaction costs etc. These inefficiencies can adversely affect the long-term policy objectives of a sound fiscal system and can even lead to policy reversals.

The next chapter will formally model policy reversals emanating from the stabilization efforts of government. The chapter proposes a theoretical framework to highlight linkages between the stabilization efforts of government and inefficiencies of the banking sector. The major characteristics of an underdeveloped financial sector as discussed in this chapter are explicitly incorporated in a general equilibrium setup. In particular, the theoretical

framework incorporates the: a) high transaction costs of making loans, b) presence of government guarantees, c) government intervention in exchange rate markets reflected by the exogenous rate of depreciation and d) restrictive capital controls captured through the risk premium of investing in the economy.

CHAPTER 3

Fiscal Deficits, Banking Crises and Adjustment Policy in a Semi-Open Economy

3.1 Introduction

A stable fiscal environment is a primary government objective. When faced with high budget deficits that may threaten public debt sustainability, the literature emphasizes the need to adopt appropriate policy measures including fiscal adjustment through expenditure cuts, tax hikes and related reforms (Blanchard and Perotti, 1999),(Romer and Romer, 2002). Therefore the effects policies enacted to ensure fiscal consolidation will have on the macroeconomic equilibrium of the economy is an important issue. In the particular case of developing countries there may be hard choices to make between fiscal consolidation and steady growth of the financial and real sectors of the economy. An other important issue is the intertemporal sustainability of the fiscal deficit i.e., will consolidation have a long lasting effect or will the fiscal deficit eventually reappear necessitating policy adjustments?[1]

[1] An important question becomes whether public debt is sustainable over a long horizon. This question is analyzed for the case of India in chapter 4.

This chapter constructs a model that incorporates this tradeoff. The implications of stabilization policy in the context of an economy with broad characteristics as discussed in chapter 2 are considered and impact on key macroeconomic variables as well as profitability of the banking sector is analyzed. Under some conditions, these effects necessitate an endogenous policy reversal. This possibility has not been examined by the extant literature.

Consider a developing economy with the following characteristics: a) high transaction costs of lending, b) managed exchange rate regime, c) imperfect capital mobility and d) presence of contingent liabilities or government guarantees. In response to high deficits a stabilization policy is undertaken. Without loss of generality, this policy is assumed to take the form of monetary restraint.[2] This restraint is introduced as an exogenous change in a general equilibrium macroeconomic model with optimizing banks, firms and household workers with endogenous government policy. The model predicts the effects of this change on the endogenous choice variables of each of the participants and, in particular, the profitability of the banking sector. Under certain circumstances these changes may induce an endogenous policy reversal on the part of government.

The principal objective of this chapter is to develop a stylized model of the interaction between the fiscal and banking sector during a period of stabilization characterized by fiscal and monetary restraint to allow for endogenous policy reversal. Subsequently the empirical predictions of this model are tested using Indian data.

The model developed in this chapter broadly follows the empirical regularities noted in section 2.4. There are four groups of competitive agents: banks, households, firms and government. The banks are assumed to be perfectly competitive, borrowing from domestic depositors and foreign creditors. They borrow in dollars from abroad and lend in the local currency thereby exposing themselves to exchange rate risk. Three assumptions are

[2]It will be shown in section 3.2.2 that this is equivalent to a restrictive budgetary policy.

introduced in the model which typically characterize developing economies and are key sources of inefficiency in the banking sector. These assumptions are:

a) Banks incur transaction costs while generating credit. As chapter 2 points out, the high transaction costs of lending adversely affect output growth.

b) The government issues contingent liabilities as a guarantee to foreign creditors in case the bank defaults on foreign borrowings.

c) There exists a risk premium reflected by the positive gap between the domestic nominal interest rate and the world nominal interest rate.

Foreign creditors determine the rate of lending on the basis of this information. Banks work out their optimal strategy given the borrowing rate they face and the guarantees against default provided by government.

Households derive utility from consumption and leisure, provide labor, own firms, spend against deposits held in banks and face a cash-in-advance constraint when making purchases. Firms produce the only output in the economy by a single factor of production (labor) using constant returns to scale technology. The government satisfies its intertemporal budget constraint.[3]

The model highlights the monetary transmission mechanism through the bank lending channel and thus fits in the literature which emphasizes the importance of banks in monetary policy transmission. The literature on the bank lending channel argues that if banks are the main source of credit generation or bank loans are imperfect substitutes for other assets in the economy, monetary policy can be effectively and independently transmitted through changes in bank loans (Kashyap and Stein, 1994). This literature can be divided into two main strands: the first comprises the earlier studies (e.g., Brunner and Meltzer

[3]This assumption is justified ex ante as the government would attempt to meet the solvency conditions. As chapter 4 reveals in the case of Indian economy this turns out to be true.

(1964), Tobin (1969) and Modigliani (1963)). These include general equilibrium models of financial intermediation with imperfect substitutability across assets. The main argument of these studies is that since bank loans are imperfect substitutes for other assets, the interest rates in the economy will not change instantly (indicating existence of "price stickiness") and hence monetary policy may remain effective.

The second literature strand comprises the more recent studies that focus on the importance of gaps between the expected returns of lenders and the cost faced by borrowers called the "external finance premium" (Bernanke and Gertler, 1995). These gaps can arise due to imperfections in the credit market: moral hazard and the costs of monitoring loans (Pankki, 2003) (Sinn, 2001), no deposit insurance (Webb, 2000), transaction costs (Edwards and Vegh, 1997), other adjustment costs (Elyasiani et al., 1995) and regulated interest rate regimes (Demetriades and Luintel, 1996). Any monetary policy measure, say an increase in the interest rate, will increase the premium, thereby increasing the cost of borrowing and subsequently lowering investment and real activity. Hence these gaps tend to move in the direction of monetary policy and have a magnifying effect. On similar lines the theoretical framework in this chapter is characterized by lending and deposit spreads as the main driving forces of the model.

In trying to explain the role of government guarantees the current theoretical framework is related to the literature on government guarantees which has mainly focussed on the recent South East Asian crisis (See Mckinnon and Pill (1998), Burnside et al. (2001), Corsetti et al. (1998b), Alejandro-Diaz (1985), Dooley (2000) among others). For example, Burnside et al. (2001) discuss a framework in which banks are reluctant to hedge their exchange rate risks arising from foreign borrowings because of the presence of government guarantees. They further develop a self-fulfilling framework in which government contingent liabilities are transformed into actual liabilities. However, their model is not credit constrained and

they do not consider any other distortions in the economy.

In order to understand the recent experiences of policy reversals in India, as discussed in chapter 2, it is imperative to model a banking sector which is simultaneously subjected to credit market distortions and government policy like presence of government guarantees. Therefore, the model used in this chapter is a substantial extension of the extant literature and more applicable to the observed empirical regularities and policy framework of select developing countries, particularly India.

The model is an extension of the framework used by Edwards and Vegh (1997)[4] who discuss the magnification of macroeconomic disturbances via the banking sector thereby emphasizing the 'bank lending channel'. It is argued that in the case of developing economies banks are not mere 'propagators' of the crisis but may actually be the cause.[5] In addition to the above, and as mentioned earlier, this approach enables an endogenous policy reversal to be modeled in respect of the government's stabilization efforts. As mentioned in section 2.4 the possibility has been very much present in India and cannot be explained by extant models.

The chapter proceeds as follows. Section 2 develops a general equilibrium model with four agents with the characteristics required for analysis: households, firms, banks and government. The third section characterizes the equilibrium by simulating the effects of some exogenous shocks to the economy. Section 4 empirically tests the transmission mechanism of the model using Indian data. As is the practice in the literature, a reduced form VAR approach and Generalized Impulse Response Function (GIRF) are used to investigate the impact of an exogenous shock to the economy. It is concluded that the empirical evidence

[4]This chapter focusses on one of the extensions suggested by Edwards and Vegh (1997): *"....the government's role in providing the credit to the banking sector in moments of distress appears as an important item on the agenda"*.

[5]An empirical analysis in chapter 5 concludes banks indeed play a crucial role in the transmission of monetary policy.

is consistent with the predictions of the theoretical model. Section 5 concludes.

3.2 The Model

A small open economy characterized by imperfect capital mobility and a managed exchange rate regime is considered. For these reasons it is referred to as a semi-open economy. There are four competitive agents: banks, households, firms and government. There is only one good (tradable and non-storable) produced. Let the domestic price of this good be P_t ($=e_t P_t^*$) where e_t is the nominal exchange rate and P_t^* is the world price of this good. Foreign inflation is π_t^* and thus domestic inflation is given by:

$$\pi_t = \pi_t^* + \epsilon_t \tag{3.1}$$

where ϵ_t is the devaluation rate in the economy. Initially the economy is in a fixed exchange rate regime with non-zero probability of devaluation (as discussed below). Hence the rate of devaluation is zero. There is only one source of uncertainty in the economy: the possibility of future exchange rate fluctuation. The exchange rate is given by:

$$e = \begin{cases} e^I & \text{with probability (1-q)} \\ e^D & \text{with probability q} \end{cases}$$

where e^I is the exchange rate in the initial time period and e^D is the exchange rate after devaluation. Thus it is implicitly assumed the central bank has some kind of exchange rate targeting mechanism in place which is true for India as discussed in section 2.3.

The world real interest rate (r_t) facing the economy, as implied by the Fisher equation is:

$$r_t = i_t^* - \pi_t^*$$

where i_t^* is the nominal interest rate in the rest of the world.

Capital mobility implies that:

$$i_t = i_t^* + \theta \quad , \theta > 0$$

where θ can be perceived as the risk premium of investing in the economy. Interest rate risk assumes that:

$$i_t = r_t + \pi_t^* + \theta \tag{3.2}$$

3.2.1 Banking Sector

Banks are perfectly competitive. They borrow from domestic households (domestic deposits = d_t) and foreign creditors (foreign borrowings=d_t^*) and lend to domestic borrowers (firms) with L_t denoting loans. Foreign borrowing are in dollars ($) which are converted to rupees (Rs.) and then loaned domestically. Thus banks are exposed to exchange rate risks. Let d_t^* be banks' foreign borrowing in dollars. The amount of domestic lending to firms, is say, Rs. Le^I. Hence banks use the domestic demand deposits (d_t) and foreign borrowing (d_t^*) to lend Rs. Le^I to firms which creates an equal value of deposits. Hence banks' total demand deposits can be perceived as the sum of d_t and Le^I on which banks have to pay the deposit rate of interest i_t^d. High powered money is

$$h_t = M_t + e^I d_t^* \tag{3.3}$$

where M_t is the domestic money supply.

Here, by definition, $M_t = d_t$ as households do not hold cash-in-hand and use their deposits for consumption. Assume that ψ is the reserve requirement ratio determined by the government and hence the banks can only lend (1-ψ) part of their total deposits. Thus alternatively h_t can be defined as:

$$h_t = \psi(d_t + e^I L_t) \tag{3.4}$$

Assume that banks incur a transaction cost of δL in making loans to firms. Banks' assets consist of:

- High powered money h_t. No interest is paid on the reserves. Hence the opportunity cost of holding h_t is $i_t h_t$.
- Credit to firms L_t. Banks' interest rate earnings from the credit are $i_t^l L_t$ where i_t^l is the banks' lending rate.

The banks' liabilities consist of:

- Interest on its total deposits base $(d_t + e^I L_t)$ which is $i_t^d(d_t + e^I L_t)$ where i_t^d is the banks' deposit rate.
- Foreign Borrowing d_t^*: The total interest payment to the foreign borrowers is $i_t^b d_t^*$ where i_t^b is the interest rate at which the foreign borrowers lend to domestic banks. Total cost of borrowing depends on the government policy and may be different from $i_t^b d_t^*$.

Thus the representative banks' net profit (in \$) from lending operations is given by:

$$\pi_t^L = i_t^l e^I L_t/e_t - \delta L_t + h_t/e_t - i_t h_t/e_t + i_t d_t/e_t - i_t^d(d_t + e^I L_t)/e_t - i_t^b d_t^* \tag{3.5}$$

which is also equal to net worth of the banks (V^B).

Foreign investors are assumed to be risk neutral. Hence the expected return on the credit is r_t, the risk free world real interest rate. The actual rate at which the foreign creditors will lend to the bank (i_t^b) may be different from r_t due to the uncertainty involved in the exchange rate regime. The banks are solvent and can fully repay foreign creditors if $V^B > i_t^b d_t^*$. In the reverse case where $V^B < i_t^b d_t^*$, banks are unable to honor their borrowings and it is assumed that government comes to the banks' rescue and pays part of the foreign borrowings to banks on condition that they have to contribute the remaining amount towards the full payment to foreign creditors (the expected value of which is rd_t^*).[6] It is assumed that government cannot renege on its guarantees, ex post as financial stability appears to be an important argument in the government's objective function in India. One example is the UTI mutual fund crisis discussed in Appendix A, where under tremendous pressure after initial reluctance the government had to bail the fund out. The determination of the foreign borrowing rate of banks will now be discussed.

Determination of i_t^b

Foreign creditors being risk neutral will set i_t^b in such a way that their expected gross return is equal to the risk free world interest rate r_t. It is assumed that foreign creditors have full knowledge of the government's policy and hence are assured of at least $r_t d_t^*$ even if banks are on the verge of insolvency. Hence foreign creditors set i_t^b in such a way that:

$$r_t d_t^* = (1-q) i_t^b d_t^* + q(r_t d_t^*) \tag{3.6}$$

which implies that in financial market equilibrium $i_t^b = r_t$. Therefore it can be concluded

[6]Such a policy can be considered analogous to the government's policy to introduce a set of performance obligations and commitments to avoid the problems of moral hazard. For example, in 1992/93, the RBI introduced some performance agreements through a Memorandum of Understanding (MOU) which needed to be fulfilled as a precondition, by the banks' receiving recapitalization benefits (Shirai, 2002).

that in the presence of government bank guarantees foreign creditors are willing[7] to lend at the risk-free world interest rate r_t. The real cost of borrowing for banks will also be different from $i_t^b d_t^*$. The bank's cost function is now derived.

Banks' Cost Function:

When solvent, banks' borrowing costs will be $i_t^b d_t^* < V^B$. When banks become insolvent, government intervenes and it is assumed that government pays fraction $\varsigma r d_t^*$ to the banks and banks have to make a contribution of $(1-\varsigma) r d_t^*$ in order to cover their losses.

Thus the real cost of borrowing for the banks in the presence of government guarantees is given by:

$$C_B = q(1-\varsigma) r d_t^* + (1-q) r d_t^* = (1 - q\varsigma) r d_t^* \tag{3.7}$$

Here it is assumed that the government decides ς in such a way that $V^B(e_t) \geq (1-\varsigma) r d_t^*$.[8]

Banks' profits from the lending Eq.(3.5) can be re-written as

$$\pi_t^L = i_t^l e^I L_t / e_t - \delta L_t + h_t/e_t - i_t h_t/e_t + i_t d_t/e_t - i_t^d (d_t + e^I L_t)/e_t - (1 - q\varsigma) r d_t^* \tag{3.8}$$

The expected profit of the bank in the presence of government guarantees is given by:

$$\Omega_t^b = E(\pi^L) \tag{3.9}$$

[7]It should be noted that in the absence of government guarantees i_t^b will be determined by attaching a markup of $(\frac{1}{1-q})$ on the real interest rate. Hence, alternatively, government guarantees neutralize the effect of exchange rate uncertainty.

[8]In the extreme case when $\varsigma = 1$ the government alone pays the whole amount of foreign borrowings. It is assumed that $\varsigma < 1$ and the risk of devaluation will be shared by the banks and the government.

The present discounted value of the banks' real profits is given by:

$$\int_0^\infty e^{-rt}\Omega_t^b dt = \int_0^\infty \{(i_t^l - i_t^d)e^I L_t/e_t - \delta L_t + rh_t/e_t - i_t h_t/e_t + (i_t - i_t^d)d_t/e_t - (1-q\varsigma)rd_t^*\}e^{-rt}dt \tag{3.10}$$

Substituting Eq. (3.8) in Eq.(3.9) and using equations (3.3) and (3.4), Eq. (3.10) can be rewritten as:

$$\int_0^\infty e^{-rt}\Omega_t^b dt = \int_0^\infty \{(i_t^l - i_t^d)e^I L_t/e_t - \delta L_t + (r - i_t)(\psi(\frac{d_t + e^I L_t}{e_t})) + \\ + (i_t - i_t^d)d_t/e_t - (1 - q\varsigma)r[(\frac{\psi e^I L_t - (1-\psi)d_t}{e_I})]\}e^{-rt}dt$$

The bank maximizes the present discounted value of Ω_t^b by choosing L_t, d_t subject to equations (3.3)) and (3.4) Hence:

The first order conditions (FOC's) are:

w.r.t L_t:

$$\frac{e^I}{e_t}[(i_t^l - i_t^d) + (r - i_t)\psi] = \delta + (1 - q\varsigma)r\psi$$

Rearranging and using Eq. (3.2):

$$\frac{e^I}{e_t}[(i_t^l - i_t^d)] = \delta + (1 - q\varsigma)r\psi + (\theta + \pi_t^*)\psi$$

w.r.t d_t: which equates

$$\frac{1}{e_t}[(i_t - i_t^d) + (r - i_t)\psi] = \frac{1}{e^I}(1 - q\varsigma)(\psi - 1)r$$

Rearranging and using Eq. (3.2)

$$\frac{1}{e_t}[(i_t - i_t^d)] + \frac{1}{e^I}(1 - q\varsigma)(1 - \psi)r = (\theta + \pi_t^*)\psi$$

The first FOC (w.r.t.L_t) equates the marginal gain from lending operations (profit from the lending spread $(i_t^l - i_t^d)$) to the marginal cost of lending comprising:

- The per unit transaction cost of making loans (δ)
- The cost of foreign borrowings to the banks attached to a one unit increase in domestic credit (adjusted for the reserve requirement ratio): $(1 - q\varsigma)r\psi$
- The per unit opportunity cost of reserve requirement ratio and imperfect capital mobility: $(\theta + \pi_t^*)\psi$

The second FOC (w.r.t. d_t) equates the marginal profits from deposit making comprising:

- The marginal profit from lending spread: $(i_t - i_t^d)$
- The marginal savings in the cost of foreign borrowings attached to a one unit increase in domestic deposits adjusted by reserve requirement ratio: $\frac{1}{e^I}(1 - \psi)(1 - q\varsigma)r$

to the marginal cost of deposits: per unit opportunity cost of the reserve requirement ratio and imperfect capital mobility: $(\theta + \pi_t^*)\psi$

Solving the FOC's and using Eq. (3.2) can solve for the deposit and lending rate:

The deposit rate is:

$$i_t^d = (1 - \psi)[i_t + \frac{e_t}{e^I}(1 - q\varsigma)r] + r\psi \tag{3.11}$$

Thus the deposit rate in the economy has three components:
(i)$i_t+\frac{e_t}{e^I}(1-q\varsigma)r$: This is the sum of the cost of domestic deposits (i_t) and the cost of foreign borrowings ($\frac{e_t}{e^I}(1-q\varsigma)r$). (ii) This total cost is then adjusted for the reserve requirement ratio($(1-\psi)$).[9] (iii) $r\psi$ is the opportunity cost to banks for holding reserves. Thus the deposit rate is always less than the total cost of deposits.

The banks' lending rate is :

$$i_t^l = i_t + \frac{e_t}{e^I}[(1-q\varsigma)r + \delta] \tag{3.12}$$

The lending rate in the economy is determined by the total cost of banks' deposits, which has two components: cost of domestic deposits (i_t) and cost of foreign borrowings ($\frac{e_t}{e^I}[(1-q\varsigma)r]$) *plus* the transaction cost of creating loans.

3.2.2 Government

The government earns revenue by imposing a lump sum tax, generates seignorage revenue and issues debt. The revenue is spent on purchases of the single good and transfer payments made to banks, subject to operations satisfying intertemporal government budget constraint. This constraint is developed below.

Spending:

Government spending consists of:

1. Purchase of the tradable good G_t. Total government purchases of the good in dollars is : G_t/e_t

[9] $\psi(i_t + \frac{e_t}{e^I}(1-q\varsigma)r)$ is the opportunity cost of holding the reserves.

2. Transfer Payments: The government makes transfer payments to banks in case they default on foreign borrowings: Γ^b. The expected value of the transfers is given by:

$$\Gamma = (1-q)0 + q(\Gamma^b) \tag{3.13}$$

The value of government transfers to banks is essentially the cost incurred by the government to bail out the banks which equals $q\varsigma rd_t^*$

Revenues:

The government finances its expenditure by taxes, printing money and issuing debt:

1. Taxes(τ): The government impose a lump sum tax on households. Take lump sum tax in dollars as τ_t^L.

$$\tau = \tau_t^L \tag{3.14}$$

2. Seignorage revenue is given by: $\dot{h}_t/e_t + \pi_t h_t/e_t$ dollars

3. Debt: The government lends and borrows in dollars at rate r. It is assumed that government issues bonds of face value B in local currency (to households) at the interest rate r. Then the dollar value of debt is: Br/e_t.

Hence the government's flow budget constraint is:

$$\dot{b}_t = rb_t + rB/e_t + G_t/e_t + \Gamma - \tau_t - \dot{h}_t/e_t - \pi_t h_t/e_t \tag{3.15}$$

Integrating forward and assuming the no-Ponzi condition: ($Lim_{t\to\infty} e^{-rt}b_t = 0$) gives

$$b_0 + \int_0^\infty (rB/e_t - \tau_t + G_t/e_t + \Gamma - \dot{h}_t/e_t - \pi_t h_t/e_t)e^{-rt}dt = 0 \tag{3.16}$$

which can be re-written as:

$$b_0 + \int_0^\infty rB/e_t e^{-rt} dt = \int_0^\infty (\tau_t - G_t/e_t - \Gamma) e^{-rt} dt + \int_0^\infty (\dot{h}_t/e_t + \pi_t h_t/e_t) e^{-rt} dt$$

The above equation is the government's intertemporal budget constraint. This requires the dollar value of initial debt plus the present discounted value of total holdings by issuing bonds to be equal to the present discounted value of surpluses and seignorage revenue.

3.2.3 Households

The household utility function is given by:

$$\mathbf{U} = \int_0^\infty [log(c_t) + log(x_t)] e^{-\beta_t} dt \tag{3.17}$$

where c_t is consumption and x_t leisure of individual households. Assuming total time endowment of unity, the labor supply is given by $1 - x_t$. The flow budget constraint facing the household is:

$$\dot{a}_t^h = r a_t^h + w_t(1 - x_t) + rB/e_t + \Omega_t^f/e_t - c_t - \tau_t^L - (i_t - i_t^d) d_t/e_t \tag{3.18}$$

where a_t^h are households assets, w_t the wage rate, and Ω_t^f firm's profit (since households own firms).

It is assumed that households don't hold cash and conduct all transactions using deposits, hence the "deposit-in-advance"' constraint is:

$$d_t/e_t = \eta c_t \tag{3.19}$$

Thus the household incurs an opportunity cost of $(i_t - i_t^d)$ for holding the deposits. Integrating forward and assuming the no-Ponzi game condition gives:

$$0 = a_0^h + \int_0^\infty \{w_t(1-x_t) + rB/e_t + \Omega_t^f/e_t - c_t - \tau_t^L - (i_t - i_t^d)d_t/e_t\}e^{-rt}dt \qquad (3.20)$$

Households maximize utility Eq. (3.17) subject to the budget constraint Eq. (3.20) and cash-in-advance constraint Eq. (3.19) by choosing c_t, x_t. The first order conditions for utility maximization are:

w.r.t c_t:

$$\frac{1}{c_t} = \lambda[1 + \eta(i_t - i_t^d)] \qquad (3.21)$$

This equation equates the marginal utility of consumption $(1/c_t)$to the marginal utility of income (λ) times the effective price of good $(1+\eta(i_t - i_t^d))$ where the effective price of good is given by its market price plus the cost associated with holding the money (in the form of demand deposits) to purchase one unit of the good.

w.r.t x_t:

$$\frac{1}{x_t} = \lambda w_t \qquad (3.22)$$

This equation equates the marginal utility of leisure to marginal utility of income (λ) times the real wage rate. As per the utility function the marginal utility of income remains constant.

Opportunity cost of holding deposits is $(i_t - i_t^d)$ which is given as:

$$i_t - i_t^d = (\pi_t^* + \theta)\psi - \frac{e_t}{e^I}[(1 - q\varsigma)(1 - \psi)r] \qquad (3.23)$$

3.2.4 Firms

For the sake of simplicity it is assumed the firm's production technology is given by:

$$y = Al \tag{3.24}$$

where y is the aggregate output in the economy and l is the labor input, the only factor of production used to produce the output. Firms pay their wage bill by using the bank credit L_t. Hence:

$$e^I L_t = \gamma w_t l_t \tag{3.25}$$

Assume firms' assets consist of foreign-traded bonds (b_t^f) and that their liability is L_t. Hence

$$a_t^f = b_t^f - L_t$$

where a_t^f are the total assets of the firms at any given time t. The change in the firm's assets is defined by

$$\dot{a_t^f} = rb_t^f + y_t/e_t - w_t l_t/e_t - (i_t^l - i_t^d)e^I L_t/e_t - \Omega_t^f/e_t \tag{3.26}$$

Integrating forward and assuming the no-Ponzi game condition, the Present Discounted Value (PDV) of the firm's profit is given by:

$$\int_0^\infty \Omega_t^f e^{-rt} dt = \int_0^\infty \{rb_t^f + y_t/e_t - w_t l_t/e_t - (i_t^l - i_t^d)e^I L_t/e_t\} e^{-rt} dt \tag{3.27}$$

Firms will maximize PDV of their profits by choosing l_t. The first order condition after using Eq. (3.24) is:

w.r.t l_t:

$$A = \frac{w_t}{e_t}[1 + \gamma(i_t^l - i_t^d)e^I] \tag{3.28}$$

Eq. (3.28) requires that in profit maximizing equilibrium firms equate the marginal productivity of labor to the marginal cost of unit labor which is the sum of the wage rate and the cost associated with holding credit in order to pay wages.

The opportunity cost of holding credit is given by the difference between the lending rates earned by firms and the deposit rates they pay $(i_t^l - i_t^d)$. Thus:

$$i_t^l - i_t^d = (\pi_t^* + \theta)\psi + \frac{e_t}{e^I}[\delta + (1 - q\varsigma)\psi r] \tag{3.29}$$

3.2.5 Aggregate Resource Constraint

According to the model specification, government finances are generated by firms' and bank profits and households' budget constraint. Hence the aggregate resource constraint can be found by adding the present discounted value of firm (Eq. (3.27)) and banks' profits (Eq.(3.10)) and households' budget constraint (Eq.(3.20)) and subtracting the government's inter temporal budget constraint (Eq. (3.16)). Using Eq. (3.2), labor market equilibrium: $l_t = 1 - x_t$ and Eq. (3.13), the aggregate resource constraint in the economy is given by:

$$a_0 + \int_0^\infty (y_t + (\dot{h}_t/e_t - \theta h_t/e_t))e^{-rt}dt = \int_0^\infty (c_t + G_t/e_t + \delta L_t + rd_t^*)e^{-rt}dt \tag{3.30}$$

where $a_0 = a_0^h + a_0^f - b_0$ The equation implies consumption, government purchases, transaction costs and foreign borrowings are financed by the output and seignorage revenue net of the risk premium earned on high powered money.

3.3 Equilibrium

The model can be solved for all endogenous variables{quantities: c_t, x_t, h_t, L_t, d_t, l_t, y_t; prices: w_t, i_t^b, i_t^l,} such that:

(i) c_t, x_t maximize household's utility function given the prices

(ii) y_t, l_t solve the firms' profit maximization problem given the prices

(iii) d_t, L_t, h_t solve banks' maximization problem

(iv) The government's intertemporal budget constraint holds

(v) The money market clears with $M_t = d_t$

(vi) The labor market clears with $l_t = 1 - x_t$

The equilibrium values of the endogenous variables are reported in Appendix B.

3.3.1 Impact of Exogenous Shocks

The transmission mechanisms in the economy are now explored by introducing some one-period exogenous shocks. Four types of shocks are considered: a productivity shock following a drop in the marginal productivity of the factor of production (labor), A, foreign interest rate shock due to a sharp rise in world interest rate r, monetary shock resulting from an increase in the reserve requirement ratio ψ and a foreign inflation shock arising from, say, an increase in the world prices of oil. Table 3.1 summarizes the signs of the marginal effects of these shocks on the principal endogenous variables.

Table 3.1: Predicted outcomes of different types of shocks

Shocks	i_t^d	i_t^l	d_t	L_t	d_t^*	h_t	M_t	l_t	y_t	c_t	x_t	w_t
Monetary Contraction	< 0	No effect	< 0	< 0	amb.	amb.	< 0	< 0	< 0	< 0	> 0	< 0
Productivity Shock	No effect	No effect	No effect	< 0	amb.	> 0	No effect	< 0	< 0	No effect	> 0	< 0
Foreign interest rate Shock	> 0	> 0	$> 0^a$	< 0	amb.	amb.	> 0	< 0	< 0	$> 0^a$	> 0	< 0
Inflationary Shock	< 0	> 0	< 0	< 0	amb.	< 0	< 0	< 0	< 0	< 0	> 0	< 0

a: Positive only if $\frac{\psi}{1-\psi} > \frac{e_t}{e^f}(1 - q\alpha)$.

amb.: Ambiguous

Note:The ambiguous results w.r.t. shocks in d_t^* and h_t indicate that

with more complicated models more of the comparative static results would have been ambiguous.

The intuition behind some of the signs in Table 3.1 follows:

- Inflationary shock: Suppose that due to fluctuations in the world business cycle foreign inflation increases. This results in an increase in the domestic inflation rate through Eq. (3.1). Equation (3.23) states that the cost of consumption will increase. Households will reduce consumption which will, via the deposit-in-advance constraint from Eq. (3.19), reduce the demand for deposits, and households will withdraw some deposits. Firms' opportunity cost of holding credit (from Eq.(3.29)) increases with the higher inflation rate and hence the real wage rate falls. Lower real wage rates lead to lower employment since labor supply falls. The demand for credit also falls because of the credit-in-advance constraint (Eq. (3.25)). Thus banks face a reduction in domestic deposits and a lower demand for credit.

  This situation may lead to a fall in the net worth of the banks such that $V^B < rdt^*$ and the government has to come to their rescue.

- World interest rate shock: Assume the world real interest rate rises. This will lead to a rise in the lending and deposit rates. The opportunity cost to firms for holding credit will increase and will reduce credit demand. Firms will also cut the real wage rate resulting in a cut in labor supply and hence aggregate output. On the other hand, due to an increase in the deposit rate, households will find it more lucrative to hold deposits and hence the level of deposits will rise leading to higher consumption via deposit -in-advance constraint (Eq. (3.19)). Higher consumption also indicate a fall in the price of consumption and hence $i_t - i_t^d$ will decrease. From the banks' perspective, an interest rate shock will result in lower credit demand and a higher level of deposits.

- Increase in the reserve requirement ratio: An increase in ψ will decrease the deposit rate (from Eq. (3.11)) as banks decide their deposit rate on the basis of funds

available for transaction. The lending rate of banks will remain unaffected. This will lead to an increase in $i_t^l - i_t^d$ which will reduce the demand for credit by firms, reduce the wage rate, employment and aggregate output. The reduction in the deposit rate will increase $i_t - i_t^d$ reducing the demand for deposits and consumption. Households will prefer to withdraw their money. Hence the economy faces a liquidity crunch with lower demand for credit and deposits.

- Productivity shock: The interest rates will remain unaffected by a decline in the productivity of factor of production (labor), A, keeping the level of consumption and deposits unaffected. However it will be an adverse shock to firms' technology reducing output which leads to a reduction in the real wage rate, employment level, and, hence, the demand for credit (via Eq. (3.25)).

- Stricter controls on capital mobility: Such a government policy will result in an increase in the value of θ. This will have exactly same effect as an increase in the domestic inflation rate as they both are related by Eq. (3.2).

It should be noted that some of these adverse shocks may be induced by the government stabilization efforts.[10] Any shock that leads to a slowdown in economic activity and threaten banks' solvency leading to a default in foreign credit may provoke government intervention. When banks face financial distress, government has to contribute its share[11] $q\alpha rd_t^*$ towards foreign credit. It is now argued that under the assumptions of the model, for a developing economy, the offsetting effect can only be eliminated in the following cases:
a) Absence of government guarantees ($\alpha = 0$). This is very unlikely in developing countries because of the political benefits of these guarantees.

b) No exchange rate uncertainty in the economy ($q = 0$): This is the only factor ame-

[10]Increase in the interest rate, reserve requirement ratio or stricter capital controls.
[11]This share can be perceived as the offsetting effect of the initial stabilization effort.

liorating the effect of risk. This scenario basically depends on agents' confidence in the economy and local currency. It is assumed that the government is initially running deficits high enough that agents expect a positive value from the probability of devaluation in the economy.

c) Absence of foreign borrowings by banks ($d_t^* = 0$): Banks will not borrow from foreign creditors if the economy's demand for credit is fully satisfied by domestic deposits net of reserve requirements. This condition implies that $(1-\psi)d_t = \psi e^I L_t$ or $\psi^* = \frac{e^I L_t + d_t}{d_t}$.[12] Hence government will have to adopt a loose monetary policy by reducing the reserve requirement ratio to the extent that the demand for domestic credit is satisfied by available domestic demand deposits. Thus the effort by the government to reduce its contribution towards bank bailouts may actually lead to an additional burden on its deficits through loose monetary policy. Thus it can be concluded that under the assumptions of this model, with every effort of deficit reduction by the government there will be an offsetting effect tending to undermine the initial effort of stabilization.

The theoretical framework is now tested empirically using Indian data.

[12]It should be noted that for any $d_t^* > 0$, $\psi > \psi^*$.

3.4 Empirical Analysis

The purpose of this section is to empirically test the transmission of shocks as described in the theoretical model. Such an analysis will aid in identifying the proximity of the "theoretical setup". The data spans the period 1990-2000 reported in the Handbook of Statistics on Indian Economy published by the RBI (RBI, 2003e) and International Finance Statistics (IFS). This period is chosen because it is the decade characterized by major economic reform in India which has significantly affected the domestic banking sector (Saez, 2001) (Shirai, 2002).

3.4.1 Methodology

The most desirable approach will be to use a large-scale structural macroeconometric model, solve the simultaneous equation system for endogenous variables to get reduced form equations and then use the dynamic multipliers to analyze the impact of shock in the system.[13] This approach cannot be applied here mainly because of the lack of availability of high frequency data for some of the key endogenous variables in the model i.e., wage rate, consumption, foreign borrowings, labor supply etc.

It is intended to use the VAR, the reduced form methodology introduced by Sims (1980). VAR is an alternative approach measuring the reaction of macroeconomy to policy actions (Stein and Song, 2002). Christ (1993) describes the procedure in VAR as: *" In VAR, a set of observable variables is chosen, a maximum lag length is chosen, and the current value of each variable is regressed on the lagged values of that variable and all other variables. No exogenous variables exist; all observable variables are treated as endogenous. Except for that, an VAR model is similar to the unrestricted reduced form of a conventional econo-*

[13]Such an approach was popular in the 1960s and 1970s mostly used by Keynesians. For further discussion see Pindyck and Rubinfeld (1976), Klein and Young (1980)

metric model." However, the recent developments in this literature do include exogenous variables in the VAR (For example see Dungey and Pagan, 2000).

The impact of an exogenous shock is measured by "impulse responses" in VAR. Impulse responses describe the dynamics of all the variables in a VAR system to a one unit increase in the current value of the error terms (Stock and Watson, 2001).[14] Stein and Song (2002) show that under some restrictions on VAR, dynamic multiplier and impulse responses turn out to be identical.

3.4.2 Data Description and Selection of Variables

The analysis is done by examining the impact of a foreign interest rate shock on the major macroeconomic variables discussed in the model.[15] It is to be noted that the major driving force in the model is the lending spread $(i_t^l - i_t^d)$ and the deposit spread $(i_t - i_t^d)$. These are affected by the domestic interest rate which, in turn, is directly related to the world interest rate through the Fisher equation (Eq. (3.2)).

The intent is to examine the impact of a shock in the world interest rate which is transmitted to the economy through the domestic interest rate which affects lending and deposit spreads and hence all endogenous variables (output, wage, consumption, money supply, foreign borrowings) in the model. Thus the VAR should thus include the deposit spread, lending spread and domestic interest rate. The banking sector plays a crucial role in the transmission mechanism and hence the banks' deposit and credit is included in the VAR model. Domestic output is also included in the VAR as a "representative" variable for all

[14] In fact the one unit increase in the error terms (also called the shock terms) are the true exogenous elements of VAR models.

[15] The analysis for other shocks is not possible due to unavailability of data. However, empirical evidence of one shock is sufficient to adjudge the proximity of the theoretical setup in the model to the actual data for a developing country.

the other endogenous variables in the model.[16] Therefore the following variables for VAR are selected:

- Lending Spread: $i_t^l - i_t^d$
- Deposit Spread: $i_t - i_t^d$
- Deposit to Credit Ratio: d_t/L_t
- Domestic Interest rate: i_t
- Output: y_t

Monthly data for India is used ranging from March 1990 to March 2001. Table 3.2 summarizes the variables used for the empirical analysis.

Table 3.2: Data Description

Variable	Notation	Data variable	Source
Bank Deposits	d_t	Demand Deposits	IFS
Bank Credit	L_t	Domestic Credit	IFS
Domestic Interest rate	i_t	Monthly average call money rates of major commercial banks	RBI
World Interest rate	r_t	US Federal Funds Rate	US Fed. Reserve System
Deposit rate	i_t^d	Bank rate	IFS
Lending Rate	i_t^l	Commercial lending rate- Prime	IFS
Output	y_t	Index of Industrial Production (IIP)	RBI
Inflation	π_t	Change in Wholesale Price Index	RBI

RBI:Handbook of Statistics on Indian Economy

IFS: International Finance Statistics

[16]Output has been used because of lack of availability of monthly data on other variables. However, as long the impact of shock on the spreads and output is in accordance with the theoretical setup, the whole transmission mechanism is justified. Although VAR incorporates all the "driving" variables in the theoretical model, it can be argued that the omitted variable bias may result in contemporaneous correlation between the error terms of the system. Hence the correlation in VAR is tested for, using the Lagrange Multiplier test and it is found that null of no autocorrelation between the residuals could not be rejected.

It is to be noted that the call money rate of major commercial banks and the Index of Industrial Production (IIP) has been taken as a proxy for the domestic nominal interest rate and output respectively.[17] The basic summary statistics of the variables is given in Table 3.3:

Table 3.3: Summary Statistics

Variable	Notation	Min.	Max.	Mean	St. deviation	Units
Bank Deposits	d_t	361.52	1310.88	751.76	251.69	Rs. Billion
Bank Credit	L_t	3126.67	9942.23	5765.13	1923.43	Rs. Billion
Domestic Interest rate	i_t	1.22	35.29	10.94	6.63	% per annum
Foreign Interest rate	r_t	2.92	6.05	4.79	1.00	% per annum
Deposit rate	i_t^d	8.00	12.00	10.93	1.51	% per annum
Lending Rate	i_t^l	12.00	20.00	15.34	2.16	% per annum
Output	y_t	84.62	174.50	121.31	23.44	Index
Wholesale Price Index	WPI	77.92	149.50	117.47	20.70	Index

It is imperative to test the series for stationarity as it is a prerequisite to the VAR analysis (Hamilton, 1994). Stationary tests make it possible to discover whether the VAR model should be formulated in levels or first differences.

Unit Root Tests

The Augmented Dickey Fuller (ADF) test of stationarity is performed on all the variables. The lag length is selected for the ADF tests using the general to specific approach suggested by Perron (1989).[18] The following table presents the results for the unit root tests:

[17] It is a standard practice in the literature to use the money market rate as a proxy for domestic interest rate. (For example see Garretsen and Swank, 1998).

[18] Hall (1994) suggests that for moderate to large samples a general-to-specific approach performs better than standard information criteria such as those due to Hannan, Quinn and Akaike and Schwartz. Ng and Perron (1995) further confirm the approach using t or F test for the significance of lags is superior to information based rules because of more robust size properties across models. Therefore, the general to specific approach adopted by Perron (1989) is used. In accordance with this a large value of $k(=8)$ is used to begin and continually reduced until the t-value (calculated from ADF test) on $\mu(k)$ is greater than 1.6 in absolute value and that of $\mu(l)$ is less than 1.6 for $l > k$.

Table 3.4: Augmented Dickey Fuller Unit Root Tests

Variable	ADF stats	Lags	Trend/No trend	Series
Credit	0.54	8	Trend	I(1)
Deposit	−1.53	8	Trend	I(1)
Deposit/credit	−2.49	0		I(1)
Lending rate	−1.03	8		I(1)
Deposit Rate	0.22	7		I(1)
Domestic Interest Rate	−2.9*	3		I(0)
Lending Spread	−2.01	0		I(1)
Deposit Spread	−5.30*	0		I(0)
World Interest Rate	−3.51*	6		I(0)
WPI	−2.07	5	Trend	I(1)
Inflation	−4.86*	6		I(0)
Output(IIP)	−0.07	8		I(1)

*: Significant at 1% level.

The results imply there is a mixture of stationary ($I(0)$) and non stationary series ($I(1)$): The null hypothesis of unit root cannot be rejected for credit, deposit, deposit to credit ratio, lending rate, deposit rate and lending spread. On the other hand, domestic interest rate, deposit spread and world interest rate are stationary at levels. In order to implement a VAR all the variables have to be made stationary. The series is made stationary using the Baxter-King filter. This filter converts the series into its cyclical components, retaining the original properties of the series and keeping the timing relationships between the series unaltered (Baxter and King, 1995).[19] The following figures plot the actual and filtered data series for all the variables used in the VAR analysis.

[19]The Baxter-King filter is an improvement on the Hodrick-Prescott filter. As Baxter and King (1995, page 18) conclude : *"....our high-pass filter is better in two dimensions: its ease of application to data sampled at frequencies other than quarterly, and its appropriate treatment of observations near the end-points of the sample."* The actual technique of the Baxter-King filter is discussed in Appendix B.

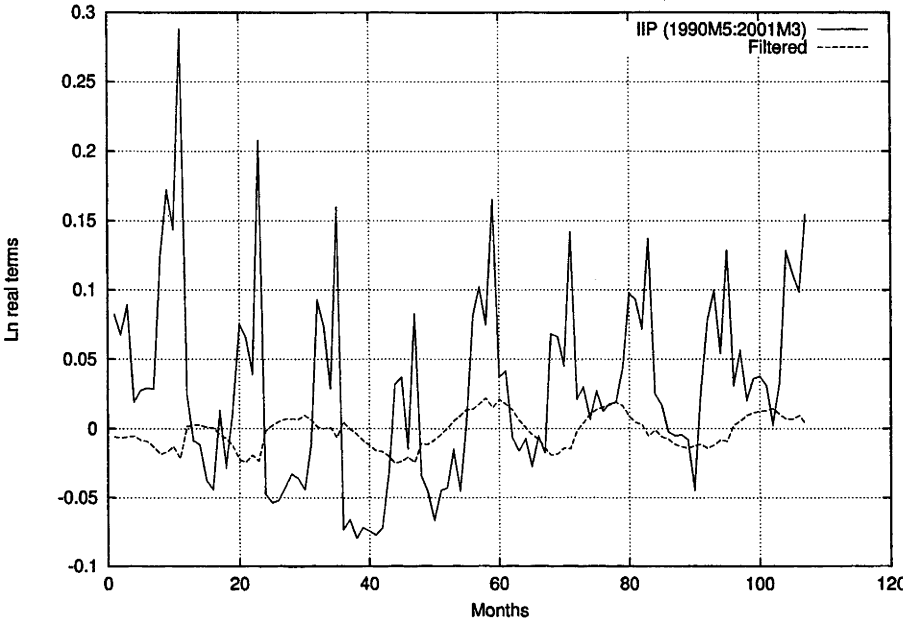


Figure 3.1: Index of Industrial Production

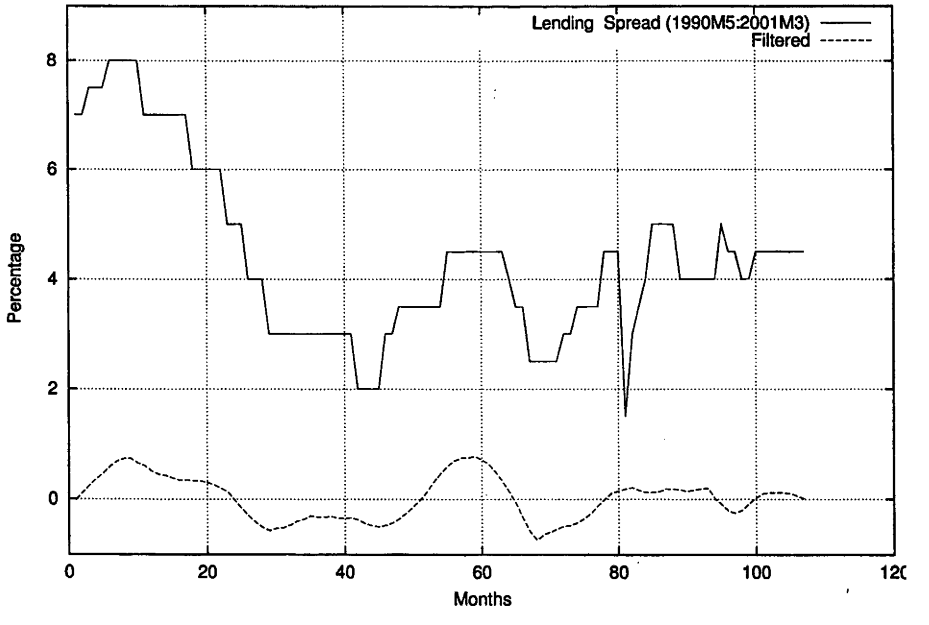


Figure 3.2: Lending Spread

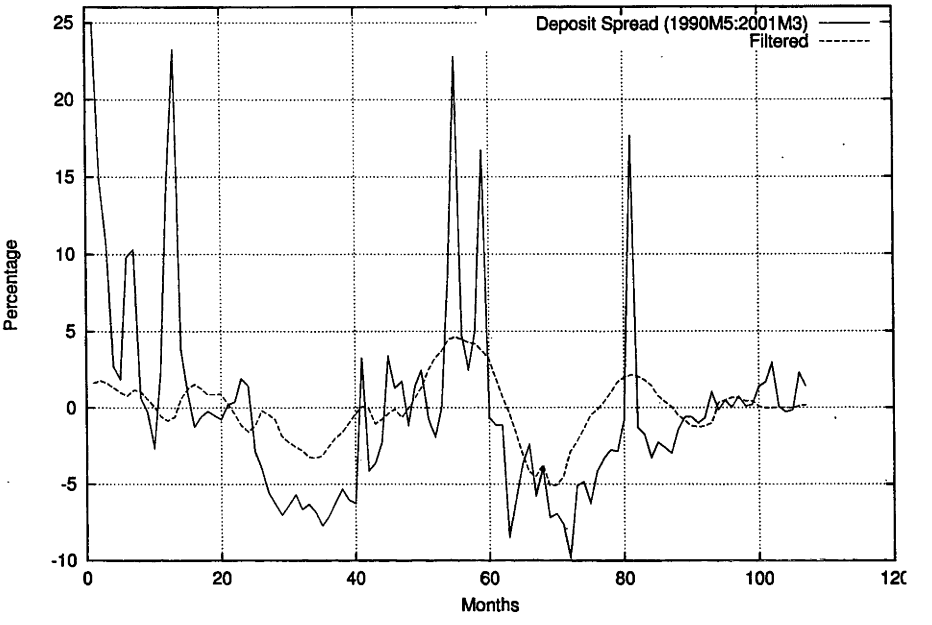


Figure 3.3: Deposit Spread

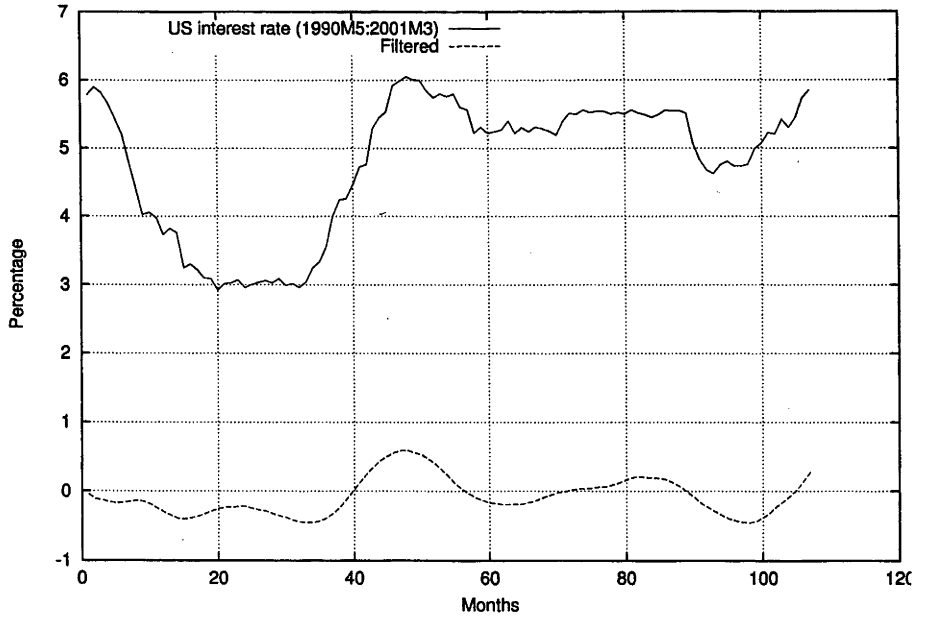


Figure 3.4: US Federal Funds rate

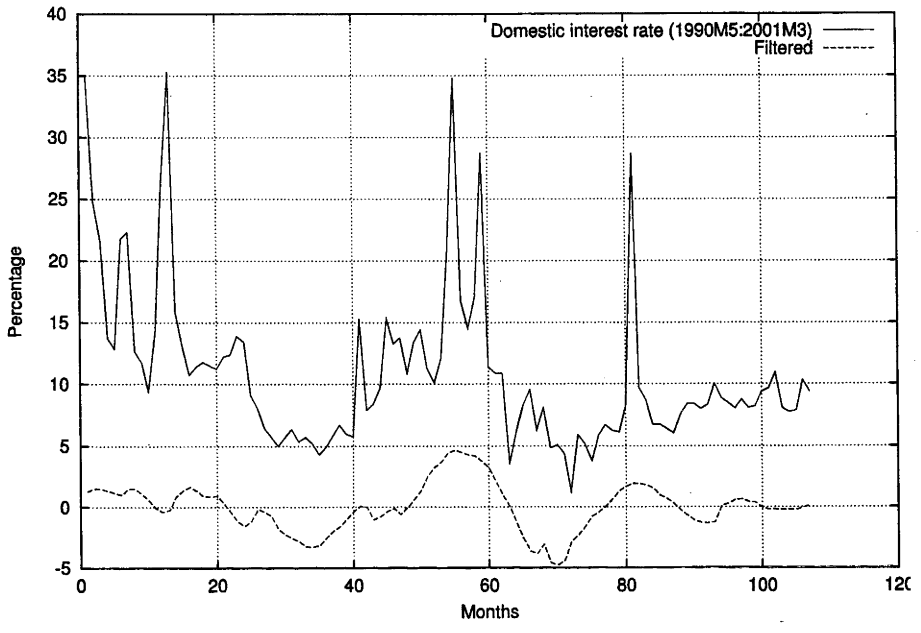


Figure 3.5: Domestic Interest Rate

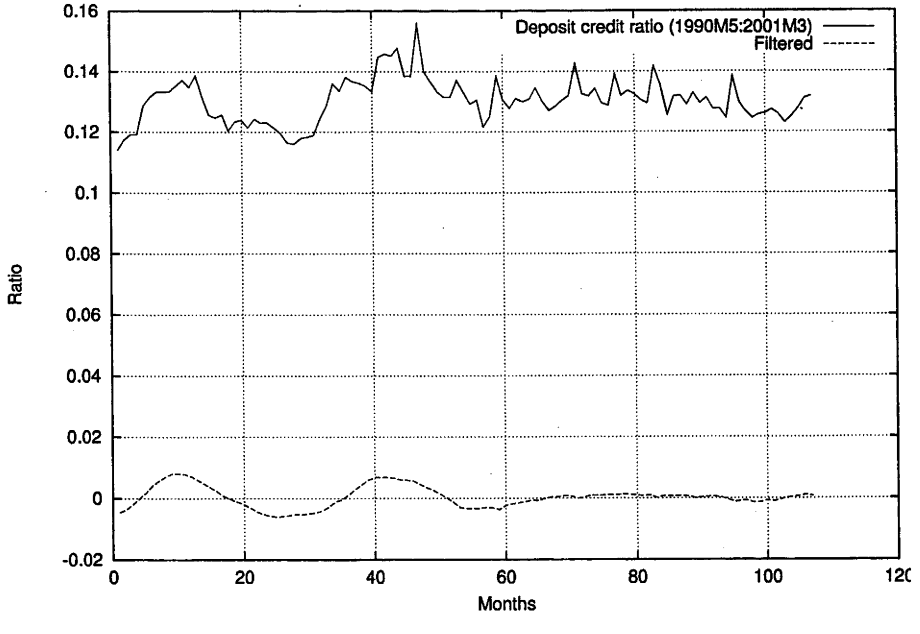


Figure 3.6: Deposit to Credit Ratio

3.4.3 Reduced Form VAR

A reduced form VAR framework is used for the analysis. A reduced form VAR expresses each variable as a linear function of its own past values, the past values of all other variables being considered and a serially uncorrelated error term (Stock and Watson, 2001). Thus there are five equations in the VAR: current output as a function of past values of lending spread, deposit spread, interest rate and deposit to credit ratio; Current lending spread as a function of past values of deposit spread, interest rate, output and deposit to credit ratio; and similarly for the interest rate, deposit spread and deposit to credit ratio equations.

The number of lagged values in each equation is determined by the Akaike Information Criteria (AIC) which is the preferred method for lag length selection when monthly data is used for the VAR analysis (Ivanov and Kilian, 2003). Six lags are used in the VAR. The VAR model can be specified as:

$$\mathbf{Z_t} = \alpha + \sum_{i=1}^{6} \beta_i \mathbf{Z}_{t-i} + \epsilon_t \tag{3.31}$$

where

$$\mathbf{Z_t} = \begin{bmatrix} y_t \\ i_t \\ (i_t^l - i_t^d)_t \\ (i_t - i_t^d)_t \\ (\frac{d_t}{c_t})_t \end{bmatrix};$$

$$\mathbf{Z_{t-i}} = \begin{bmatrix} y_{t-i} \\ i_{t-i} \\ (i_t^l - i_t^d)_{t-i} \\ (i_t - i_t^d)_{t-i} \\ (\frac{d_t}{c_t})_{t-i} \end{bmatrix};$$

$$\epsilon_t = \begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \\ \epsilon_{3t} \\ \epsilon_{4t} \\ \epsilon_{5t} \end{bmatrix}$$

α is the vector of intercepts and β_i the coefficient vector. The literature ((Lutkepohl, 1993),(Stock and Watson, 2001)) argues that VAR and impulse responses give meaningful interpretation under the following assumptions:

- $E(\epsilon_t) = \mathbf{0}$
- $E(\epsilon_t \epsilon_t') = \mathbf{\Omega}$ for all t, where $\mathbf{\Omega} = \sigma_{ij}, i, j = 1, 2, ...5$ is a positive definite matrix
- No Autocorrelation between residuals of VAR models: $E(\epsilon_t \epsilon_t') = \mathbf{0}$ for all $t = t'$. The Lagrange Multiplier LM test for autocorrelation in residuals for VAR models suggested in Johansen (1995) can be applied to test this assumption.
- Stability of VAR: All the roots of the equation $|\mathbf{I_5} - \sum_{i=1}^{6} \beta_i z^i| = 0$ lie outside the unit circle. This assumption can be tested by checking absolute values of the eigenvalues which should be less than one.

The above assumptions are satisfied in the VAR framework. The null hypothesis of no autocorrelation between the residuals could not be rejected ($\chi^2(16) = 18.75$, P value is 0.28). The stability condition of VAR is also satisfied as all the eigenvalues lie inside the unit circle. The purpose of the VAR analysis is to find the impact of a one period shock in the domestic interest rate to all the other variables in the system. Impulse Response Functions (IRF's) are now discussed.

Impulse Response Functions

The IRF's for the model are now derived. Eq. (3.31) can be re-written using lag operator as:

$$\mathbf{Z_t} = \alpha + \delta(L)\mathbf{Z}_t + \epsilon_t$$

or

$$[\mathbf{I} - \delta(\mathbf{L})]\mathbf{Z}_t = \alpha + \epsilon_t$$

Given that the stability condition is satisfied, gives:

$$\begin{aligned}
\bar{\mathbf{Z}} &= [\mathbf{I} - \mathbf{\Delta(L)}]^{-1}(\alpha + \epsilon_t) \\
&= [\mathbf{I} - \mathbf{\Delta}]^{-1}\alpha + \sum_{i=0}^{\infty} \mathbf{\Delta^i}\epsilon_{t-i} \\
&= \bar{\alpha} + \sum_{i=0}^{\infty} \mathbf{\Delta^i}\epsilon_{t-i} \\
&= \bar{\alpha} + \epsilon_t + \mathbf{\Delta}\epsilon_{t-i} + \mathbf{\Delta^2}\epsilon_{t-i} + \ldots
\end{aligned}$$

The coefficients of the ϵ terms are the impulse response functions for $\mathbf{Z_t}$ when ϵ is shocked. Generally it is a standard practise in the literature to choose a finite time horizon and

plot these coefficients. The plot traces the effect on the variables of one time innovation in the system. The GIRFs suggested by Pesaran (1997) are used which are invariant of the ordering of the variables in the VAR model. Figures 3.7, 3.8 and 3.9 present the impulse responses of output, deposit to credit ratio and lending spread respectively, to a one period shock in the domestic interest rate for a five month horizon. The interest is in the initial responses of the variables as that can be directly compared to the theoretical evidence from our model.[20] The impulse responses are each normalized to begin at zero. The bold line indicates the mean response and the 95 per cent confidence intervals of these responses are also indicated by broken lines.

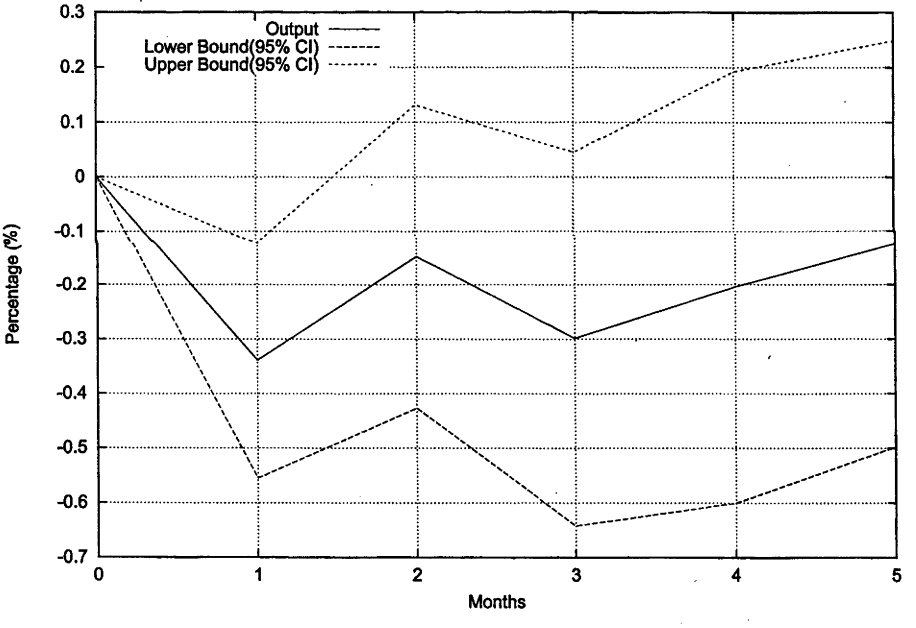


Figure 3.7: GIRF: Output

[20]This is essentially because model is static.

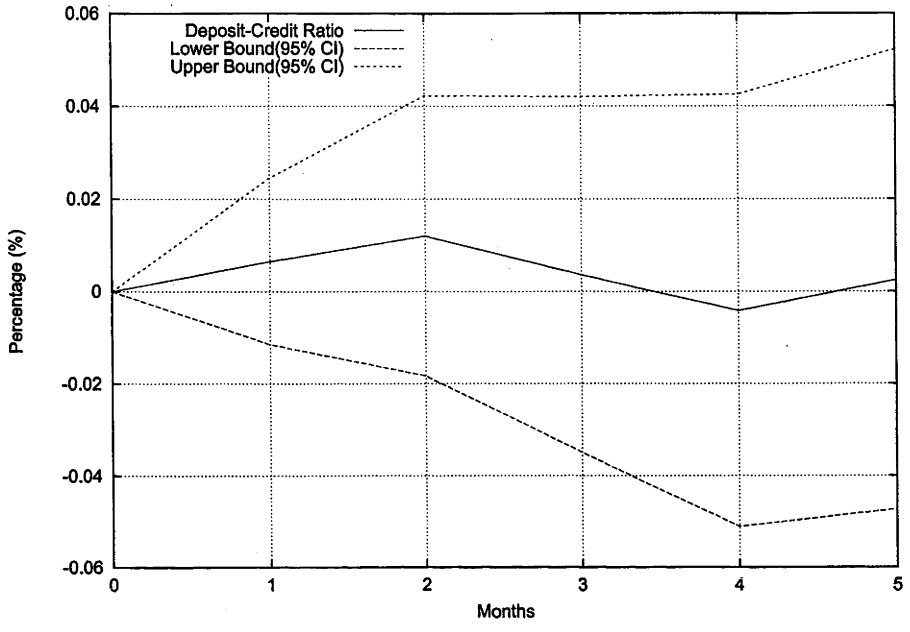


Figure 3.8: GIRF: Deposit-Credit Ratio

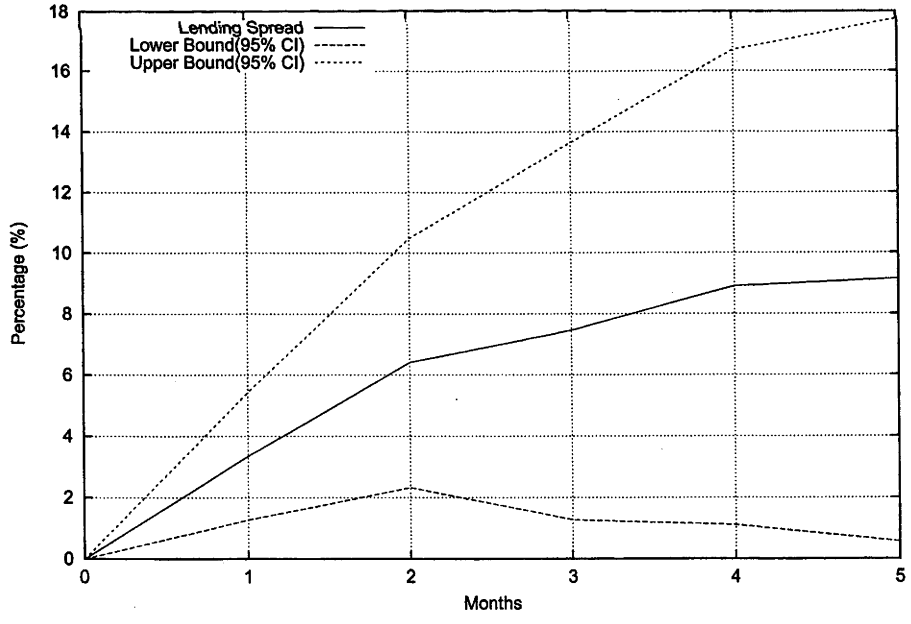


Figure 3.9: GIRF: Lending Spread

As predicted by the model there is a decline in output. Output falls by 0.3 per cent of its value in the first month. The lending spread rises by around 3 per cent with a one period shock in the interest rate. This is also in accordance with the theoretical prediction of the model. The demand to credit ratio increases in the first two months in accordance to the model and then declines for two periods after which it rises again. The subsequent dynamic behavior as shown in these graphs is less significant since the model is static. Further the confidence bands widen considerably with time indicating towards insignificant trends in the long run. Such behavior is common in this literature, e.g. see IRF's reported by Edwards and Vegh (1997).

3.5 Concluding Remarks

This chapter has developed a general equilibrium model to investigate the transmission and impact of stabilization efforts and the possibility of policy reversal in developing economies. The main highlights of the model are the presence of government guarantees to banks, imperfect capital mobility, exchange rate uncertainty, and transaction costs incurred by the banking sector. The interaction of all four sectors of the model: Household, banks, government and firms has been established and the impact of transmission of shocks is determined theoretically. It has been argued that under the assumptions of the model, there exists an offsetting effect with each stabilization effort of the government. In particular this offsetting effect is endogenously determined and in the current model quantifies the government guarantees. In actuality, the government guarantees are significantly high for developing economies.[21] The model is then tested empirically using Indian data. A reduced form VAR methodology and impulse response functions are used to determine the impact

[21] According to Bhattacharya and Patel (2003) the government guarantees are estimated to be 12 per cent of GDP for India.

of exogenous shocks on major endogenous variables of the model. The empirical evidence is broadly consistent with the theoretical model.

As mentioned earlier the model is predicated on two critical empirical assumptions: (i) that government satisfies an intertemporal budget constraint, and (ii) that banks affect the credit transmission mechanism. In chapters 4 and 5, the veracity of these assumptions is established.

CHAPTER 4

Structural Breaks, Unit Roots and Cointegration: An Analysis of the Sustainability of the Fiscal Deficit of Center and State Governments in India

4.1 Introduction

Rapid accumulation of domestic debt can lead to severe macroeconomic problems, and impede control of the fiscal deficit itself. This is particularly relevant for developing countries where the need for public expenditure is high and tax systems, public regulation and accountability are weak. For example, the combined gross fiscal deficit of the central and state governments in India overshot its budgeted target by one per cent in 2002-03 (RBI, 2003a). The tax-GDP ratio is also showing a downward trend and has fallen by 2 per cent of GDP from the late 1980's to 2001-02 year. Given recent experience in India, a number of commentators have expressed concern over the government's deficit and mounting debt. Solvency conditions appear to be violated in the Indian case ((Buiter and Patel, 1992),

(Buiter and Patel, 1995) and (Jha, 1999)) and there is fear that, with existing trends, the public sector may become bankrupt in the long run.

Despite recent adverse trends the Indian government has strengthened its commitment towards sound fiscal management, making distinct gains in expenditure management by reducing current spending. The state governments were also able to contain revenue expenditure at the budgeted level. The central government's resolve towards fiscal adjustment is further evident from the Fiscal Responsibility and Budget Management Bill (FRBMB) introduced in Parliament in December 2000. The bill is aimed at eliminating the government revenue deficit[1] over the next five years and cutting the fiscal deficit to two percent of GDP. The combined fiscal deficit of state and central governments in India has shown a declining trend[2] in the 1990's but remains at high levels in the range of 5 to 5.5 per cent of GDP. The recent high deficits can be attributed to an economic slowdown causing a fall in tax revenues, restructuring of the financial sector as part of wider economic reforms which forces the adoption of measures like recapitalization of public sector banks,[3] as well as some exogenous factors like severe drought which leads to a rise in food subsidies.

Since the solvency tests involve analysis of time series properties of revenue and expenditure series, the present chapter argues for the debate on debt sustainability to be examined in the light of recent advances on endogenous structural breaks in case of unit root analysis and cointegration since revenue and expenditure series are susceptible to structural breaks in response to sharp economic shocks. These shocks may be external shocks like the Indo-China or Indo-Pak war, or oil price shocks like those in the 1970's, or domestic shocks arising from government policies, like the financial restructuring of the mid 1980's, or the initiation of the liberalization process in 1993. It is discovered that structural breaks or

[1]Revenue deficit is the difference between revenue expenditure and revenue receipts.

[2]The average growth of combined gross fiscal deficit in 1990's was 15 per cent compared to 18 per cent in the 1980's.

[3]As discussed in chapter 2, the government is spending around 0.7 per cent of GDP every year on cleaning up the balance sheets of PSBs in order to make them attractive for private sector investment.

regime shifts play a crucial role in time series analysis of revenue and expenditure series. Once the structural breaks are accounted for in the analysis the series are indeed found to be trend-stationary. The results question the robustness of earlier studies' results and pose the possibility that the debt in the Indian case may not be unsustainable.

The plan of this chapter is as follows. Section 2 develops the intertemporal government budget constraint; Section 3 details the data used in this chapter; section 4 tests the unit root properties of the revenue and expenditure series allowing for endogenous structural breaks as suggested by Zivot and Andrews (1992) and Lumsdaine and Papell (1997); while section 5 concludes.

This chapter makes two contributions - (i) it provides a basis for testing for debt sustainability even in the absence of data on debt; (ii) it provides a methodology for inducting unknown structural breaks in the analysis of the sustainability of public debt at both the unit root testing and cointegration stages.[4] In the particular case of India, it is discovered that the debt is not unsustainable which is in sharp contrast to the widely prevalent view in extant literature and policy discussions. The analysis here also confirms the solvency of intertemporal budget constraint in the theoretical model used in chapter 3.

[4]The structural break analysis at cointegration stage is not directly applicable to the data used and hence is discussed in Appendix C.

4.2 Sustainability of the Domestic Fiscal Debt

The Government Intertemporal Budget Constraint

In this section the simple analytics of sustainability for domestic deficit are developed.[5] The most straightforward way to assess the sustainability of a public debt situation is to start from the governmental intertemporal budget constraint. This is written in nominal terms as:

$$G_t - T_t + i_t^g B_{t-1} = B_t - B_{t-1} \tag{4.1}$$

where G_t is the value of government expenditure (purchase of goods and services plus transfer payments); B_t the government debt at the end of period t, T_t government tax revenue and i_t^g the one-period rate of interest payable on government debt. Eq. (4.1) states that in the absence of money finance, the government budget deficit must be financed by new debt creation. Hence, expressing Eq. (4.1) in terms of ratios to GDP gives:

$$b_t = (1 + i_t^g)(1 + \pi_t + \eta_t)^{-1} b_{t-1} + (g_t - \tau_t) \tag{4.2}$$

where the lower case letters denote the ratio of the corresponding uppercase variables to nominal GDP: $b_t = B_t/P_tY_t$; $g_t = G_t/P_tY_t$; $\tau_t = T_t/P_tY_t$; with P and Y being the price level and real GDP respectively. $\pi_t = (P_t - P_{t-1})/P_{t-1}$ is the rate of inflation and $\eta_t = (Y_t - Y_{t-1})/Y_{t-1}$ the rate of growth of real GDP. The derivation of Eq. (4.2) has used the relationship that:

$P_tY_t = (1 + \pi_t)(1 + \eta_t)P_{t-1}Y_{t-1} \approx (1 + \pi_t + \eta_t)P_{t-1}Y_{t-1}$

$(g_t - \tau_t)$ is the primary deficit expressed as a percentage of GDP. We have the following cases:

Case 1: $i_t^g - \pi_t < \eta_t$

[5]This section heavily draws from Jha and Sharma (2004).

In this case in Eq. (4.2) the debt ratio will stabilize and the economy will remain solvent if: $\lim_{t\to\infty} E(b_t) = 0$

If the initial debt to GDP ratio (b_0) is strictly positive, this requires two conditions: $i_t^g - \pi_t < \eta_t$ for all t so that the debt ratio stabilizes rather than explodes. This is the so- called sustainability condition and makes any stable path of the primary deficit consistent with a stable public debt to GDP ratio. In addition there is condition (b) that $g_t - \tau_t \leq 0$ on average, if not in every period, so that the debt burden is ultimately liquidated.

These two conditions are necessary and sufficient and ensure that, no matter how large the debt, it can be paid off through tax increases, expenditure cuts or inflation. Thus the government is solvent. The steady state (finite) value of the debt-GDP ratio is:

$$\bar{b} = b_t = b_{t-1} = (1+\eta+\pi)(\eta-(r-\pi))^{-1}(g-\tau)\ if\ r-\pi<\eta \tag{4.3}$$

Eq. (4.3) emphasizes a strong link between government indebtedness and its primary deficit.

Case 2: $i_t^g - \pi_t > \eta_t$

In this case the debt is unsustainable and the debt stock will become infinite no matter what sequence of primary deficits are chosen, unless the debt stock itself can be offset by matching the sequence of increasing but discounted primary surplus in the future. To consider sustainability further here Eq. (4.2) is transformed to get:

$$b_t = (1+\varphi_t)b_{t-1} + (g_t - \tau_t) \tag{4.4}$$

where the fact:

$(1+i_t^g)(1+\pi_t+\eta_t)^{-1} = 1+i_t^g-\pi_t-\eta_t$ has been used. $\varphi_t = i_t^g - \pi_t - \eta_t$ is the real interest rate minus the rate of growth of real GDP. Eq. (4.4) will always hold *ex post*. Looking

forward the identity can be written in Eq. (4.4) for time period $t+1$ as:

$$b_t = E_t[(1+\varphi_t)^{-1} b_{t+1} - (g_{t+1} - \tau_{t+1})] \tag{4.5}$$

where b_t is known in period t. For this one period constraint to hold in expectational terms, it must equal the expected discounted net debt-to-GDP ratio in period $t+1$ conditional on information at time t. For fiscal policy to be sustainable for one time period Eq. (4.5) must hold. Writing the budget constraint of Eq. (4.5) for subsequent time periods $t+2$, $t+3$ etc. and solving forward gives:

$$b_t = E_t \sum_{s=0}^{\infty} \prod_{i=1}^{s} (1+\varphi_{t+i})^{-1} (\tau_{t+s} - g_{t+s}) + E_t \prod_{i=1}^{s} (1+\varphi_{t+i})^{-1} b_{t+s} \tag{4.6}$$

It is apparent that $\prod_{i=1}^{s}(1+\varphi_{t+i})^{-1}$ is a time-varying real discount factor adjusted for growth of real GDP with $\varphi > 0$. A necessary and sufficient condition for sustainability is that as $s \rightarrow \infty$ the discounted value of the expected debt-to-GDP ratio converges to zero. This is a transversality condition and can be expressed as:

$$\lim_{s \to \infty} E_t \prod_{i=1}^{s} (1+\varphi_{t+i})^{-1} b_{t+s} = 0 \tag{4.7}$$

Eq. (4.7) implies that a government is solvent if the transversality condition guarantees the non- explosiveness of public debt and when no Ponzi games are allowed, i.e., no new debt is issued by the government to meet interest payments. Hence it follows that current debt is offset by the sum of the current and expected future discounted surpluses, implying that the budget constraint holds in present value terms with:

$$b_t = \lim_{s \to \infty} E_t \sum_{s=0}^{\infty} \prod_{i=1}^{s} (1+\varphi_{t+i})^{-1} (\tau_{t+s} - g_{t+s}) \tag{4.8}$$

The Critical Value of Debt-GDP Ratio

Given Eq. (4.8) and using $z_m = \tau_{max} - g_{min}$ as a definition of the maximum level of the government's primary surplus the critical value of the public debt ratio (b^C) can be determined, which will satisfy the sustainability condition:

$$b_t \leq b^C = z_m(r - \pi - \eta)^{-1} \tag{4.9}$$

The necessary primary surplus can also be determined, given the initial debt ratio, b_0, the real interest rate and the growth rate of real GDP, to stabilize future debt to GDP ratio. when $r - \pi > \eta$. Eq. (4.2) can be used to define the finite value (b_0) to which b converges as:

$$z^{**} = (r - \pi - \eta)(1 + \eta + \pi)^{-1} b_0 \tag{4.10}$$

The gap between the stabilizing primary surplus (z^{**}) and the actual primary surplus ($\tau_t - g_t$) may be used as a sustainability indicator. This indicator gives the magnitude by which either revenue must be increased or expenditure cut relative to income to stop the debt ratio from growing.

Thus the sustainability of public debt is essentially an intertemporal question. In particular, every temporary deficit can be sustainable so long as it is matched by an adequate future surplus. Most empirical tests on sustainability apply time series methods and ask whether the observed characteristics of debt-related variables satisfy the solvency condition in Eq. (4.7). This solvency condition can be tested in a variety of ways depending on the processes postulated for the primary deficit ($g_t - \tau_t$) and the real interest rate adjusted for output growth (φ_t). Hamilton and Flavin (1986) and Trehan and Walsh (1991), among others, examine the case where ($g_t - \tau_t$) is strictly exogenous and φ_t is constant. Wilcox (1989) considers the case with exogenous ($g_t - \tau_t$) but variable φ_t. Uctum and Wickens

(1997) consider the case where φ_t is stochastic and $(g_t - \tau_t)$ could be exogenous or endogenous. For the sake of simplicity, it is assumed that the real interest rate adjusted for output growth, φ_t, is constant with an unconditional mean. To proceed further now take the first difference of Eq. (4.6), substitute for Δb_t using Eq. (4.4) and simplify to get:

$$\Delta b_t = \rho_t - \tau_t = \sum_{s=0}^{\infty}(1+\varphi)^{-s-1}E_t(\Delta\tau_{t+s} - \Delta d_{t+s}) + \lim_{s\to\infty}(1+\varphi)^{-s-1}E_t b_{t+s} - \\ - \lim_{s\to\infty}(1+\varphi)^{-s-1}E_{t-1}b_{t+s-1} \tag{4.11}$$

where $\Delta b_t = g_t + \varphi b_{t-1} - \tau_t = \rho_t - \tau_t$ with $\rho_t = g_t + \varphi b_{t-1}$
is defined as total government expenditure inclusive of expenditure on goods and services, transfer payments and interest on debt. If the government satisfies its intertemporal budget constraint the expected limit term in Eq. (4.11) is zero so that the sum of the current budget surplus $(\tau_t - \rho_t)$ and the expected present discounted value of the future surplus will equal the amount needed to repay the principal and interest on the initial debt. When this condition holds, it can be said that the current expected paths of government spending and taxation are sustainable.

As Papadopoulos and Sidiropoulos (1999) demonstrate, if the limit terms on the right-hand-side of Eq. (4.11) are zero, then a certain cointegrating relationship emerges. Hence cointegration is a necessary condition for the intertemporal budget constraint to hold. To see this assume that d_{t+s} and τ_{t+s} follow random walks with drift, i.e., these variables follow the following time series processes:

$$\Delta\rho_t = \alpha_d + \nu_{d,t+s} \tag{4.12}$$

$$\Delta\tau_t = \alpha_\tau + \nu_{\tau,t+s} \tag{4.13}$$

where α_d and α_τ are constants and ν_d and ν_τ are zero-mean stationary processes. Hence Eq. (4.11) can be rewritten as:

$$\rho_t - \tau_t = \alpha + \lim_{s\to\infty}(1+\varphi)^{-s-1}E_t b_{t+s} - \lim_{s\to\infty}(1+\varphi)^{-s-1}E_{t-1}b_{t+s-1} + \nu_t \tag{4.14}$$

with

$\alpha = \sum_{s=0}^{\infty}(1+\varphi)^{-s-1}(\alpha_d - \alpha_\tau)$

$\nu_t = \sum_{s=0}^{\infty}(1+\varphi)^{-s-1}(\nu_{d,t+s} - \nu_{\tau,t+s})$

Given that ρ_t and τ_t are $I(1)$ and given that equations (4.12) and (4.13) imply stationarity on the right hand side of Eq. (4.11), the left hand side of Eq. (4.11) must also be stationary for which a necessary condition is that Eq. (4.14) be stationary, which will be the case when ρ_t and τ_t are cointegrated.

Thus a test for sustainability of the debt would check for the cointegration of these two variables if they are $I(1)$. This cointegrating regression would take the form:

$$\tau_t = \alpha + \beta\rho_t + \nu_t \tag{4.15}$$

Formally, then, if ρ_t and τ_t are $I(1)$, the null hypothesis is that ρ_t and τ_t are cointegrated and that $\beta = 1$. If this null hypothesis is not rejected the public debt is sustainable. Thus understanding the time series properties of the revenue and expenditure series would be crucial to establishing the sustainability or otherwise of the public debt. This chapter focuses on this issue. Of particular interest is the possibility that the data might actually be $I(0)$ with one or more structural breaks whereas standard unit root tests could be rejecting the null of unit roots.

A structural break is said to have taken place when a change is observed in the regression parameters of the model. Several studies have reported instances where a series which

was classified as non-stationary (i.e., I(1)) in the absence of structural break hypothesis was actually trend stationary once structural break was accounted for in the analysis. Thus the conventional unit root tests erroneously fail to reject the null of unit root for the series. Structural breaks are a result of some event significantly affecting the variables being studied. Such breaks can lead to a permanent shift in the level or slope (or both) of the series but the basic nature of the series remains unchanged. With such events or shocks accounted for, the series can be trend stationary but with a structural break. More recent literature admits the possibility of more than one such structural break.

The purpose of this chapter is to ascertain whether the combined public debt of the Indian central and state governments is sustainable when the possibility of endogenous structural breaks is allowed for. Buiter and Patel (1992) and Buiter and Patel (1995) base their test on the unit root properties of the public debt series whereas Jha (1999) uses the cointegration approach but does not permit structural breaks.

4.3 Fiscal Sustainability with structural breaks

Conventional time series analysis has worked with structural breaks but the literature on structural break hypothesis in the context of unit root testing is sparse. A brief review of this literature follows.

Several studies have reported cases where a series which was classified as non-stationary (i.e., $I(1)$) in the absence of structural break hypothesis was actually trend stationary once a structural break was allowed for in the analysis. This means the conventional unit root tests falsely fail to reject the null of unit root for the series which are stationary with structural breaks. The argument given is that structural breaks which are a result of some event significantly affecting the macroeconomic variables, can lead to a permanent shift in

the level or slope (or both) of the series but that the basic nature of the series remains unchanged. Thus, once these events or shocks are allowed for the series then can be trend stationary but with a structural break. The importance of the structural break hypothesis is evident from the fact that ignorance of the structural break can result in incorrect inferences from the model. For example the inferences drawn from the techniques like co-integration and error correction modeling (which are applicable to non-stationary series) would be redundant if the underlying series is actually stationary with structural breaks.

The recent debate in the structural break literature was initiated by Nelson and Plosser (1982) who analyzed historic time series data over a very long period with the objective of fitting an appropriate model for each time series under consideration. This empirical characterization led to the conclusion that most of the macroeconomic series under consideration displayed non-stationary process with no tendency of returning to a deterministic path. This result was crucial as it was contrary to the traditional view prevailing in the then literature that macroeconomic time series display stationary fluctuations around a deterministic trend. Nelson and Plosser opined that shocks have a permanent effect on the long run level of the macroeconomic series. This challenged the prevailing view which held that external shocks subside after a period of time and in the long run have minimal effects leaving the basic nature of the series remaining the same.

Perron (1989) re investigated the same set of series as those considered by Nelson and Plosser and carried out the analysis after allowing for structural break. Perron assumed the structural break to be determined exogenously. The possibility of structural break was checked by considering three models. The first allowed for a one point change (i.e.,single break) in the intercept, the second model allowed for the one point change to have taken place in the slope coefficient and the third model considered both effects to have taken place i.e., one point change in the intercept as well as in the slope. Perron (1989) opines

that the conventional unit root test mostly fails to reject the unit root hypothesis even for the series which were known to be trend stationary with structural break.[6] The author goes on to suggest a modified version of the conventional ADF test which he uses in his analysis.

Perron's (Perron, 1989) test rejected unit root hypothesis for all but three series i.e., except for three series all of the remaining series under consideration were found to be stationary with a structural break. These results almost reversed the Nelson and Plosser (1982) findings. Thus Perron (1989) was a crucial landmark in the structural break debate. However this analysis was subject to the criticism that structural breaks chosen were arbitrary. It was argued that selection of pretest exogenous break, as done by Perron, involves subjectivity.

In criticizing Perron, Zivot and Andrews (1992) tried to tackle the problem by endogenising the date of structural break i.e., considering the date of the break to be determined endogenously within the model. The testing procedure adopted by Zivot and Andrews (1992) involved estimation of the date of the structural break by using sequential methods. The results obtained were observed to have partially reversed Perron's results. Zivot and Andrews failed to reject the unit root null for four of the series. Thus four series which were declared to be $I(0)$ using Perron's test actually had unit roots. As the empirical exercise in the present thesis closely follows the technique used by Zivot and Andrews (1992), a detailed discussion of the technique is provided in section 4.5.

[6]This assertion is based on some Monte Carlo studies carried out by Perron (1989).

4.4 Data

The empirical analysis is done by combining the revenue and expenditure of the central and state governments of India. The revenue and expenditure data series (1951-2000) is taken from various issues of the Budget documents of Government of India and the Handbook of statistics on the Indian Economy published by RBI (RBI, 2003e). The analysis is done using data in real and nominal magnitudes. The real series is calculated by deflating the nominal data using the CPI based inflation rate. A quick look at the data from figures 4.1, 4.2 and 4.3 reveals there is a sharp variation in the revenue and expenditure series over time during the period of analysis.[7]

[7]Please note 1 crore = 10 million.

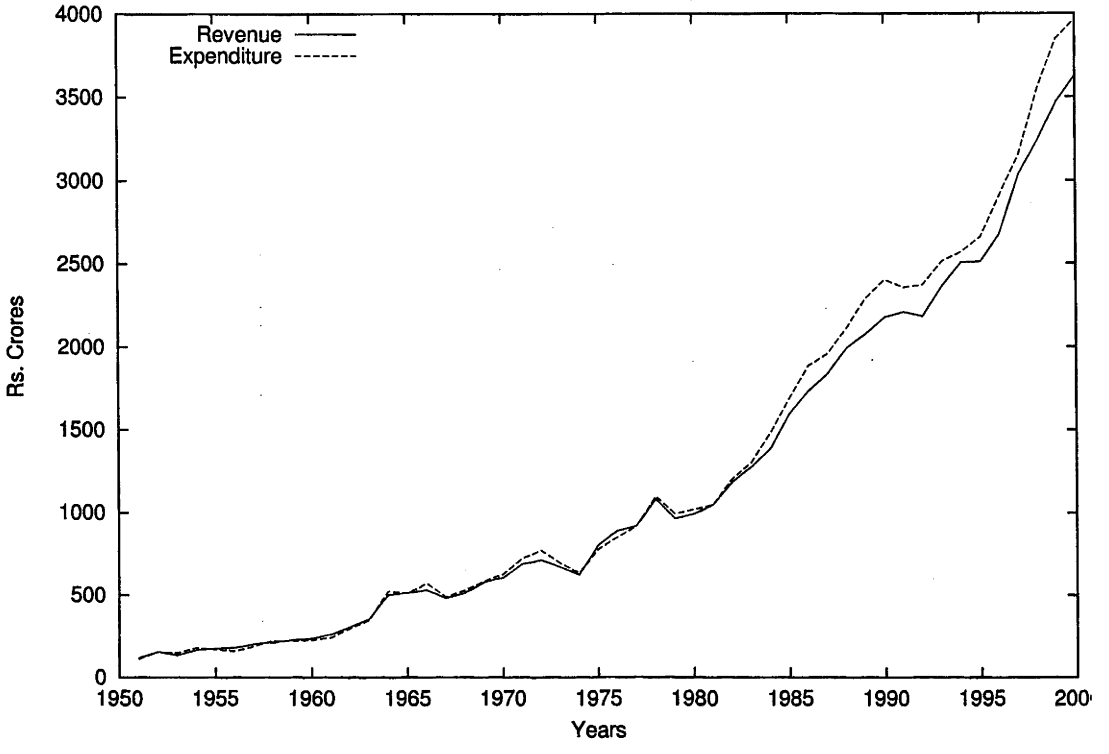


Figure 4.1: Combined revenue and expenditure for central and state governments: Real Magnitudes (1951-2000)

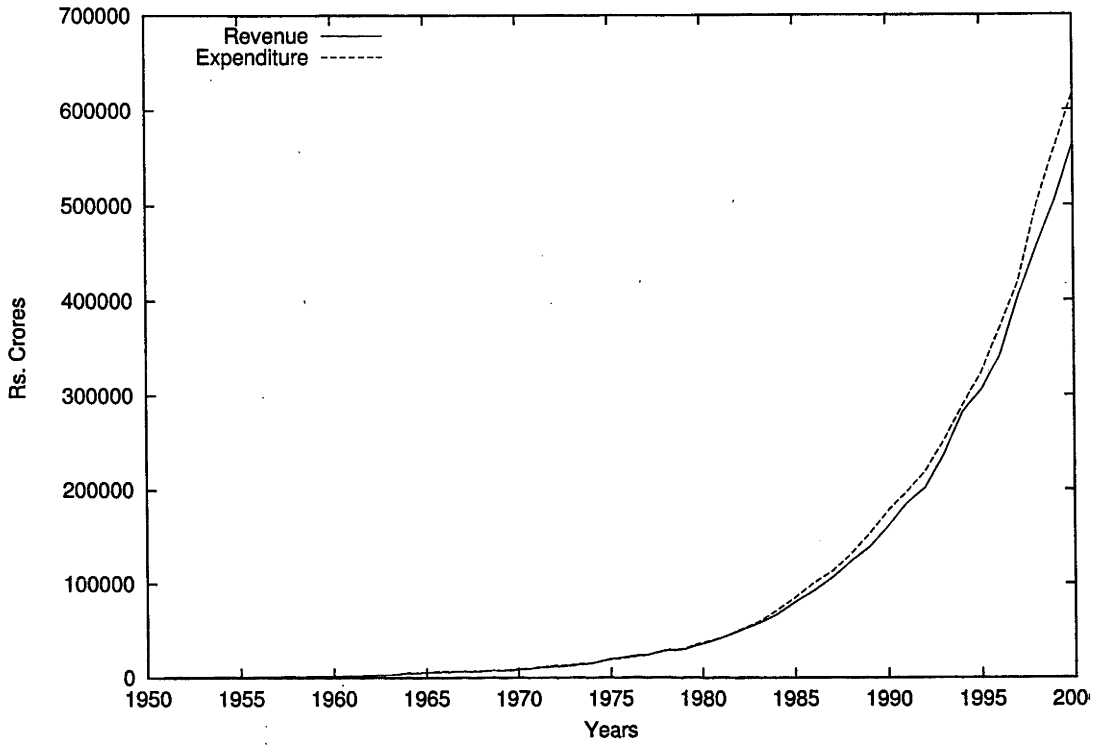


Figure 4.2: Combined revenue and expenditure for central and state governments: Nominal Magnitudes (1951-2000)

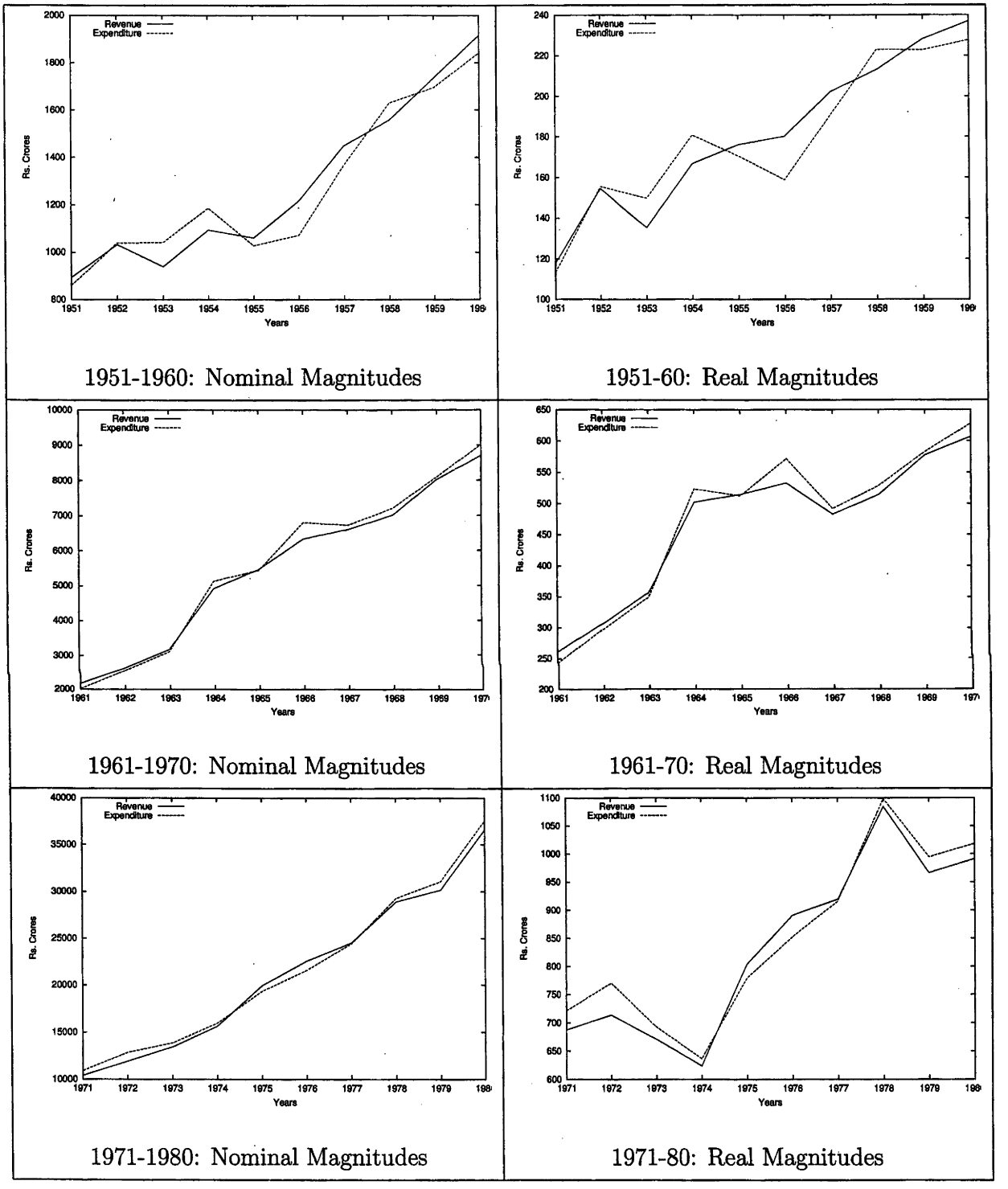


Figure 4.3: Combined revenue and expenditure for central and state governments over shorter time spans

4.5 Methodology

The methodology considers one break analysis initially and then extends it by incorporating an additional break. Due to the constraint of sample size, the analysis for more than two structural breaks is beyond the scope of this study. The estimation of break dates is a prerequisite for the analysis. To do so the following null hypothesis is considered:

$$R_t = \alpha + R_{t-1} + \epsilon_t \tag{4.16}$$

where R_t is the combined revenue of central and state governments.

In words this equation means that the series is difference stationary i.e., integrated of order one. The alternative hypothesis is the case where the series is subject to fit some trend stationary process in the presence of an endogenous structural break. The model specification allows for a change in both the level and the slope of the series. The estimation of the break date is followed by testing for the null hypothesis. The test cannot use the standard ADF critical values or the standard normal distributions due to the small sample bias in the asymptotic distribution of the test statistics (Zivot and Andrews, 1992). In the present study the one break analysis closely follows the technique used by Zivot and Andrews (1992) for one structural break. The following subsection briefly discusses this methodology and specification of this model.

4.5.1 One Break Model

Model Specification

The model considered is :

$$\Delta R_t = \alpha + \beta t + \gamma DI1_t + \omega DS1_t + \mu R_{t-1} + \sum_{i=1}^{k} c_i \Delta R_{t-i} + \epsilon_t \tag{4.17}$$

for t =1.....T, where $c(L)$ is a lag polynomial of known order k and $1 - c(L)L$ has all its unit root outside the unit circle.

$DI1_t$ is the indicator dummy variable for a mean shift occurring at time $SB1$ and $DS1_t$ is the corresponding trend shift variable.

$DI1_t = 1$ if $(t > SB1)$

$DS1_t = (t - SB1)$ if $(t < SB1)$

The k extra regressors are taken in order to take care of the autocorrelation i.e the temporal dependence in the error terms. The test for unit root hypothesis is under the null of $\mu = 0$. Hence the hypothesis to test for unit root are:

Null Hypothesis H_0 : Series is $I(1)$

Alternative Hypothesis H_A : Series is trend stationary with one structural break

The model allows for changes in both the slope and trend coefficients.

Empirical Analysis

The lag value k can be selected by two possible strategies discussed in the literature. One is to set the value of k (exogenously), to a fairly large value,[8] such that the true value is less than the chosen value k. Another method to choose k is to endogenize the value of k

[8]This is done in order to be on the safer side.

i.e., the lag value is data dependent in this case.[9] There are several methods of selecting the data based lag value of k, namely Hannan and Quinn's information criteria, Akaike's Information criteria and Schwarz's information criteria. Apart from these, an approach known as the general to specific approach is also used to find the optimal lag length k. However, according to Hall (1994) the estimation of k can affect the distribution of the ADF test which is used for unit root testing. On analyzing the distortions in the distribution of ADF statistics Hall (1994) concludes that for moderate to large sample sizes the general-to-specific approach performs better than various information criteria. Hence, the present study uses the well known Perron (1989) criteria, based on the general to specific approach. As per this criteria, first a maximum value of k is set to some k^* and then k is narrowed down (here k^* is set at 8 and thereafter the first value of k is chosen such that the t-stats (calculated from ADF test) on μ_k is greater than 1.6 in absolute value and that of μ_l is less than 1.6 for $l > k$). Table 4.1 summarizes the lag values calculated (i.e., value of k) for each of the series.

Table 4.1: Lag length k

Nominal Magnitudes	
Revenue	8
Expenditure	8
Real magnitudes	
Revenue	8
Expenditure	8

The technique allows the structural break to vary between 2 and $T-1$ where T is the sample size. This means the series is trimmed from the edge as this technique does not allow for structural break at the beginning or the end of the series. Having trimmed the data a dummy variable is assigned for each value of T varying between 2 and $T-1$. Hence

[9]This method is more popularly used than the previous one, the reason being that unlike the previous method this does not involve any subjectivity.

giving $T-2$ combinations of the data set.

The next step is to estimate the unknown break point. The criteria for choosing this is to take the break point supporting the alternative hypothesis the most (i.e. supports the null hypothesis the least). This is implemented practically as follows: Firstly, a sequential OLS procedure is run to test for the coefficient of R_{t-1} i.e., $\mu = 0$ over these data sets to get the $T-2$ t-stats 't' attached with the corresponding coefficients. It is to be noted that 't' is a function of T. Now to decide the date of the structural break, $SB1$, the minimum value is chosen of one sided (left tailed to be more precise) 't' statistic calculated above, the date corresponding to this t-stats is the estimated date of the structural break. Thus, the date of the structural break is:

$t(SB1) = \min_{T_i} t_\mu(T_i)$

The minimum of all the $T-2$ t-stats is taken the T_i selected corresponding to that t-stats. This gives date of the structural break $SB1$.

Critical Values

It should be noted here that the asymptotic distribution of the t-stats computed above is not the standard distribution and hence the test of significance can not be done using the standard t-statistics. Hence one has to generate the finite sample critical values. Zivot and Andrews (1992) report the sample specific asymptotic critical values for the above model. However asymptotic critical values are less than the finite sample critical values and are conclusive for the analysis only if the computed t-statistics are less than these values.[10] For the scenario in which computed t-stats are higher that the asymptotic critical values, there are two possibilities: The coefficient is significant or the value of the computed statistics lies between the asymptotic critical value and the finite sample critical value and thus the

[10]This will mean the coefficients are insignificant and will remain so even if the finite sample critical values are used.

coefficient is insignificant. Hence it is necessary to compare the statistics with the finite sample critical values. Vogelsang and Perron (1998, Page 1082) report the finite sample (for sample size 50) critical values for the model specification used here. The same is used for this analysis for testing the significance of μ. Table 4.2 presents the results for one break model.

Table 4.2: Tests for Unit Roots: Combined revenue and expenditure for central and state governments, One Break

Series	$SB1$	γ	ω	μ
		Nominal Magnitude		
Revenue	1961	0.144	0.024	-0.591
		(-3.32)	(2.32)	(-4.76)
Expenditure	1975	-0.081	-0.006	-1.24
		(-2.16)	(-1.85)	(−5.91*)
		Real Magnitude		
Revenue	1962	0.167	-0.053	-1.1
		(2.39)	(-2.71)	(-5.49)
Expenditure	1961	0.27	0.038	-0.851
		(3.19)	(-0.693)	(−5.93*)

t-statistic are in parentheses.

*: Significant at 5% level.

Critical values of Vogelsang and Perron (1998) for $T = 50$ are -6.29 (at 1%) and -5.59 (at 5%).

The above results show that the null of unit root could not be rejected for the revenue series (both real and nominal magnitudes). However the unit root null is rejected for the expenditure series and hence it can be argued that the expenditure series is trend stationary with one structural break.

In the recent literature of structural breaks, Lumsdaine and Papell (1997) suggest a null of unit root which is accepted in the analysis considering a one break model may be rejected if the analysis is repeated with one additional endogenous structural break i.e., the model is specified so as to incorporate two structural breaks. The inferences by Lumsdaine and

Papell (1997) motivates a further extension of present analysis to allow for two structural breaks in the series to check whether any additional information is revealed about the nature of the series. The following subsection discusses the two break model given by Lumsdaine and Papell (1997).

4.5.2 Two Break Model

The technique used in the two break model was given by Lumsdaine and Papell (1997) and is based on sequential test procedures given by Banerjee et al. (1992). Although this technique is similar to that of Zivot and Andrews (1992), the analysis is done considering two breaks instead of one.

Theory and Model Specification

The model considered in the case of two structural breaks is :

$$\Delta R_t = \alpha + \beta t + \gamma DI1_t + \omega DS1_t + \psi DI2_t + \Theta DS2_t + \mu R_{t-1} + \sum_{i=1}^{k} c_i \Delta R_{t-i} + \epsilon_t \quad (4.18)$$

for t =1.....T, where $c(L)$ is a lag polynomial of known order k and $1 - c(L)L$ has all its roots lying outside the unit circle.

$DI1_t$ and $DI2_t$ are indicator dummy variables for a mean shift occurring at times $SB1$ and $SB2$, respectively and $DS1_t$ and $DS2_t$ are the corresponding trend shift variables, such that:

$DI1_t = 1$ if $(t > SB1)$

$DI2_t = 1$ if $(t > SB2)$

$DS1_t = (t - SB1)$ if $(t < SB1)$

$DS2_t = (t - SB2)$ if $(t < SB2)$

The test for unit root is under the null hypothesis of $\mu = 0$. Hence

Null Hypothesis H_0 : Series is $I(1)$

Alternative Hypothesis H_A : Series is trend stationary with two structural breaks

The model allows for the changes in both the slope and trend coefficients in both $SB1$ and $SB2$.

Empirical Analysis

Although, the basic intuition here is exactly the same as in the one break model, it is imperative to take account of several noteworthy points owing to the incorporation of one additional break $SB2$.

The possibility of two consecutive structural breaks is ruled out i.e, $SB1 \neq SB2 \pm 1$ and $SB1 \neq SB2$. Hence a positive shock followed by a negative shock or vice versa is not considered by the technique.

In accordance with the underlying theory of the technique used, the test for the change in coefficients is not considered at the ends of the sample. This means that $SB1$ and $SB2$ are allowed to vary between 2 and $T-1$ only. This requires trimming of data at the edges.

The unknown $SB1$ and $SB2$ are calculated from the minimum of the sequence of t-stats computed over a two dimensional matrix of the possible combinations of k_1 and k_2. The set corresponding to minimum t-stats gives the point of structural breaks $SB1$ and $SB2$.

The lag length k is estimated within the model using the Perron criteria as done in the one break analysis of the previous section.

Critical values reported by Lumsdaine and Papell (1997) have been used for testing the

significance of the coefficient μ.[11] The details of the theory underlying the multiple structural break technique is provided in Appendix C. The results for the two breaks analysis are reported in Table 4.3.

Table 4.3: Tests for Unit Roots: Combined revenue and expenditure of central and state governments, Two Breaks

Series	Years	γ	ω	ψ	Θ	μ
			Nominal Magnitude			
Revenue	1963	0.256	0.021	0.126	-0.003	-1.12
	1984	(5.19)	(2.55)	(3.94)	(-1.18)	(−7.41**)
Expenditure	1976	-0.22	-0.0002	-0.027	-0.041	-2.43
	1994	(-5.54)	(-0.074)	(-0.684)	(-3.90)	(−8.15**)
			Real Magnitude			
Revenue	1963	0.273	-0.064	0.168	-0.009	-1.42
	1985	(4.29)	(-3.92)	(3.99)	(-2.70)	(−7.87**)
Expenditure	1963	0.189	-0.136	0.185	-0.008	-1.44
	1984	(2.38)	(-4.05)	(3.64)	(-2.20)	(−6.95*)

t-statistic are in parentheses.

**: Significant at 1% level.

*: Significant at 5% level.

Critical values of Lumsdaine and Papell (1997) are -7.34 (at 1%) and -6.82 (at 5%).

The results show that when the analysis is extended by allowing for two breaks, the null of difference stationarity is rejected for the revenue as well as the expenditure series. Hence structural breaks indeed play a crucial role in deciding the time series properties of the revenue and expenditure series.

The crucial question of selection of model specification (one break against two breaks) remains. It is worth mentioning that the literature on endogenous structural breaks is based on the fact that if the series is trend stationary instead of I(1) then any analysis

[11] Papell reports the finite sample critical values generated under the null of unit root ($\delta y_t = \epsilon_t$)

done by assuming the series as I(1) will give incorrect results. The revenue and expenditure series for the case of India have been taken as I(1) until now, whereas the present chapter concludes they are in fact trend stationary. Given this information set it will be incorrect to take the series as I(1). The series has to be taken as trend stationary with structural breaks as Perron (1989, Page 1389) clearly mentions *"Hence for all practical purposes, it may be more advantageous to adopt the trend stationary view with breaks and de-trend our series accordingly prior to analyzing the remaining noise".*

Hence in order to avoid any subjectivity, bias and ignorance, the models selected are the ones for which the series turn out to be trend stationary with structural break(s). Hence it can be concluded that the combined revenue and expenditure series are trend stationary rather than difference stationary. These findings are crucial for time series analysis of these series. The nature of the series is critical to the frequently used cointegration analysis and ECM mechanisms as these techniques can be used if, and only if, the series under consideration are non-stationary and integrated of the same order.

4.6 Conclusions

This chapter has revisited an important policy issue in the Indian context - sustainability of the public debt. It began by spelling out the result that if public expenditure and revenues are both stationary or non-stationary and cointegrated with a cointegrating vector of [1,-1], public debt is sustainable. However, critical to this is the correct determination of the time series properties of the expenditure and revenue series, in particular to account for structural breaks.

Whereas standard ADF tests have revealed the public expenditure and revenue series in India to be $I(1)$, this chapter has generalized this analysis by admitting structural breaks. This analysis is conducted by taking the combined revenue of India's state and central governments. Public expenditure and revenue are found to be $I(0)$ with regime shifts. The endogenously determined dates of structural breaks are close to some major economic events that have affected Indian economy in last 50 years as reported in Table 4.4.

Table 4.4: Dates of structural breaks

Date of Structural Break	Event
Revenue	
1961	
1962	Indo-China War
1963	
1984	
1985	Initiation of first phase of financial reforms
Expenditure	
1961	Indo-China War in 1962
1963	Indo-China War in 1962
1975	Oil Price shock 1974
1976	
1994	Rupee made fully convertible on current account in 1993

Hence the results of the extant literature suggesting public debt in India as unsustainable may not be as robust as previously thought.

CHAPTER 5

Incomplete Reforms: The Role of Banking Sector in Credit Transmission Mechanism in India

5.1 Introduction

Both the financial crisis of 1991 and the subsequent initiation of the financial reform in India has generated considerable interest in the recent literature ((Cerra and Saxena, 2002), (Shirai, 2002), (Bhattacharya and Patel, 2003), (Bhide et al., 2001)).[1] This chapter addresses the question: Has the financial liberalization of recent years affected the monetary transmission mechanism by altering the channels through which it operates? There is renewed interest in the literature towards the bank lending channel of transmission of monetary policy (For example, Thornton and Wheelock (1995)). According to this channel real economic activity can be affected through the supply of loans in the financial sector and keeping interest rates broadly unchanged. Banks respond to a monetary contraction through decreasing the supply of loans thereby adversely affecting the aggregate output

[1]This literature has been surveyed in chapter 2.

and inflation in the economy. The basic underlying assumption for the existence of a credit channel is imperfection in the capital markets and it is argued that this channel tends to weaken with financial innovation and liberalization of capital markets (Kashyap and Stein, 1994).

As discussed in chapter 2 the post-reform decade in India has been characterized by the efforts to reduce inefficiencies in the financial sector thereby making it more competitive. The aim of the present chapter is to test the importance of the banking sector as a credit transmission channel in India's post reform period. Gertler (1995) points out that the lending channel for monetary policy is a special case of a financial propagation mechanism. It should be noted that a crucial mechanism of magnification of macroeconomic disturbances is through the banking sector. This has been elaborated in the theoretical framework discussed in chapter 3. The present chapter will empirically test the above underlying assumption of the importance of banking sector in the theoretical framework. The extant literature based on the tests of a bank lending channel[2] using aggregate data tests for the significant impact of credit on aggregate output which in turn is assumed to be evidence of the existence of bank lending channel. One drawback of these studies is that they do not distinguish between credit supply and credit demand.

The impact of credit on output may be the result of two possible scenarios: a) adjustment in the credit market is through the demand side and b) adjustment in the credit market is through the supply side. The bank lending channel will be significant in the second scenario only if the credit supply adjusts in response to an exogenous shock (Bernanke and Blinder, 1988). Hence it is imperative to investigate the supply side of the credit market in order to reach any conclusion about the bank lending channel.

There are two principal contributions in this chapter. First, using aggregate data, a cointe-

[2]Please note that the terms 'bank lending channel' and 'credit channel' are used interchangeably throughout the thesis.

grating relationship is established between the interest rate spread (difference between the lending rate and banks' return on investment) and bank credit thus indicating the long-run response of bank credit to changes in this spread. Second, the response of bank credit to an exogenous shock is identified and the short-run dynamics tested to check if bank loans adjust significantly in the direction of equilibrium. As far as is known, such an analysis involving the estimation of a long-run relationship and understanding the short-run dynamics of the credit market has not previously been attempted in the extant literature.

The chapter is planned as follows: Section 2 motivates the analysis by discussing the role of banks in the lending channel and outlining the necessary conditions that should be satisfied for a significant impact of bank credit in monetary policy transmission. Section 3 briefly summarizes the empirical literature on credit channels based on tests using aggregate data. Section 4 empirically identifies credit supply and its determinants for India. Since the data span a period with considerable policy change there is the possibility that any long run relation may involve a regime change. This indeed turns out to be the case for this data set. Hence the cointegration technique allowing for regime change is applied. A structurally stable long run relationship for bank credit with significant coefficients on the interest rate spread is discovered. The estimation of short run dynamics reveals that once such regime change is allowed for, bank loans indeed adjust significantly in the direction of equilibrium after the system is subjected to an exogenous shock. Thus it can be concluded that banks play a critical role in the transmission mechanism and the results of this chapter support an important underlying assumption of the model (i.e. banks' importance in the credit transmission mechanism) developed in chapter 3, further validating the robustness of the theoretical model. Section 5 concludes.

5.2 Motivation

The conventional theory of monetary transmission is the "money" view or the view represented by the standard textbook IS-LM model (Kashyap and Stein, 1993). In its simplest form, there are two assets in the economy: money and bonds. The banks' have a passive role - they create money by issuing demand deposits and invest in bonds. A tight monetary policy, say an increase in the reserve requirement ratio, will force banks to reduce the issue of demand deposits and hence bond holdings. In a two sector model including households, this will lead to less money and more bonds for the households. Under the assumption of sticky prices the real wealth of households will decrease leading to a rise in interest rates adversely affecting investment and aggregate output.

According to proponents of the lending view or the capital-market-imperfections approach (Bernanke and Gertler, 1995), the two asset specification in the money view may be too simplistic. In an alternative specification, the lending view considers three assets: money, publicly issued bonds and loans under the assumption that bonds and loans are imperfect substitutes. The banks in this framework make credit or loans in addition to creating money. Therefore monetary policy shocks can be transmitted through two independent channels: the interest rate channel and through impact on the supply of credit (Kashyap and Stein, 1993). This view emphasizes the importance of the lending channel.

If the lending channel exists in an economy it is possible to significantly affect investment and output without much change in the interest rate. The quantitative significance of the lending channel is sensitive to the institutional characteristics of financial markets and can thus be used as a measure of the extent of financial liberalization in the economy (Kashyap and Stein, 1994). It is imperative to analyst the significance of the lending channel as this will help in investigating the importance of financial sector reforms to the impact of monetary policy.

Bernanke and Blinder (1988) suggest three necessary conditions for the existence of the lending channel:

- Bank credit and open-market bonds should not be perfect substitutes for borrowers in the economy. In other words, borrowers can not simply offset the decrease in bank loans by borrowing from the bond market. In that scenario there will be no real effect from monetary shocks in the economy.

  A traditional view is that this condition is likely to hold in the Indian banking sector as other debt alternatives like debt and equity markets and Non Banking Finance Companys (NBFCs) are still developing and are at a nascent stage. Table 5.1 reports the share of deposits with NBFCs from 1970 to 1999.

Table 5.1: Deposits with Non-Banking Financial Companies

Period	As % of Bank Deposits	% of GDP
1970-71 to 1974-75	0.71	0.02
1975-76 to 1979-80	0.68	0.16
1980-81 to 1984-85	0.46	0.14
1985-86 to 1989-90	0.81	0.30
1990-91 to 1992-93	1.18	0.45
1993-94	5.02	2.02
1994-95	6.01	2.52
1995-96	8.11	3.28
1996-97	9.47	3.90
1997-98	3.70	1.57
1998-99	2.65	1.16

Source: RBI (2003b)

- It should be noted that equity markets have grown rapidly during the post reform period. The market capitalization to GDP ratio has increased from 5.6 per cent in 1983 to 43 per cent in 2002-03 and the primary equity market is attracting a number of successful issues like Initial Public Offerings (IPO's) of Maruti Udyog Limited.

The issues mainly include public sector stocks, bank stocks or large corporates which are popular among retail investors. But there is still a lack of confidence among investors for other issues. On the other hand, in 2003, public sector banks accounted for almost 80 per cent of total assets in the economy (CII, 2004). Depositors tend to have more confidence in the PSBs (most of them owned by the government) as they perceive an implicit government guarantee is attached, making it very unlikely a deposit-run would take place even if such a bank was on the verge of insolvency (Bhattacharya and Patel, 2003).

- The supply of credit should be affected if the central bank alters the quantity of reserves to the banking system. This condition essentially requires that any monetary shock in the economy should lead to adjustments in credit supply rather than credit demand. Banks can insulate their lending activity, and keep the flow of credit unchanged, from an adverse reserves shock only if they reduce their dependence on deposits and keep a "buffer stock" by investing in non-deposit based sources of finance like equity markets, issuance of time deposits or Certificate of Deposits (CDs) etc. In the case of post reform India due to some stringent measures of risk management, banks are indeed showing interest in the equity market and alternative sources of finance by the central bank.

  However, the share of such investments is very low and government securities are mainly preferred for investment, due to the low risk involved. The government's high deficits in the post reform period have forced the issue of large numbers of government securities to raise money. In fact, at the end of September 2003, the assets of commercial banks in government securities[3] was around 45 per cent which is much higher than SLR of 25 per cent.[4] Therefore as Bhattacharya and Patel (2003,

[3]These include central government securities such as treasury bills with different periods of maturity.
[4]As reported in RBI Weekly Supplement, October 11, 2003.

Page 18) point out for the banks: *"In deciding on a trade-off between credit flows and investing in government securities, the economic, regulatory and fiscal environment is stacked against the former"*. Hence banks will be reluctant to offset a credit crunch by laying off some of its investment in government securities, at least in the short run. Therefore it is very unlikely the banking sector will be insulated from adverse reserves shock in the economy and keep its credit supply unchanged. Hence there should be some adjustment from the supply side of the credit market. Figure 5.1 elaborates on this issue through a simple demand-supply analysis of the credit market using bank credit L_t and lending rate i_t^l.

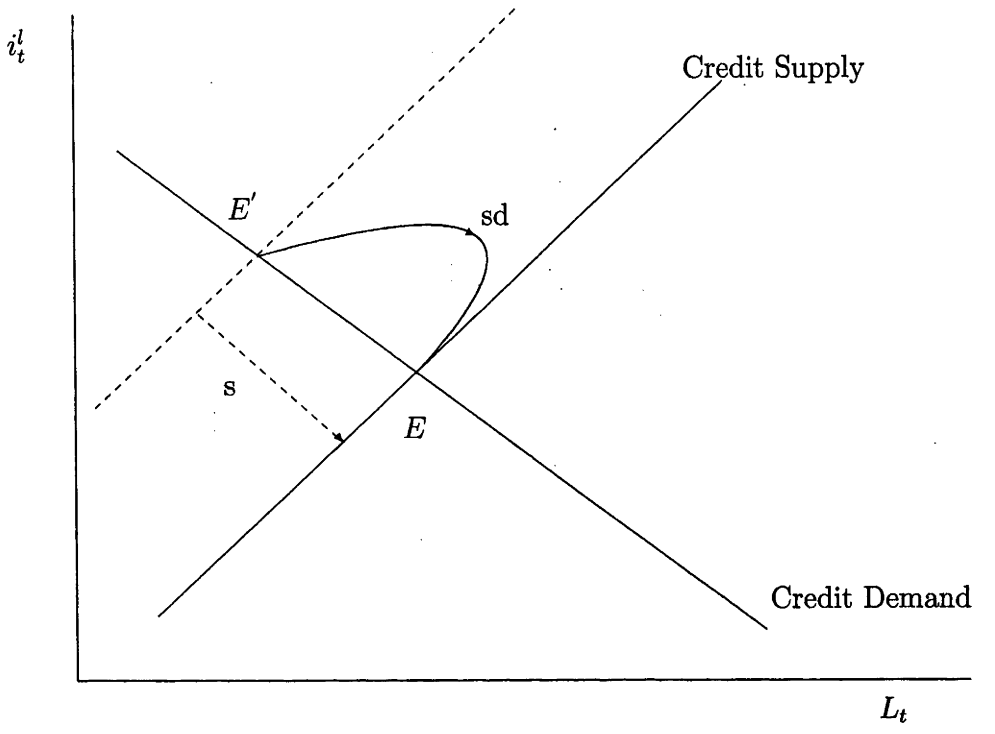


Figure 5.1: Credit Market

The credit market equilibrated at E, once subjected to a shock will move to say E'. The interest here is the short run adjustment in the market. If a lending channel is at work in the economy it will return to equilibrium through two possible paths: path *s* or path *sd*. Along the first path total adjustment is through the supply side and credit demand remains unaffected. This is an extreme case of the existence of a credit channel. In the second path the adjustment starts in the direction of credit supply and then the system eventually returns to the initial equilibrium. The other extreme would be that total adjustment

is through the demand side (which is not shown in the figure). The chapter intends to empirically investigate the short run adjustment in bank credit for the case of India. A significant adjustment in the direction of equilibrium will suggest that the potential paths for adjustments will be either path *s* or *sd*. In these cases it can be concluded that banks play a crucial role in the credit transmission mechanism in India.

- The third necessary condition for the existence of the lending channel is imperfect price adjustment in the economy so that monetary policy can have real effects. There is a huge literature (For example see Anderson (1994)) which suggests prices are indeed "sticky" in the inefficient and developing financial sectors like those in India.

Whereas evidence exists for the first and third conditions, the second condition needs to be formally empirically tested. This has not yet been attempted and forms the core of the analysis in this chapter. The empirical literature in this area which is broadly based on testing the bank lending channel is discussed next.

5.3 Literature

The empirical literature on the bank lending channel can be divided into two broad categories: tests using aggregate time-series data and tests using cross-section or panel data. The seminal paper by Bernanke (1983) indicated the importance of the bank lending channel. Bernanke examined the Great Depression period of 1930-33 and quantified the contribution of the traditional interest rate channel to the sharp decline in aggregate output. He concluded this channel did not explain a significant part of the decline in output. This component was better explained by the crisis in the banking sector during the period. This evidence supported the view that the supply of bank loans may have had an impact on aggregate output.

Using structural VARs Bernanke (1986) further confirmed that shocks to credit had significant real effects on output and were independent of the shocks to other government spending. This evidence supports one of the necessary conditions of the existence of the bank lending channel: loans are imperfect substitutes for other sources of financing.

Bernanke and Blinder (1992) investigate whether monetary policy can shift the supply curve of credit by examining the co-movements between credit and aggregate output. The authors conclude that an increase in the interest rate reduces banks' credit, and subsequently, economic output. However, this response of credit is gradual and occurs with a lag. Romer and Romer (1990) confirm that while money leads output, credit moves contemporaneously with output. Collated together such evidence tends to weaken the argument for the lending channel.

On the other hand Kashyap and Stein (1994) believe this evidence may not be contradictory to the existence of the lending channel because a recession may immediately lead to a rise in credit demand from small firms feeling the credit crunch and even if the credit supply was

falling, it would not be manifested as a decrease in the total volume of credit. Thus there is an identification problem which cannot distinguish between credit supply and credit demand.

Kashyap et al. (1993) address this identification problem by considering the relative fluctuations between bank credit and its close substitute commercial paper. They argue that the movement in the issuance of commercial paper should trace the demand for bank loans. Therefore a system can be identified under this assumption: for example if bank credit is falling and the issuance of commercial paper rising implies the fall in bank credit was due to a contraction in credit supply and not in credit demand. The empirical evidence in Kashyap et al. (1993) suggests that with a tight monetary policy, there is an increase in the issuance of commercial paper and a gradual decline in bank loans. The authors further confirm that shifts in loans supply can independently explain the movements in inventory investment which could not be explained by alluding to the conventional interest rate channel. The authors repeated the study by using the relative prices, i.e., the gap between lending rate and commercial paper rate and confirmed that with tightening monetary policy, the prime rate rises relative to the commercial paper rate thereby supporting the lending view. A similar study by Hoshi et al. (1991) confirm these results for Japan. However, these studies stop short of identifying precisely the behavior of credit supply in the economy. Moreover, most of the empirical evidence based on the aggregate data for bank lending channel is available for the developed economies and not for developing countries.

The discussion now proceeds to the empirical analysis and tests the second necessary condition of the existence of the lending channel i.e. whether banks' credit is significantly affected by a monetary policy shock. The essential point is to understand the impact of interest rate spread on credit availability. Bank credit availability will be affected by the

difference between the returns from its investment and the lending rate. This difference can be perceived as a profit margin. Establishing a relationship between bank credit availability and its profit margin involves a two step procedure in case the variables are non-stationary: a) To check whether the profit margin has a significant long-run relationship with credit availability[5] and b) To establish whether in the short run the changes in the profit margin lead to a significant adjustment of bank credit towards the equilibrium.

5.4 Empirical Analysis

The empirical methodology involves the use of the most popular methodology to find a long run relationship between integrated variables-cointegration analysis. Consider the following fully specified regression model:

$$y_t = \beta\, x_t + \epsilon_t \tag{5.1}$$

The above specification assumes the error terms ϵ_t are stationary, white noise processes. This may not be true if y_t and x_t are integrated series. For example if x_t and y_t are both $I(1)$ and hence growing with time trends, the difference between them should also be growing unless there is a β such that

$$\epsilon_t = y_t - \beta\, x_t \qquad \epsilon_t \sim I(0)$$

In such a case the difference between the two series is not exploding and is stable at a fixed mean which is $I(0)$. The two series are then said to be cointegrated and the vector $[1, -\beta]$ is called the cointegrating vector. The cointegration technique allows for distinction between

[5]If in the long-run relationship, profit margin is positively related to the credit availability then in standard parlance this will be called the supply equation.

the long run relationship between the vectors y_t and x_t and the short run dynamics i.e. the deviation of y_t from its long run trend. The particular interest here is in such a analysis in order to investigate the existence of a stable relationship of credit supply and the path through which it returns to its equilibrium in the short run after being subjected to an exogenous shock. The short run dynamics of a cointegrating relationship can be captured through its alternative representation: Vector Error Correction Model (VECM). The representation of the error correction model is in terms of three variables: $\Delta y_t = y_t - y_{t-1}$, Δx_t and $(y_t - \beta x_t)$ which are all $I(0)$ assuming the existence of cointegrating vector$[1, -\beta]$. The error correction model can be specified as:

$$\Delta y_t = \theta' z_t + \gamma(\Delta x_t) + \lambda(y_t - \beta x_t) + \epsilon_t \tag{5.2}$$

The above equation describes variation in y_t in terms of $I(0)$ exogenous variables z_t, the variation of x_t and the error correction term $(y_t - \beta x_t)$ representing the short run adjustment towards the long run equilibrium. It is to be noted that $y_t - \beta x_t$ will be stationary only when y_t and x_t are cointegrated and hence VECM is an alternative representation of cointegration which clearly distinguishes between the long run and short run adjustments towards the stable cointegrated relationship. The particular interest here is in the coefficient λ whose magnitude shows the speed of adjustment in the short run and the sign shows the direction of adjustment. For example if λ is negative and $|y_t - \beta x_t| > 0$ the short run adjustment is towards the long run equilibrium and the system is stable in the sense that it will return to its initial equilibrium after being subjected to a shock (Greene, 1997).

The number of linearly independent cointegrating vectors existing in the equilibrium system is called its cointegrated rank. The maximum and minimum value of cointegrating rank may lie between $k-1$ and 1, respectively, where k is the number of variables in vector y_t. Johansen proposes a test to determine the cointegrating rank by estimating VECM

using maximum likelihood estimation. The estimation is done under various assumptions regarding the restrictions on the parameter and trends and subsequently conducting likelihood ratio tests. Johansen suggests two tests for determining the cointegrating rank r.

- The Lambda-Max Test: The test is based on the Log likelihood ratio $ln[L_{max}(r)/L_{max}(r+1)]$ and is conducted sequentially for $r = 0, 1, 2.....k-1$. The null hypothesis is that the cointegrating rank is equal to r against the alternative that the cointegrating rank is equal to $r+1$.

- The Trace Test: The test is based on the Log likelihood ratio $ln[L_{max}(r)/L_{max}(k)]$ and is conducted sequentially for $r = k-1, ...1, 0$. The null hypothesis is that the cointegrating rank is equal to r against the alternative that the cointegrating rank is equal to k.

5.4.1 Data and Results

As discussed earlier, commercial banks in India invest heavily in government securities to minimize risks. Thus, at the end of September 2003, the assets of commercial banks in government securities was around 45 per cent much higher than the SLR of 25 per cent. Hence the spread between the lending rate and the returns from banks' investment in securities are the crucial determinants of credit availability in India. Therefore the prime lending rate (i_t^l) and the yield on 91-day Government Treasury Bills (i_t^{bh}) are taken as variables for the cointegration analysis. Also taken is the banks' investment (bh_t) which is the sum of their holdings of government securities and other approved securities, and the real activity in the economy measured by the IIP (y_t).[6] A variable is required to indicate

[6]This is the only activity variable for which data is available on a monthly basis.

the extent of liberalization in the economy. This is to be used as a control variable in order to help isolate the effect of liberalization policies from the effect of the bank spread and other variables on credit availability.

One possibility is to use an index of concentration (e.g. the Herfindahl index) in the banking industry. The Herfindahl Index H is a concentration indicator and can be used to examine the concentration and evolution of the banking industry during the post reform decade (Juan-Ramon et al., 2001). The index H is defined as:

$$H = 100 * \sum_{i=1}^{N} a_i^2 \ , \ a_i = \frac{A_i}{\sum_{i=1}^{N} A_i}$$

where A_i is i^{th} banks attribute measuring its size based on its assets or deposits and N is the number of banks under consideration. Theoretically, the minimum and maximum value of H can be 1 and 100 respectively, with the value of one indicating totally even distribution or a perfectly competitive banking sector and the value of 100 indicating a very high concentration or monopoly. For any number N the lower limit of H is $\frac{100}{N}$ and the upper limit is 100. Juan-Ramon et al. (2001) suggest that since the index H is dependent on number of banks which varies across bank group and periods, the ratio of H and minimum bound for each bank should be reported as it removes the influence of banks. The value of the Herfindahl Index for all commercial banks based on assets and deposits is reported in Table 5.2.

Table 5.2: Herfindahl Index: All Commercial Banks

Year	1997	1998	1999	2000	2002	2003
Deposit Based						
Herfindahl Index	6.6	6.5	7.0	7.0	7.1	7.0
$\frac{100}{N}$	1.0	1.0	1.0	1.1	1.1	1.1
Ratio	6.6	6.5	7.0	6.4	6.5	6.4
Asset Based						
Herfindahl Index	7.6	7.3	7.6	7.6	7.4	7.6
$\frac{100}{N}$	1.0	1.0	1.0	1.1	1.1	1.1
Ratio	7.6	7.3	7.6	6.9	6.7	6.9

Source: Shirai (2002), updated by author.

The Herfindahl Index reveals the concentration of the banking sector is more or less unchanged from 1997-2003.[7] This evidence reveals that the bank concentration indicator cannot be used as a potential variable to capture the liberalization process in the Indian financial sector. In any case data on this and other concentration variables, e.g. the share of public sector banks in total credit is only available on an annual basis.

The nominal average monthly exchange rate (e_t) is used with respect to the US dollar for this purpose.[8] This is for at least two reasons: First, the progressive liberalization of India's exchange rate and external accounts has widely been cited as an indicator of India's opening up, in particular, and economic reform in general. Second the interest is in analyzing the impact of devaluation on bank performance as outlined in chapter 3. The banks' performance is sensitive to variations in the exchange rate. Hence it is natural to use the exchange rate with respect to India's dominant trading partner.[9] A central

[7]The index prior to 1997 could not be calculated because of inconsistency in the data.

[8]This is because most of the external trade in India is dollar denominated. Moreover, the US has emerged as India's main trading partner in the last decade: the share of Indian exports to America increased by 9 per cent to 25 per cent during the period 1991-2000 as reported by the Federal Ministry of Commerce, India.

[9]However the final form of the cointegrating vector is parsimonious as the null hypothesis that the coefficients of exchange rate is zero can not be rejected. The results remain qualitatively the same if the real effective exchange rate based on trade weights of 36 countries is used for the analysis.

purpose of this chapter is to assess how much of an effect financial liberalization has had on the credit transmission channel. It is natural, therefore to take the period when such liberalization was initiated as the starting point. Hence the data set begins at April 1992, and ends in July 2003, which is the latest period for which consistent data are available. Monthly data taken from various issued of Reserve Bank of India Bulletin (RBI, 2003d) are used and the data set spans 136 months. Figure 5.2 presents the plots and Table 5.3 the summary statistics for all variables.

Table 5.3: Summary Statistics: April 1992-July 2003

Variable	Notation	Min.	Max.	Mean	St. deviation	Units
Bank Credit	L_t	3590.68	15434.40	8013.36	3537.61	Rs. Billion
Bank Investment	bh_t	915.65	6070.61	2562.81	1361.64	Rs. Billion
TB rate	i_t^{bh}	4.77	13.16	9.65	2.18	% per annum
Lending Rate	i_t^l	11.50	19.00	14.05	2.06	% per annum
Real IIP*	y_t	0.92	1.23	1.02	0.06	Index
Exchange Rate	e_t	28.46	49.02	38.93	6.85	Rs/US$

*: Base Year:1995

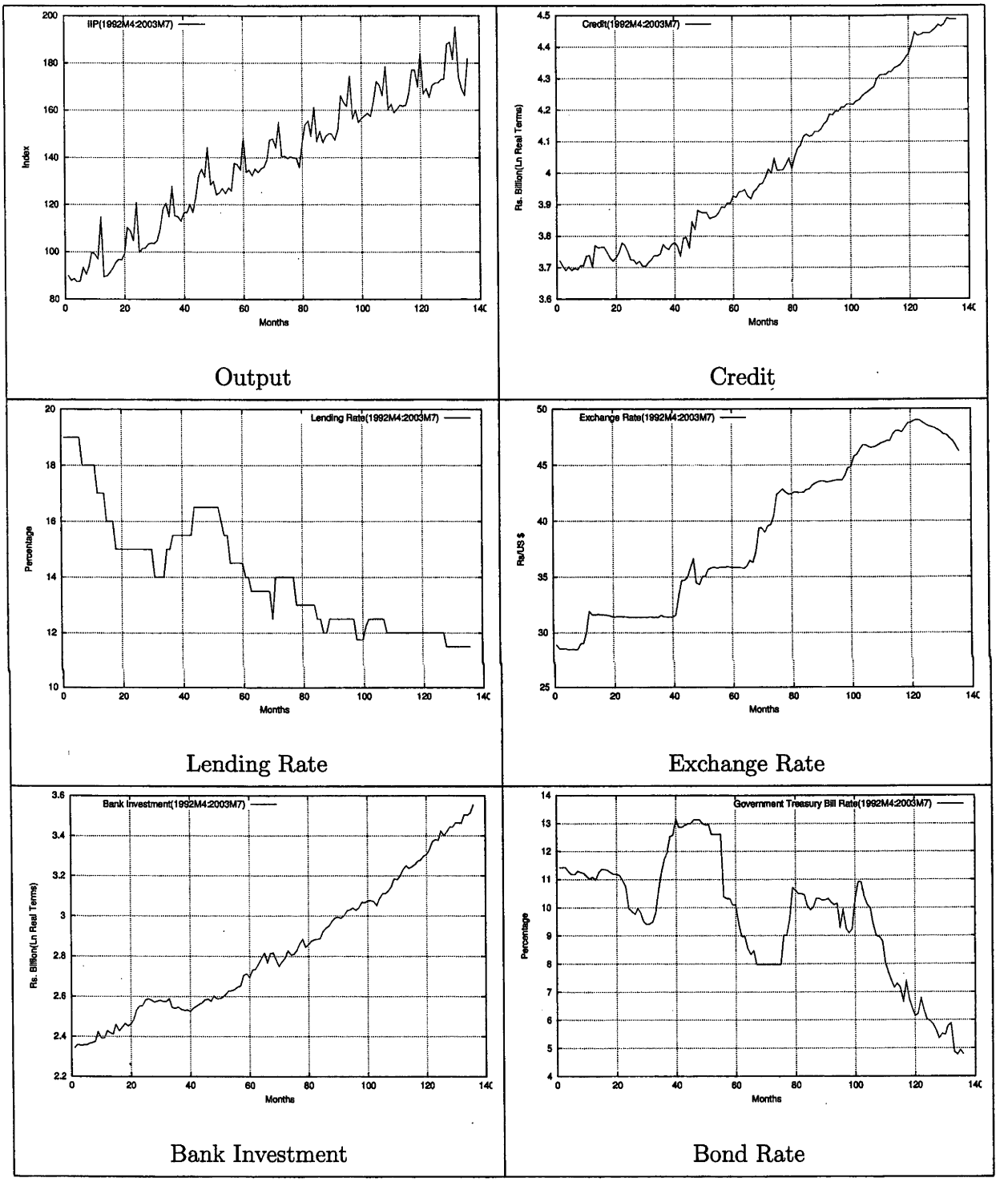


Figure 5.2: Data Plots (April 1992 - July 2003)

The presence of unit roots in the variables are tested for, and a check on, whether all the variables are $I(1)$ and can thus be used for the cointegration analysis, is done. The results from the ADF[10] tests are reported in Table 5.4:

Table 5.4: Unit Root Tests

Variable	Notation	Estimate	P value*	Series
TB Rate	i_t^{bh}	-0.004	0.93	$I(1)$
Lending Rate	i_t^l	-0.087	0.29	$I(1)$
Credit	L_t	-0.070	0.34	$I(1)$
Bank Investment	bh_t	-0.380	0.99	$I(1)$
Output	y_t	-0.352	0.13	$I(1)$
Exchange Rate	e_t	-0.054	0.73	$I(1)$

*: Null Hypothesis– Unit Root Present

The variables for the cointegration analysis are taken in log real terms except the lending rate, exchange rate and TB rate. The results confirm that all the variables are non-stationary. The plots show a time trend in all the series and seasonality especially in monthly output. Hence we allow for a time trend in the cointegration space along with seasonal dummies. Johansen's cointegration method is used for the analysis. Prior to that the weak exogeneity test is conducted. The weak exogeneity hypothesis for output, exchange rate, lending rate, TB rate and bank investment, based on Wu-Hausman statistics, is rejected at the 1 per cent level. These tests indicate that none of these variables is weakly exogenous and therefore they all belong in the cointegrating vector. The results from the lambda-max test for cointegration rank are reported in Table 5.5:

[10]The KPSS test which does not have a bias in favor of accepting non-stationarity also indicates that each of these variables is $I(1)$.

Table 5.5: Cointegration: Rank Test[a]

Rank	Test Statistic	90% Critical Value	Conclusion[b]
0	44.54	40.76	Reject
1	23.77	35.04	Accept
2	21.89	29.13	Accept
3	11.19	23.10	Accept
4	9.46	17.18	Accept
5	5.77	10.55	Accept

a: LR test (Lambda-max test) $H0$: r cointegrated vectors; HA: $r+1$ cointegrating vectors

b: Test concludes $r = 1$

The test reveals that there is exactly one long run relationship. The trace test also yields the same and the results are skipped here. Thus the long-run relationship (the cointegrating vector) will take the following form:

$$\gamma_0 L_t + \gamma_1 t + \gamma_2 i_t^l + \gamma_3 i_t^{bh} + \gamma_4 y_t + \gamma_5 bh_t + \gamma_6 e_t = 0 \tag{5.3}$$

where t is the time trend and $[\gamma_0, \gamma_1, \gamma_2, \gamma_3, \gamma_4, \gamma_5, \gamma_6]$ is the cointegrating vector. The cointegrating vector estimated by Johansen (1988)'s procedure are given in Table 5.6. Based on the Akaike's Information Criteria, a lag length of three is used. The second row gives the unrestricted vector. Since there is only one cointegrating vector, initially just one homonizing restriction can be placed on the cointegrating vector. Credit's coefficient is normalized to one i.e. $\gamma_0 = 1$. The results are presented in the third row of the table. Identification of this cointegrating vector is done by imposing restrictions suggested by economic theory. As discussed above bank credit is determined by the spread between two policy variables (i_t^l and i_t^{bh}) i.e. $i_t^l - i_t^{bh}$. It requires to test for a cointegration relationship of the following form: $[1, \gamma_1, -\gamma_2, \gamma_2, 0, 0, 0]$. Testing for the existence of such a cointegrating relationship will involve imposing more than one restriction or imposing over-identifying restrictions. The over identifying restrictions are tested using the Log-likelihood ratio test

statistics under the null hypothesis that the restrictions hold and the statistic is distributed as a χ^2 variate with degrees of freedom equal to the number of over-identifying restrictions. The results are reported in the last row of Table 5.6. In this case, only three over-identifying restrictions are accepted by the LR test: $\gamma_2+\gamma_3 = 0$, $\gamma_5 = 0$, $\gamma_6 = 0$ and the null hypothesis that the restrictions hold is accepted with $\chi^2(3) = 2.21$ and P value of 0.53.

Table 5.6: Cointegrating Vectors

L_t	bh_t	i_t^l	i_t^{bh}	y_t	e_t	Trend
Unrestricted						
-0.990	0.299	0.033	-0.005	2.210	0.023	0.001
Credit Normalized to 1						
1.000	-0.299	-0.033	0.005	-2.210	-0.023	-0.001
Identified Cointegrated Space*						
1.000	–	-0.010	0.010	-9.096	–	-0.005

*: Over-Identifying Restrictions Accepted $\chi^2(3) = 2.21$ P value $= 0.529$

The tests for model specifications namely: serial correlation, functional form and Normality are reported in Table 5.7. The results confirm the absence of serial autocorrelation and justify the functional form. The null of normality is rejected at 2 per cent level but that should not be taken as a serious problem because, as Gonzalo (1994) points out, Johansen's cointegration method is robust even with non-normal errors.

Table 5.7: Misspecification Tests

Test Statistics	*LM* Version	*F* Version
Serial Correlation	2.28	2.04
	[0.13]	[0.15]
Functional Form	2.96	2.66
	[0.085]	[0.10]
Normality	7.33	–
	[0.026]	–

P values in square brackets.

The long run relationship between bank credit and its profit margin is given by the identified cointegrating vector:

$$\begin{array}{rcccccc} L_t & = & 0.005\,t & + & 9.09\,y_t & + & 0.010\,(i_t^l - i_t^{bh}) \\ & & (2.33) & & (0.68) & & (0.27) \end{array} \tag{5.4}$$

where t-statistics are in parentheses.

Equation 5.4 represents a long-run relationship between bank credit and its determinants, the interest rate spread between the lending rate and treasury bill rate. Theoretically, the bank's credit should increase with the increase in spread as it makes lending more attractive compared with investment in any alternative financial market, ceteric paribus. The above equation depicts the correct sign for the spread but the coefficient is not significant. The error correction equation for the credit gives the value of $\lambda = -0.01$ with t-stats of -2.45, which is significant at 1.6 per cent. This implies that in the short run, bank credit adjusts significantly and relatively fast in the direction of the long run credit supply.

The long run cointegrating relationship with insignificant coefficient and error correction term with significant coefficients are apparently conflicting results. One underlying reason behind the conflict may be that estimated parameters in the cointegrating relationship may be unstable. In particular, the Indian economy faced many exogenous shocks and policy

changes in the post reform decade (Callen and Cashin, 2002).[11] These had significant effects and may have caused parameter estimates to change over time. Thus it is very important to incorporate regime changes or structural breaks in the analysis and ensure the long-run parameter estimates are structurally stable before interpreting the long-run relationship between the variables. The tests suggested by Hansen (1992) are used to examine the hypothesis of parameter instability in the cointegrated models. Hansen suggests tests for parameter instability as an alternative test for cointegration between two I(1) variables. In the context here this amounts to estimating the following model:

$$Z_t = \mathbf{A_t}\, X_t + \epsilon_t \tag{5.5}$$

where Z_t is credit and X_t is a vector of regressors namely the spread $(i_t^l - i_t^{bh})$ and the output (y_t) and $\mathbf{A_t}$ is a vector of parameters. The presence of parameter stability results in the uniform convergence of the estimated regression coefficients to the cointegrating relationship in the whole space of the sample. Hansen (1992) describes three test statistics for testing parameter instability in the context of fully modified estimation of cointegrated regression models. These are: *Sup F* test, *Mean F* test and the L_c test.[12] For all three tests the null hypothesis is the same - $\mathbf{A_t}$ is constant but these tests differ on alternative hypothesis. Hansen (1992) points out that no cointegration is a special case of the alternative hypothesis for which the L_c statistics is an LM test statistics and hence he concludes that L_c ia a test of null of cointegration against the alternative of no cointegration.

$$\begin{array}{rcccccccc} L_t & = & 3.45 & + & 0.006\, t & + & 0.26\, y_t & + & 0.023\, (i_t^l - i_t^{bh}) \\ & & (66.97) & & (17.28) & & (1.04) & & (2.57) \end{array} \tag{5.6}$$

[11] It should be noted the tests for endogenous structural breaks at unit root stage were applied and the null hypothesis of series being $I(1)$ could not be rejected.

[12] All the three tests assume unknown timing of the structural break.

$$\hat{M} = 0.57$$

$$\text{SupF} = 7.66\ [> 0.20]$$

$$\text{MeanF} = 4.62\ [> 0.20]$$

$$L_c = 0.50\ [0.12]$$

Here $\hat{M}$ refers to the bandwidth parameter selected according to the recommendations of Andrews (1991) using univariate AR(1) approximating models. All the estimated regression coefficients and t-statistics are the fully modified estimates of Phillips and Hansen (1990).[13]

Figures in parentheses in Equation 5.6 indicate corresponding t-values and in square brackets the p-values. This test does not reject the null of cointegration. The *SupF* test, under the alternative hypothesis of parameter instability, is focussed on any abrupt shift in the cointegrating vector. The results reject the alternative hypothesis of instability. This is further evident from the plot of the F-stats sequences shown below. The actual F-statistic does not exceed any of the critical values thereby indicating parameter stability.[14]

[13]The estimation is using the Gauss code provided by Bruce E. Hansen.

[14]It should be noted that Hansen's analysis requires trimming of the data on edges. We have trimmed 15 per cent of the data from both sides of the sample and hence the analysis is done using the data from November-1993 (month 20) to November 2001(month 116).

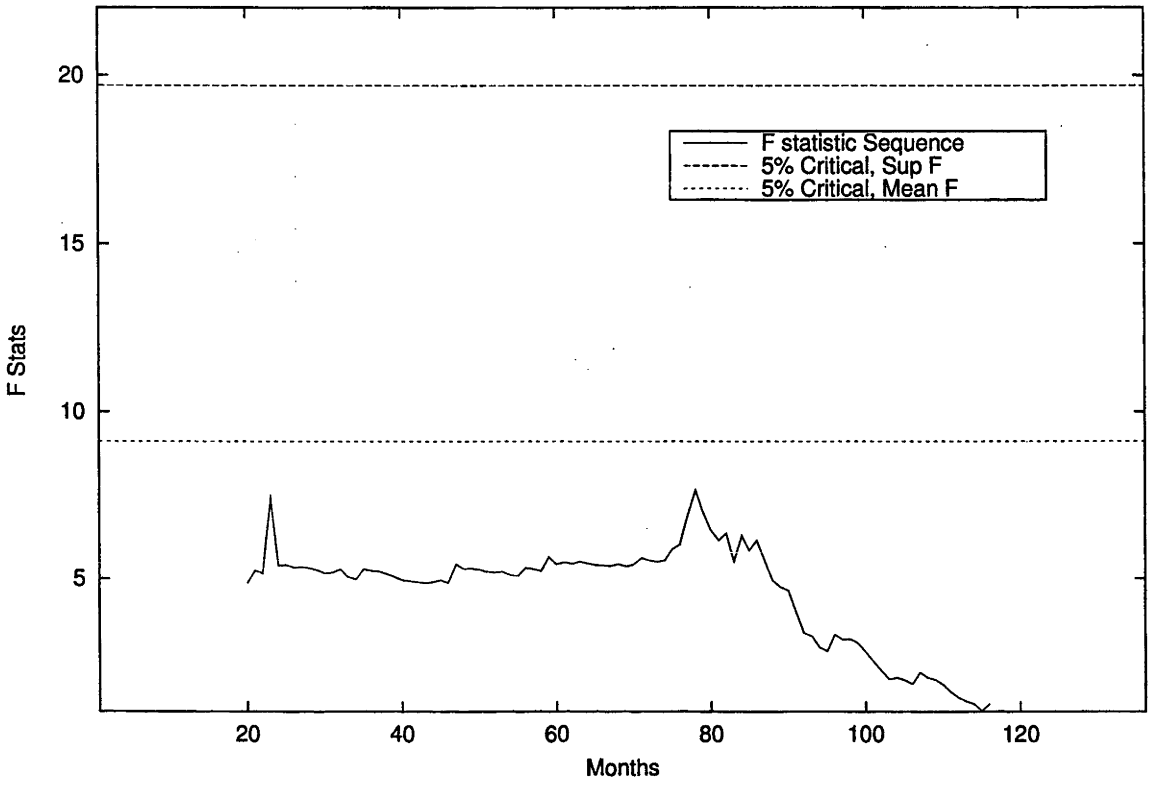


Figure 5.3: F - Statistics Sequence

The cointegrating relationship in Eq. (5.6) suggests that once the unknown structural break is accounted for, the coefficient on the spread is significant and the long-run relationship is structurally stable. The error correction model is now recalculated using the new stable cointegrating vector. The results show the value of λ to be -0.076 with a t-statistics of -2.60 significant at 1 per cent level. This is further evident from the plot of the persistent profile of effect of the system wide shock to the structurally stable cointegrating vector shown in Figure 5.4.

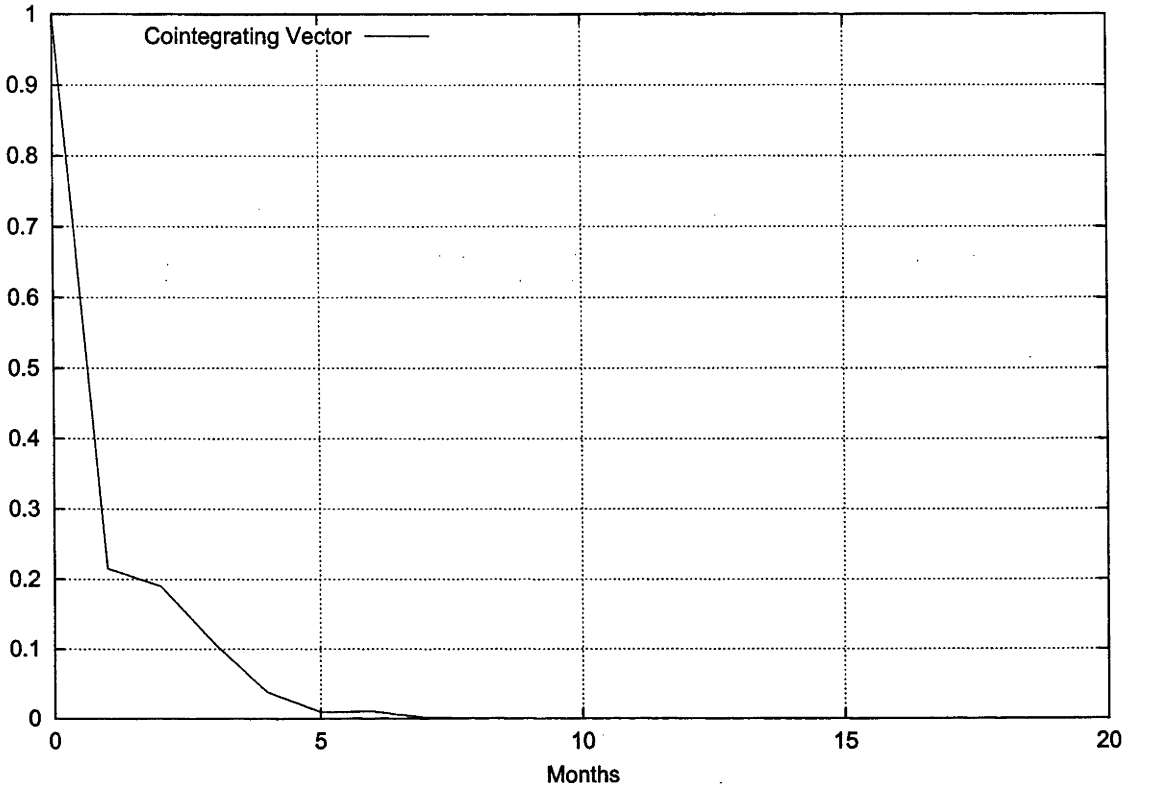


Figure 5.4: Persistent Profile of the effect of system wide shocks to Cointegrating Vector

The plot of the persistence profile of the cointegrating vector clearly shows the long-run relationship has a strong tendency to converge to its long-run equilibrium and the speed of adjustment is also fast.

The results confirm that bank credit adjusts significantly towards the equilibrium in the direction of long-run credit supply. In other words, through their impact on credit supply, banks play a crucial role in the transmission of monetary policy shocks.

5.5 Conclusion

The present chapter has addressed an important issue of identifying and investigating the importance of the banking sector in financial propagation mechanism for India. The empirical exercise uses monthly data of the post reform period in India and applies cointegration analysis incorporating regime shifts and VECM to test if a monetary shock leads to a significant shift in bank credit availability. In other words the significance of the banking sector in financial propagation mechanism is tested for. The empirical evidence indicates the presence of a structurally stable long run relationship between bank credit and its profit margin or spread, and further reveals that in the short run, bank credit does adjust significantly in the direction of equilibrium. This confirms the role of banks in transmitting monetary shocks. The results therefore support the underlying assumption of the importance of the banking sector in the theoretical framework outlined in chapter 3. The results also hint towards the pace of Indian economic reform: it can be safely concluded the reform process has not yet reached an extent where capital markets are competitive enough to make banks' role in credit formation insignificant. Public sector banks remain a significant source of credit generation in the economy.

CHAPTER 6

Summary and Conclusions

This dissertation combines the role of credit market distortions in monetary policy transmission and the impact of government policies on the financial sector. To date these have been studied separately in the literature. The dissertation formally models partial policy reversals subsequent to the introduction of stabilization programs particularly in developing countries. It then provides empirical support for this result using data from India.

Chapter 2 provides an overview of the Indian banking sector emphasizing the possibility of policy reversal. The chapter concludes financial sector reform in India is incomplete. The banking sector remains inefficient due to several factors viz. high reserves and liquidity requirements, a poor regulatory and supervisory framework, the presence of implicit government guarantees and high transaction costs.

Chapter 3 considers the implications of stabilization policy in the context of an economy with the broad characteristics discussed in chapter 2 and analyzes the impact of this policy on key macroeconomic variables as well as on profitability of the banking sector. The chapter develops a stylized model of the interaction between the fiscal and banking sectors of the economy during a period of stabilization characterized by fiscal and monetary restraint to allow for endogenous policy reversal.

The policy reversal is further quantified in terms of its offsetting effect. The theoretical predictions of the model are subsequently tested empirically using Indian data. The empirical evidence is found to be consistent with the predictions of the theoretical model.

Chapter 4 confirms the government is solvent in that it satisfies the intertemporal budget constraint in the theoretical model used in chapter 3. It is argued that the debate on debt sustainability should be examined in the light of recent advances on endogenous structural breaks in the cases of unit root analysis and cointegration since revenue and expenditure series are susceptible to structural breaks in response to sharp economic shocks . The empirical analysis discovers that in the case of India structural breaks or regime shifts play a crucial role in time series analysis of revenue and expenditure series. The contributions of this chapter are that it provides a basis for testing for debt sustainability even in the absence of data on debt; and a methodology for inducting unknown structural breaks in the analysis of the sustainability of public debt at both the unit root testing and cointegration stages. In the particular case of India, it is discovered that the debt is not unsustainable, which is in sharp contrast to the widely prevalent view in extant literature and policy discussions.

Chapter 5 empirically tests the importance of the bank lending channel in India. The chapter uses aggregate data to establish a long run relationship between the interest rate spread and bank credit using cointegration. The analysis further reveals that bank credit does adjust significantly in the direction of equilibrium in the short run confirming the role of banks in transmitting monetary shocks.

The major findings of the thesis are:

- The offsetting effect attached to stabilization policy can only be eliminated by adopting a loose monetary policy thereby undermining the government's initial stabilization measures.

- The combined debt of state and central governments in India is sustainable once the regime changes are allowed for.
- The reform process in India that began after the 1991 financial crisis remains incomplete and manifests itself in lack of competitiveness in the banking sector.
- The Indian banks play a significant role in the transmission of monetary policy through the credit channel.

The above findings lead to several policy lessons as follows:

6.1 Policy Lessons

The theoretical and empirical evidence in the dissertation indicate the following policy lessons for India:

- The credit channel, relative to the interest rate channel, plays a significant role in monetary policy transmission, especially in the post reform period. The impact of the interest rate shock on output traced by the generalized impulse response function in section 3.4.3 is not significant as evident from the wide confidence bands. On the other hand, bank loans indeed adjust significantly in the direction of equilibrium after the system is subjected to an exogenous shock, thus indicating the importance of the banking sector in monetary policy transmission. Hence government policy should emphasize credit generation schemes rather than inefficient interest rate controls. Accordingly, potentially effective policy instruments in India are the CRR and SLR which directly affect liquidity in the economy through their impact on bank loans.
- Regime shifts in important time series data on India have significant effects on the economy. This result argues that while reviewing the impact of extant policies in the

long run, it is imperative to allow for endogenous regime shifts or economic events. For example, this dissertation discovers the public debt in India is not unsustainable, in sharp contrast to the widely prevalent view in extant literature and policy discussions. This result is also complementary to the findings of Callen and Cashin (2002) who examine the solvency and sustainability of India's external imbalances by using an intertemporal model of the current account that allows for capital controls. After allowing for endogenous regime shifts, their results indicate the path of India's current account imbalances is sustainable.

- Inefficiencies in the banking sector are the root cause of an offsetting effect or partial policy reversal following any stabilization program. Chapter 3 shows that this offsetting effect cannot be eliminated totally. The recent experiences in India (for example the UTI crisis) have shown that soft government policy towards fiscal management, and political compulsions have led to significant bailouts, adversely affecting the government exchequer. Instead of finding alternative ways of financing the offsetting effect (most of which eventually contributes to a rise in government debt), the government should try to minimize it. This can be done via policy shifts. One noted example is the Fiscal Responsibility and Budget Management Act (FRBMA) which came into effect on August 26, 2003. The Act forces the central government to *"ensure inter-generational equity and rise above populism"* (Indian Express (July 2, 2004)). As part of its strict compliance measures, the Indian government is planning to include annual targets of assuming contingent liabilities in the form of guarantees and total liabilities as a percentage of GDP, in its next budget. However, it should be noted that the Indian government has a history of non-compliance with such Acts. For example FRBMA follows the FRBMB which revises the date of elimination of government revenue deficit, from 2005 to 2008. The delay in stabilization reforms can be attributed to a tendency to backtrack. For example, the recently

elected United Progressive Alliance (UPA) government in India has scrapped the disinvestment ministry (the main function of which was to facilitate privatization of Public Sector Units (PSUs) as part of economic reform) established by the previous National Democratic Alliance (NDA) and now going slow on privatization. The banking sector remains lacks competition because of the governments "*U-turn from the opening of Indian banking sector*" (Business Standard, July 05, 2004). The financial reform allowed up to 74 per cent of Foreign Direct Investment (FDI) in the private banks. The latest RBI policy in order to diversify the investment has put a cap od 10 per cent holding per entity. The entry barriers have also been increased for private banks: the minimum capital requirement for new banks is increased from Rs. 2 billion to Rs. 3 billion. Such policy pattern will result in less investment in the sector, less competition and less efficiency. The broad impact of such policy will be increased ineffectiveness of the governments' stabilization efforts (due to increase in the offsetting effect).

6.2 Future Directions

One obvious question arising from the present dissertation is the significance of the offsetting effect attached to a stabilization effort. In future work, the offsetting effect can be formally modeled empirically and an econometric test proposed for testing its significance.

Another issue not explicitly modeled in the present dissertation is the time inconsistency of government policy. Ex ante government commits to a policy of financial discipline and could be reluctant to commit to explicit bank bailouts to avoid moral hazard (which reduces banks' incentive to monitor loans) but ex post the government could opt for bailing out banks because of the cost of liquidation or other political compulsions. This further

leads to the question of credibility of government policy. The government can stick to its commitment of financial discipline only if it has a strong incentive to build credibility on economic reforms. However it may be very difficult in democratic countries like India where the effective government horizon is short due to political instability and it may be forced to succumb to populism in order to ensure survival. These questions may be addressed in a theoretical set up focussing on interaction of the banking sector and government incorporating time inconsistency and moral hazard.

Finally, for the case of India, a program of rapidly attaining and maintaining debt sustainability can be integrated with the notion of pro-poor fiscal adjustment as adjudged in Jha (2004).

APPENDIX A

APPENDIX TO CHAPTER ONE

A.1 UTI Crisis

The section is compiled from the www.rediff.com archives. UTI mutual fund commenced operation on July 1964. It was established by the central government to channel community savings into productive uses in order to speed up industrial growth. To quote then Finance Minister T.T. Krishnamachari *"the trust would be open to any person or institutions to purchase the units offered by the trust. However, this institution as we see it, is intended to cater to the needs of individual investors, and even among them as far as possible, to those whose means are small."* The main objective of the UTI was to invest retail savings in the capital market and pass the benefits back to small investors. UTI had a monopoly in the funds industry until 1986. Subsequently, PSBs sponsored funds entered the market and in 1993 there were 8 mutual funds. After 1993 private sector mutual funds were allowed. The funds industry has grown at a compounded average rate of 27 per cent from an asset base of Rs. 250 million in 1964 to its current size of Rs. 900 billion. The share of UTI is around Rs. 600 billion. UTI invests about a quarter of this through the US-64 fund, India's largest, and accounts for about 15 per cent of the domestic mutual fund industry's assets in a year. The mutual funds (particularly UTI) are very popular among small investors and became

even more attractive in 1996 when the mutual fund dividend returned by equity-oriented schemes was exempted from tax.

In mid 2002, the UTI bank decided to skip a dividend for its flagship US-64 scheme for the year 2001-02. This was because the Net Asset Value (NAV) of the scheme had eroded sharply and was much lower than its face value of Rs.10. On 1^{st} August, 2002 the NAV of US-64 was Rs.5.80.

This was the first time the UTI had skipped paying a dividend for the US-64 scheme, since its inception in 1964. The UTI Board decided to skip a dividend as the government had been providing budgetary support to unit holders, to bridge the gap between the NAV and repurchase price of 2001. In the period January-June 2002 the Security and Exchange Board of India (SEBI) reported that the UTI had redemption/repurchase to the tune of over Rs.63 billion against a mobilization of just Rs. 6.3 billion. All the Minimum Income Plans (MIPs) schemes of the UTI showed negative reserves on 30 June 2002. According to a report by SEBI, 35 out of 63 schemes (whose unaudited results were available) had negative reserves. For the MIP schemes, negative reserves totalled up to Rs.30 billion. MIP97(III) had negative reserves of Rs. 2.6 billion and MIP97(IV) had negative reserves of Rs. 2.5 billion. For the three years between 1999 and 2002, UTI consistently lost market share in terms of net assets. On 31 March 1999, UTI had a 77 per cent market share with assets at Rs. 531.45 billion out of total Rs. 681.93 billion. These figures dropped dramatically over the following years and on 30 June 2002 the market share of UTI was 46 per cent with assets amounting to Rs.463.96 billion out of total Rs. 1007.03 billion. UTI's investments make up 11 per cent of the value of all stocks traded on the Bombay Stock Exchange.

The collapse of UTI began in 1999. The UTI mutual fund scheme was ailing, the government had issued a Special Securities Scheme for Rs. 33 billion by taking over a large percentage of public sector scrips which had a considerably lower book value. The govern-

ment continued to pay interest of 11.2 per cent to the trust until 2002. UTI had not paid any dividend to the government until then. However, things did not turn out as planned and due to harsh market conditions, especially with the tech meltdown, US-64 holdings fell by Rs.10 billion during January to November 2001. The problem was aggravated because unlike most open ended schemes US-64 did not declare its NAV on a daily basis.

In 2001-02, the government provided a cash support of Rs. 3 billion to US-64 following the sudden freezing of sale and repurchase of units on 2^{nd} July 2001. In 2002, the central government doled out Rs. 5 billion and promised another Rs.5 billion for the US-64 scheme to meet the difference between its net assets value and the administered repurchase price. The government planned to work out a tax concession package to enthuse investors to remain with the scheme after May 2003. A committee was set up to investigate the matter and make recommendations. The committee revealed certain weaknesses in investments made by UTI. These were:

- Bad investments, including in firms it had been warned against investing in by its own internal advisory team. For example, UTI lost Rs 328 million investing in an Internet company against the advice of their own research department.
- All 19 individual investment decisions of the trust were imprudent and turned out to be in error.

Apart from these investment inconsistencies, the stock scam in 2001 revealed the unhealthy nexus between the UTI (and possibly other mutual funds as well) and local operators and promoters/corporates. It was believed the UTI mutual fund was the backbone of purchases in the infotech sector supported by the infamous operator Ketan Parikh. The tech meltdown of 2001 resulted in sharp redemption for the scheme in early 2002.

In mid 2002, the UTI decided to skip a dividend for its flagship US-64 scheme for the

2001-2002 year. This was because the NAV of the scheme has eroded sharply and was much lower than the face value of Rs. 10. On 1^{st} August 2002, the NAV of US-64 was only Rs. 5.80.

The RBI was reported as contemplating a repurchase arrangement with UTI. This behavior of the RBI was an attempt to insulate the guilds market from the UTI crisis which was already having an impact on the equity market. Even some commercial banks such as the Bank of India, and State Bank of India started extending loans against UTI's US-64 scheme at a steep discount. However, many other banks adopted a wait and watch policy.

The finance minister, Y. Sinha was initially reluctant to provide any sort of government support to UTI. In a press conference he was quoted as saying, "*We cannot go on spending government money for bailouts. A budgetary support is not a desirable option at the moment.*" However this policy could not be sustained. A majority of public sector banks rejected the proposal of buying stocks held under its flagship US-64 scheme. However, these banks were willing to extend clean loans to UTI for a short period, provided the central government gave a "comfort letter" ensuring timely payment of the interest and principal amount. However, the finance minister was not keen on providing a "sovereign guarantee" to public sector banks in lieu of loans extended to UTI. The chairman of UTI, M. Damodaran was quoted as saying that "*There were problems on two fronts - liquidity and solvency. The liquidity can be taken care of by the banks line of credit. But, to address the solvency issue, the government will have to step in at the second stage, if the market does not pick up by that time- That is, the government will have to bail out UTI.*" M. Damodaran said that, in the wake of a problem regarding the solvency issue, if the government was not forthcoming with funding, UTI would dump its illiquid stocks in the market.

A report by global consultancy firm Mckinsey declared that UTI may need $500 million

to stay solvent. Mckinsey argued that, given the high fiscal deficit, recapitalization from government funds would not be easy. Also, funds raised from the capital market would not be sufficient. After a series of meetings between UTI chairman, M. Damodaran and Secretary of the Department of Economic Affairs and later with Finance Minister Y. Sinha, the government decided to provide cash assistance to UTI of Rs. 5 billion. Officials said the liabilities to the center would be provided for either in the budget or the final supplementary demand for grants and will be in the nature of a contingent liability on the government. Financial analysts began suggesting the government would have to bail out the country's largest mutual fund operator for another year. In the light of a negative reserve of about Rs. 37 billion and payment obligation for about Rs. 9 billion for two of its MIP schemes maturing 2002 UTI had demanded around Rs. 50 billion. The Cabinet Committee on Economic Affairs chaired by the Prime minister, Mr. A. B. Vajpayee, approved a bailout package of over Rs.145 billion for UTI to meet the liabilities on its flagship US-64 and assured return schemes.

The government also considered some tax concessions for US-64 unit holders so as to create a market, reduce redemption and keep up investment in the scheme. The Finance Minister also asserted there would be no budgetary impact as a result of the package, although it would add to the fiscal burden and contribute to public debt. The UTI case provides an interesting and important example of policy reversal in the face of financial crisis.

APPENDIX B

APPENDIX TO CHAPTER THREE

B.1 Values of Endogenous Variables

Labor market equilibrium implies:

$$l_t = 1 - x_t \tag{B.1}$$

Wage rate: w_t

Substituting equations (3.6) and (3.12) into Eq. (3.28) gives

$$w_t = \frac{Ae_t}{\left[1 + \gamma e^I\{(\pi_t^* + \theta)\psi + \frac{e_t}{e^I}[\delta + (1 - q\varsigma)\psi r]\}\right]} \tag{B.2}$$

Credit: L_t

Substituting equations (B.2) and (B.1) in Eq. (3.25) gives:

$$e^I L_t = \frac{\gamma A e_t}{\left[1 + \gamma e^I\{(\pi_t^* + \theta)\psi + \frac{e_t}{e^I}[\delta + (1 - q\varsigma)\psi r]\}\right]} - \frac{\gamma}{\lambda} \tag{B.3}$$

Consumption: c_t

Substituting equations (3.12) and (3.2) in Eq. (3.21) gives:

$$c_t = \frac{1}{\lambda[1+\eta\{(\pi_t^*+\theta)\psi - \frac{e_t}{e^I}[(1-q\varsigma)(1-\psi)r]\}]} \tag{B.4}$$

Demand Deposits: d_t

Substituting Eq. (B.4) in Eq. (3.19) gives:

$$d_t = \frac{\eta e_t}{\lambda[1+\eta\{(\pi_t^*+\theta)\psi - \frac{e_t}{e^I}[(1-q\varsigma)(1-\psi)r]\}]} \tag{B.5}$$

Leisure x_t

Substituting Eq. (B.2) in Eq. (3.22) gives:

$$x_t = \frac{1}{\lambda}\left[\frac{[1+\gamma e^I\{(\pi_t^*+\theta)\psi + \frac{e_t}{e^I}[\delta+(1-q\varsigma)\psi r]\}]}{Ae_t}\right] \tag{B.6}$$

High Powered money h_t

Substituting equations (B.5) and (B.3) in Eq. (3.4) gives:

$$h_t = \psi\left[\frac{\eta e_t}{\lambda[1+\eta\{(\pi_t^*+\theta)\psi - \frac{e_t}{e^I}[(1-q\varsigma)(1-\psi)r]\}]}\right] + \psi\left[\frac{\gamma A e_t}{[1+\gamma e^I\{(\pi_t^*+\theta)\psi + \frac{e_t}{e^I}[\delta+(1-q\varsigma)\psi r]\}]} - \frac{\gamma}{\lambda}\right] \tag{B.7}$$

Foreign Borrowings: d_t^*

$$e^I d_t^* = (\psi - 1)\left[\frac{\eta e_t}{\lambda[1+\eta\{(\pi_t^*+\theta)\psi - \frac{e_t}{e^I}[(1-q\varsigma)(1-\psi)r]\}]}\right] + \left[\frac{\gamma A e_t}{[1+\gamma e^I\{(\pi_t^*+\theta)\psi + \frac{e_t}{e^I}[\delta+(1-q\varsigma)\psi r]\}]} - \frac{\gamma}{\lambda}\right] \tag{B.8}$$

B.2 Baxter King Filter

Baxter and King (1995) suggest six requirements for a detrending method:

- The filter should extract a cyclical component within a specified range of periodicities, and leave the characteristics of this component undistorted;
- there should be no phase shift, i.e. the filter should not change the timing of the turning points in the series under analysis;
- The filter should be an optimal approximation to the "ideal" filter;
- the filter should have trend-reducing properties;
- the filter should yield business cycle components unrelated to the length of the observation period; and
- the method must be operational.

They proposed a new digital filter, the derivation of which is explicitly based on these requirements. The theory behind the filter is now discussed.

B.2.1 Theory

The Baxter-King (BK) filter is an approximation to an ideal band-pass filter. The ideal filter has the following two-sided infinite moving average representation:

$$a(L) = \sum_{k=-\infty}^{\infty} a_k L^k$$

where symmetry ($a_k = a_{-k}$) is imposed so that the filter does not include a phase shift. The extent to which periodic components of the filtered series are related to periodic

components of the unfiltered series is determined by the *transfer function.* The BK filter is designed to pass through a stationary component of output whose periodicity ranges from 18 to 96 months per cycle. The transfer function for a stationary series of this ideal filter is defined as:

$$\alpha(\omega) = \begin{cases} 1 & \text{if } \pi/48 \leq |\omega| \leq \pi/9; \\ 0 & \text{otherwise.} \end{cases}$$

where the frequency band is derived for the monthly series using $\omega = 2\pi/P$. For practical purposes Baxter and King (1995) use the truncated version of the ideal filter, which is the optimal approximation:

$$a(L) = \sum_{k=-K}^{K} a_k L^k$$

The approximate band-pass filter, with the corresponding transfer function $\alpha_K(\omega)$ truncates the sample by 2K data points. In our case $K = 8$ is used and hence the sample is trimmed by 8 months each from the each end of the sample and thus the analysis is done with 107 observations ranging from May 1991 to March 2000. The BK filter renders the trending series as stationary. This is done by assigning weights to the symmetric moving average such that the weights sum to zero ($\sum_{k=-K}^{K} a_h = 0$). Thus, if the weights sum to zero the filter can be factored out as:

$$\begin{aligned} a_k(L) &= -(1-L)(1-L^{-1})\Psi_{K-1}(L) \\ &= L^{-1}(1-L^2)\Psi_{K-1}(L) \end{aligned}$$

where

$$\Psi_{K-1}(L) = \sum_{h=-(K-1)}^{K} \Psi_h L^h$$

and the coefficients of $\Psi_{K-1}(L)$ are given by

$$\Psi_{|h|} = \sum_{j=|h|+1} (j - |h|)a_j$$

The BK filter contains two differencing operators and hence it removes linear and quadratic time trends and up to two unit roots.

APPENDIX TO CHAPTER FOUR

C.1 Theoretical Justification of Multiple Structural Breaks and Unit-Root Hypothesis

The following section draws upon from (Lumsdaine and Papell, 1997), (Banerjee et al., 1992), (Sims et al., 1990)

The transformed regressors

$Y_t = [Y_t^1, 1, (R_t - \bar{\alpha_0}t), t+1, DI1_{t+1}, DI2_{t+1}, DS1_{t+1}, DS2t+1]'$ are taking

$Y_t^1 = (\Delta R_t - \bar{\alpha_0}, ..., \Delta R_{t-k+1} - \bar{\alpha_0})$

$\bar{\alpha_0} = E(\Delta R_t)$

In order to write the Eq. (4.18) in the transformed form as suggested by Sims, a parameter vector $\boldsymbol{\xi}$ is defined and Eq. (4.18) rewritten as

$R_t = \boldsymbol{\xi}' Y_{t-1} + \epsilon_t$

The errors are assumed to satisfy the following assumption

ϵ_t is a martingale difference sequence and satisfies $E(\epsilon_t^2|\epsilon_{t-1,...} = \sigma^2, E(|\epsilon_t|^i|\epsilon_{t-1,...} = \rho_i (i = 3,4)$, and $sup_t E(|\epsilon_t|^{4+\nu}|\epsilon_{t-1,...} = \bar{\rho} < \infty$ for some $\nu > 0$

The above assumption gives $T^{-1/2} \sum_{t=1}^{[T\lambda]} \Longrightarrow \sigma W(\lambda)$. It is to be noted that "$\Longrightarrow$" i.e. weak

convergence is uniform if $\lambda \in [0,1]$ and in this case W is the standard one dimensional Brownian motion. We also have following properties :

$T^{-1}\Sigma_{t=1}^{T} Y_{t-1}^{1} Y_{t-1}^{1'} \xrightarrow{p} \Omega_k$

$T^{-1/2}\Sigma_{t=1}^{T} Y_{t-1}^{1} \epsilon_t \Longrightarrow \sigma B(1)$, $T^{-3/2}\Sigma_{t=1}^{T} Y_{t-1}^{1} R_t \Longrightarrow 0$ where Ω_k is a non random positive semidefinite matrix, and $B(1)$ is a k dimensional Brownian Motion with covariance matrix Ω_k, independent of W. Take δ_0 as the startup fraction and define δ_1 and δ_2 as the fractions of the sample at which the first and second (endogenous) structural breaks occur i.e. $\delta_1 = SB1/T$ and $\delta_2 = SB2/T$. The test statistics are computed over a two-dimensional grid of possible distinct combinations of k_1 and k_2 where $k_0 = [T\delta_0]$ and $k_1 = k_0, k_0 + 1, ..., T - k_0$. It is evident now that the OLS test statistics of the estimated coefficients are a function of δ_1 and δ_2 or in other words their value depends on the dates of structural breaks. The sequential OLS estimator of the coefficient vector is $\hat{\xi}(\delta_1, \delta_2) = (\sum_{t=1}^{T} Y_{t-1}([T\delta_1], [T\delta_2]) Y_{t-1} 9[T\delta_1], [T\delta_2]))^{-1} (\sum_{t=1}^{T} Y_{t-1}([T\delta_1], [T\delta_2]) R_t)$. It is worth noting that the asymptotic distribution of the t-statistic under the unit-root hypothesis i.e. $\mu = 0$ is given by :

$$\boxed{\hat{t}(\delta_1, \delta_2) \Longrightarrow \int_0^1 W^*(s) dW(s) / [\int_0^1 W^*(s)^2 ds]^{1/2}}$$

where W^* is the continuous time residual from a projection of a Brownian motion onto the functions $[1, s, \mathbf{1}(s > \delta_1), \mathbf{1}(s > \delta_2), (s - \delta_1)\mathbf{1}(s > \delta_1), (s - \delta_2)\mathbf{1}(s > \delta_2]$.

C.2 Cointegration with Unknown Structural Breaks

This appendix heavily draws upon from Jha and Sharma (2004). The present appendix proposes a methodology of incorporating endogenous structural breaks if the series are indeed integrated of order one after allowing for breaks at the unit root stage. There is an important literature ((Chow, 1960), (Quandt, 1960), (Chu, 1989)) emphasizing the need to allow for changes in the values of estimated parameters, over time, in time series regressions. However, these studies do not consider models with non-stationary regressors. (Hansen, 1992) permits this possibility by suggesting a test of parameter instability for $I(1)$ processes. Hansen suggests tests for parameter instability as an alternative test for cointegration between two I(1) variables. In the context here this amounts to estimating the following model:

$$R_t = \mathbf{A_t}\, E_t + \epsilon_t \tag{C.1}$$

where R_t is revenue, E_t expenditure and $\mathbf{A_t}$ is a vector of parameters.[1] The presence of parameter stability results in the uniform convergence of the estimated regression coefficients to the cointegrating relationship in the whole space of the sample. Hansen (1992) describes three test statistics for testing parameter instability in the context of fully modified estimation of cointegrated regression models. These are: *Sup F* test, *Mean F* test and the L_c test.[2] For all the three tests the null hypothesis is the same - $\mathbf{A_t}$ is constant but these tests differ on alternative hypothesis. Hansen (1992) points out that no cointegration is a special case of the alternative hypothesis for which the L_c statistics is an LM test statistics and hence they conclude L_c is a test of null of cointegration against the alternative of no cointegration.

[1] There is no presumption that Eq. (C.1) indicates the pattern of causality between the two variables.
[2] All the three tests assume unknown timing of the structural break.

If the above tests reveal lack of cointegration then Gregory and Hansen (1996) suggest residual-based tests for cointegration allowing for regime shifts. These tests are complementary to the above test and can be used to distinguish between lack of cointegration and a regime shift. These tests reject the null hypothesis of no cointegration if there is cointegration with regime shifts. These residual-based tests incorporate regime shifts in trend as well as slope of the standard cointegration model similar to the procedure adopted in the case of unit root models. The model specifications are:

Standard Cointegration:

$$R_t = \mu + \alpha^\top E_t + e_t, \quad t = 1, \ldots, n \tag{C.2}$$

Level shift(C):

$$R_t = \mu_1 + \mu_2 \varphi_{t\tau} + \alpha^\top E_t + e_t, \quad t = 1, \ldots, n \tag{C.3}$$

Level shift with trend(C/T):

$$R_t = \mu_1 + \mu_2 \varphi_{t\tau} + \beta t + \alpha^\top E_t + e_t, \quad t = 1, \ldots, n \tag{C.4}$$

Regime shift(C/S):

$$R_t = \mu_1 + \mu_2 \varphi_{t\tau} + \alpha_1^\top E_t + \alpha_2^\top E_t \varphi_{t\tau} + e_t, \quad t = 1, \ldots, n \tag{C.5}$$

Gregory and Hansen (1996) suggests three tests to detect cointegration in the possible presence of regime shifts. The first two are modified Phillips (1987) test statistics ($Z_t(\tau)$, $Z_\alpha(\tau)$) and the third is date dependent ADF statistic (ADF^*). These statistics are computed for each possible structural change and then the smallest value (largest negative value)[3] is taken across all break points. Thus the following test statistics are used for the

[3]The smaller the test statistic the more evidence against the null hypothesis

analysis:

$$Z_{\alpha}^{*} = \inf_{t \in \tau} Z_{\alpha}(\tau) \tag{C.6}$$

$$Z_{t}^{*} = \inf_{t \in \tau} Z_{t}(\tau) \tag{C.7}$$

$$ADF^{*} = \inf_{t \in \tau} ADF(\tau) \tag{C.8}$$

The significant value of test statistics implies rejection of null of no cointegration against the alternative of cointegration with regime shift.

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