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Shamim Ahmed
Md. Ezazul Islam

September 2006

Policy Analysis Unit (PAU)
Research Department, Bangladesh Bank
Head Office, Dhaka, Bangladesh
(www.bangladeshbank.org.bd)
(www.bangladesh-bank.org)

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The Monetary Transmission Mechanism in Bangladesh: Bank Lending and Exchange Rate Channels

Shamim Ahmed & Md. Ezazul Islam*

September 2006

Abstract

In view of changes in legal, institutional and policy frameworks in the financial system of Bangladesh under the Financial Sector Reform Programs (FSRPs) initiated in the early 1990s, the paper attempted to empirically investigate whether *bank lending* and *exchange rate channels* exist in the economy through which monetary policy changes can influence aggregate output and prices. An assessment of the empirical evidence has been established through the unrestricted vector autoregressions (VARs) approach using quarterly data for the period of July-September 1979 to April-June 2005. The results of the empirical analysis suggest *weak* existence of both *bank lending* and *exchange rate channels* in the Bangladesh economy for the full-sample period as well as in the sub-sample period (i.e., January-March 1990 to April-June 2005). These findings have important implications with respect to the operation of monetary policy. Specifically, knowing the distinct active channels of monetary transmission in the economy would guide the monetary authority in formulating and conducting monetary policy pursuant to its objectives under the current regime, i.e., floating exchange rate and market based monetary policy instruments.

Keywords: Monetary Transmission Mechanism and Vector autoregressions (VARs).

JEL Classification: E51, E52, 023.

* Research Economist, Policy Analysis Unit (PAU), Research Department, Bangladesh Bank, Dhaka, Bangladesh. The authors would like to thank World Bank Institute (WBI) Resident Economic Adviser at the Bangladesh Bank Prof. Syed M. Ahsan and Dr. Md. Habibur Rahman, Senior Research Economist, PAU, Bangladesh Bank for their helpful suggestions and comments.

The Monetary Transmission Mechanism in Bangladesh: Bank Lending and Exchange Rate Channels

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1. Introduction

The monetary transmission mechanism, a complex but interesting area, has drawn considerable attention of macroeconomists and central bankers all over the world in the last few decades.[1] Particularly, the determination of different channels through which money supply changes (i.e., monetary policy actions) affect aggregate output and prices still remains a *black box* due to continuous monetary innovations as well as financial market integrations (Bernanke and Blinder, 1995).[2] Generally, in a well-functioning economy, the transmission process begins either with open market operations (OMOs) or interest rates engineered through the demand-supply interactions of money, and finally, transmission proceeds through any of the several active channels (Kuttner and Mosser, 2002). In this connection, it is important to mention that any model or theory of transmission mechanism assumes the existence of some degree of friction (i.e., stickiness) in the economy so that nominal prices cannot adjust immediately and proportionally following changes in the monetary base of the economy (Ireland, 2005). Besides, the channels of monetary transmission are not mutually exclusive, i.e., the overall response of the economy to a monetary policy action integrates the influence of a variety of channels (Kuttner and Mosser, 2002).

To date, extensive empirical research (e.g., Bernanke and Gertler (1995), Bernanke and Blinder (1992, 1995), Meltzer (1995), Mishkin (1977), Ramey (1993), and Taylor (1995)) has been conducted in searching the presence of various channels of monetary transmission through which monetary policy changes are propagated in an economy. However, there have been very few empirical studies that attempted to investigate the existence of one or more channels of monetary transmission in Bangladesh. Younus (2004) has attempted to explore whether *bank lending channel* exists in the economy. In particular, using quarterly data set for the period between January-March 1975 to October-December 2000 and employing vector autoregressions (VARs) approaches (i.e., structural and recursive VARs), she concludes that the *bank lending channel* is non-existent in Bangladesh.

Following the work of Younus (2004), the objective of the paper is to empirically investigate whether *bank lending* and *exchange rate channels* exist in Bangladesh.[3] This is timely and important due to several reasons. Firstly, although a considerable number of years have elapsed since independence, the distinct channels of monetary transmission through which aggregate

[1] The monetary transmission mechanism is primarily defined as a series of inter relationships between policy-induced changes in money supply and aggregate output, i.e., the impact of monetary policy changes on aggregate demand and the subsequent effect of changes in aggregate demand on output, prices and employment.

[2] The different channels include the traditional (i.e., *Keynesian*) interest rate channel, the credit channel (i.e., bank lending, balance sheet, cash flow, unanticipated price level, and household balance sheet channels), the exchange rate channel, and the asset price channel (i.e., equity price, wealth, housing and land price channels). For an elaboration see Mishkin (1995, 1996, and 2004, pp. 617-625).

[3] Apart from the period of data coverage, the empirical estimation of the present paper regarding the existence of *bank lending channel* differs from Younus (2004) since the paper has used quarterly data on aggregate output, i.e., real GDP instead of quantum industrial production index. Besides, it is worth mentioning that the paper only explores the existence of *bank lending* and *exchange rate channels* in Bangladesh due to non-availability of appropriate data for other channels (if any exists) of monetary transmission.

output and prices could be influenced in the economy are still not well-identified. Secondly, there have been significant changes in the legal, institutional and policy frameworks of the financial system of Bangladesh under the Financial Sector Reform Program (FSRP) of the 1990s. These changes enable Bangladesh Bank (BB) to conduct monetary policy on the basis of market based instruments instead of direct instruments in order to achieve price stability and smooth financial intermediation. Therefore, knowing the distinct active channels of monetary transmission in the Bangladesh economy would guide the monetary authority in formulating and conducting monetary policy.

The empirical analysis in the paper have been conducted by unrestricted vector autoregressions (VARs) approach using quarterly data for the period of July-September 1979 to April-June 2005. In particular, the paper examines the existence of *bank lending* and *exchange rate channels* separately for two periods: (i) July-September 1979 to April-June 2005 (i.e., full-sample period) and (ii) January-March 1990 to April-June 2005 (i.e., sub-sample period). The latter estimation is of interest since the FSRP began in the early 1990s and most of the reforms were fully in effect only from the late 1990s and the early 2000s. The results of the empirical analysis suggest *weak* existence of both *bank lending* and *exchange rate channels* in the economy for the full-sample period. Alongside, both of these channels also exist *weakly* in the sub-sample period even though the country adopted the FSRP in the 1990s. These results have important implications for the conduct of monetary policy in the economy.

The remainder of the paper is organized as follows: Section 2 briefly discusses the financial system, the monetary policy framework, and the behavior of selected economic indicators in Bangladesh. Section 3 discusses the theory of *bank lending* and *exchange rate channels*, the respective unrestricted VAR models, and methodology used for empirical analysis presented in the paper. Section 4 provides data specification and estimated results, and finally, section 5 presents a summary of the main conclusions and policy implications.

2. Financial System, Monetary Policy Framework, and Movements in Macroeconomic Indicators in Bangladesh

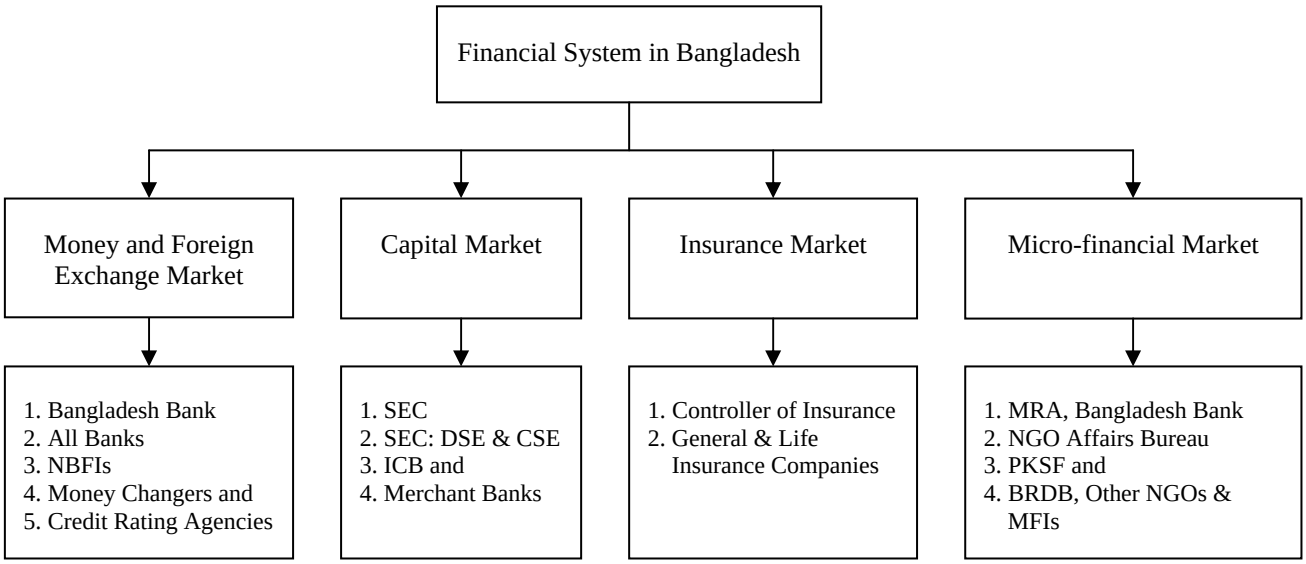
2.1 The Financial System in Bangladesh[4]

In Bangladesh, the financial system comprises of BB as the central bank, 4 nationalized commercial banks (NCBs), 5 government owned specialized banks (SBs), 30 domestic private commercial banks (PCBs) including 6 Islamic banks (IBs), 9 foreign banks (FCBs), 28 non-bank financial institutions (NBFIs), and a large number of micro-finance institutions (e.g., *Bangladesh Rural Advancement Committee* (BRAC), *Grameen Bank*, *Proshika*, and *Association of Social Advancement* (ASA)) and 62 insurance companies (e.g., *Jiban Bima Corporation*, *Shadharan Bima Corporation*, and *American Life Insurance Company* (Alico)). In addition, the financial system also includes 2 stock exchanges (i.e., Dhaka and Chittagong Stock Exchanges (DSE & CSE)) under the Securities and Exchange Commission (SEC) and a number of co-operative banks as well as credit rating agencies. Out of the 5 SBs, *Bangladesh Krishi Bank* (BKB) and *Rajshahi Krishi Unnayan Bank* (RAKUB) have been launched in order to meet the credit demands of the agricultural sector, while *Bangladesh Shilpa Bank* (BSB) and *Bangladesh Shilpa Rin Sangtha* (BSRS) extend term loans to the industrial sector. Finally, *Bangladesh Small Industries and Commerce* (BASIC) Bank Limited provides loans to the

[4] This section draws heavily from Ahmed and Islam (2006). Besides, all the information provided in this section regarding the number of institutions in the financial system are as of 31st December 2005.

small-scale and cottage industries of the economy. Figure 1 presents these financial market participants in a schematic way.

Figure 1: The Financial System in Bangladesh[5]



Note: BRDB: Bangladesh Rural Development Board, ICB: Investment Corporation of Bangladesh, MRA: Micro-finance Regulatory Authority, NGO: Non Government Organization, MFI: Micro-finance Institution, and PKSF: Palli Karma Shahayak Foundation.

Table 1: Position of Deposits and Credits in the Banking System

Bank Groups	Deposits	% of Total Deposits	Credits (Advances & Bills)	% of Total Credits	Credit-Deposit Ratio
NCBs	627.74	40.52	493.67	32.91	0.79
SBs	92.41	5.97	111.55	7.44	1.21
PCBs	719.83	46.47	811.79	54.11	1.13
FCBs	109.09	7.04	83.15	5.54	0.76
Total	**1549.06**	**100.00**	**1500.16**	**100.00**	**0.97**

Notes: 1. All figures regarding deposits and credits are in billion BDT (outstanding amounts) at the end of December 2005.
2. PCBs also include IBs.

Source: Banking Statistics Division, Statistics Department, BB and authors' calculation.

Table 1 reveals that PCBs (including IBs) dominate the banking system in terms of total deposits by holding 46.47 percent at the end of December 2005.[6] In this connection, it is important to mention that, although NCBs' share in total deposits has been dominant since 1970s, it has been declining continuously in recent years. Even as late as December 2002, NCBs held 50.32 percent of total deposits. Moreover, if credit (i.e., sum of advances and bills)

[5] Adapted from *Financial Sector Review* (May 2006, p.1).
[6] The scheduled banking system governed by BB is a major segment of the financial system which comprises of NCBs, SBs, PCBs (including IBs), and FCBs.

of individual bank groups as a share of total credit is considered, it can be observed that PCBs (including IBs) has the highest share, 54.11 percent, at the end of December 2005. Again, it is notable that although NCBs' share of total credit has declined in recent years, it had the highest share of more than 40 percent at the end of September 2003. This in turn, demonstrates increasing domination of PCBs (including IBs) in the financial market of Bangladesh.

2.2 The Monetary Policy Framework in Bangladesh

2.2.1 Background

After independence, BB, the central bank of the country, was established by the Bangladesh Bank Order of 1972 (Presidential Order No. 127 of 1972) with effect from 16th December of 1971. The founding charter identified price, exchange rate and financial system stability as the main objectives of BB as the monetary authority.[7] Since then, to achieve these objectives among others, BB conducted monetary policy under a fixed exchange rate regime on the basis of direct instruments (i.e., bank rate, cash reserve requirement (CRR), and statutory liquidity ratio (SLR)) as well as quantitative monetary control to some extent (i.e., the volume of credit, margin on letters of credit (L/C), and refinancing facility). Besides, BB also determined interest rates, particularly, lending and deposit rates offered by scheduled banks to both depositors and borrowers in the economy.

Starting the early 1990s, there have been significant changes in legal, institutional and policy frameworks under the FSRP. In particular, there have been major changes regarding interest rate liberalizations (i.e., lending and deposit rates have been gradually freed from restrictions), development of money market instruments (i.e., introduction of *repo* in 2002 and *reverse repo* in 2003), OMO by various government treasury bills (TBs) auction (e.g., 28-day, 91-day, 182-day, 364-day, 2-year, and 5-year), adoption of floating exchange rate (on 31st May 2003), etc.[8] Consequently, these changes allow BB to conduct monetary policy relying on market based instruments along with direct instruments. It is important to mention that although BB is currently conducting monetary policy under the floating exchange rate, the amended Bangladesh Bank Order of 2003 allows room for BB to bring about any necessary adjustment in the foreign exchange market in an orderly fashion.[9]

2.2.2 The Monetary Programming[10]

The framework of monetary programming followed by BB is quite intuitive and simplistic. The programming exercise involves the estimation of the *required limit* (also known as *safe*

[7] According to the original charter of 1972, the broad objectives of BB were: (i) to regulate the issue of the currency and the keeping of reserves; (ii) to manage the monetary and credit system of Bangladesh with a view to stabilizing domestic monetary value; (iii) to preserve the par value of the Bangladesh Taka (BDT); (d) to promote and maintain a high level of production, employment and real income in Bangladesh; and (e) to foster growth and development of the country's productive resources for the national interest.

[8] In addition to different government treasury bills for OMOs, BB on 21st September 2006 re-introduced its own 30-day and 91-day bills.

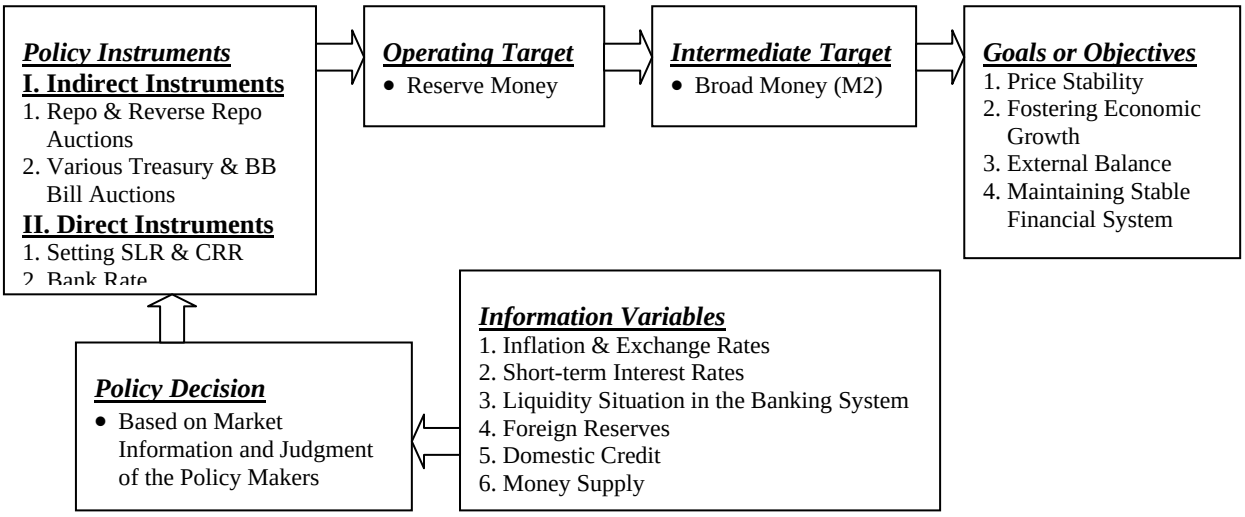
[9] The amended charter of 2003 mandates BB to: (i) formulate and implement monetary policy; (ii) formulate and implement intervention policies in the foreign exchange market; (iii) give advice to the Government on the interaction of monetary policy with fiscal and exchange rate policy, on the impact of various policy measures on the economy and to propose legislative measures it considers necessary or appropriate to attain its objectives and perform its functions; (iv) to hold and manage the official foreign reserves of Bangladesh; (v) promote, regulate and ensure a secure and efficient payment system including the issue of bank notes; and (vi) to regulate and supervise banking companies and financial institutions.

[10] This section draws heavily from *Monetary Policy Review* (October 2005, pp. 20-21).

limit) of monetary expansion (i.e., broad money) on the demand side based on the growth estimates of GDP, CPI and income velocity of money demand.[11] In particular, BB programs the *safe limit* of monetary expansion, broad money (M2), derived from the classical quantity equation of money demand, i.e., $\hat{M} = \hat{Y} + \hat{P} - \hat{V}$, where $\hat{M}$, $\hat{Y}$, $\hat{P}$, and $\hat{V}$ are the growth rates of money demand, anticipated real output, expected inflation rate and income velocity of money respectively.

Having determined the *safe limit* of monetary expansion, BB attempts to clear the money market by changing the nominal stock of money (M2) in the economy by an equivalent amount on the supply side (Taslim, 2001). In particular, the simple relationship between broad money (M2) and reserve money (RM) allows the latter to be used as an *operating target* to reach the *intermediate target*, i.e., broad money (M2) via the money multiplier (MM). This is done on the basis of the equation, $M^s = \beta H$ where $M^s, H,$ and β are the nominal stock of money, monetary liabilities of BB or high powered money, and the money multiplier, i.e., M2, RM and MM respectively in the case of Bangladesh.[12] Figure 2 provides a simple schematic illustration of the monetary policy framework of BB.

Figure 2: Monetary Policy Framework of Bangladesh Bank[13]



Since BB does not have direct control over money supply, in order to reach its estimated *intermediate target* M2 it influences money supply by using a set of both direct and indirect instruments. In particular, M2 is influenced indirectly by changes in direct and indirect policy instruments that target and monitor RM via MM. The primary mechanism engaged in this purpose is the direct control of liquidity on a day-to-day basis achieved by the *repo* (repurchase

[11] Previously, BB used income elasticity of demand for money approach to estimate the *safe limit* of monetary expansion. Particularly, BB used the relationship $\varepsilon = \hat{M}/\hat{Y}$ for deriving the point estimates of ε where $\hat{M}$ and $\hat{Y}$ are the growth rates of nominal money demand and nominal income respectively. For an elaboration, see Taslim (2001).

[12] The MM can be defined as $\beta = \left[1/\{c + d(rr + er)\}\right]$ where *c*, *d*, *rr*, and *er* are currency-money, deposit-money, required reserve, and excess reserve ratios respectively. An estimate of MM determines the change in RM necessary to clear the money market (Taslim, 2001).

[13] Adapted and modified from *Monetary Policy Review* (October 2005, p. 20).

agreement), *reverse repo* and the weekly TBs auctions. These indirect instruments would in turn have an impact on the inter-bank call money rate for overnight money market transactions.[14] While adjusting the excess liquidity in the banking system, BB also asserts its monetary policy stance by simultaneously re-setting the *repo* and *reverse repo* rates on a regular basis. Besides, BB also infrequently uses CRR and SLR to influence money supply. Conversely, in recent years, the traditional bank rate, i.e., the rate at which BB stands ready to lend to the scheduled banks, has not been effective in signalling the monetary stance via the adjustment of the deposit and borrowing rates in the banking system.

2.3 Behavior of Selected Economic Indicators

The Bangladesh economy experienced robust economic growth beginning the early 1990s marking a departure from the *weak* macro-economic performance of the 1970s as well as the early 1980s. Particularly, the country has experienced steady economic growth of 5.44 percent on average during the first-half of the 2000s in comparison to 2.82 percent in the 1970s, and 3.72 percent and 4.26 percent during the first and second halves of the 1980s, respectively (Table 2). Alongside, there was a modest rate of inflation throughout the 1990s compared to both 1980s and 1970s indicating price stability in the economy. In the first-half of the 1990s, inflation was on average 5.55 percent, although the rate during the second-half was a bit higher at 5.70 percent. This modest trend of inflation was also sustained during the first-half of the 2000s with an average of 4.28 percent, the lowest half-decade average since independence. However, inflation in the very recent year, i.e., FY06 demonstrates an upward trend; the rate has gradually increased to around 7-percent from 1.94 percent in FY01.

Apart from economic growth and inflation, in the external sector, export performance in the 1990s was also impressive compared to pervious periods. The average growth rate of exports (measured in USD) during the first-half of the 1990s was 18.34 percent while the average for the second-half declined to 10.72 percent. During the first-half of the 2000s, growth remained robust although there was a set-back in export performance in FY02 with a negative growth of 7.74 percent.[15] Conversely, import growth during the first-half of the 1980s was very modest with an average of 3.42 percent (also measured in USD) and the period average for the second-half increased to 7.7 percent. Throughout the first five years of the 1990s, imports registered an average growth of 10.36 percent due to faster trade liberalizations as well as surge in input flow for export-oriented domestic industries, mainly, ready-made garment (RMG). However, in the second-half of the 1990s, imports registered a lower average growth of 5.63 percent compared to the previous period. The import growth in FY05 has been 20.63 percent, the highest in the first-half of the new decade after the 1990s. This recent higher growth of imports stems mainly from increased prices of major imported commodities (e.g., petroleum, food grain and capital machinery) in the international market (Ahmed, 2006).

[14] Through *repo* operation, a bank or financial institution is able to borrow funds from BB by selling its securities for an agreed time period and after that it will re-purchase those securities from BB. Conversely, the *reverse repo* facility enables participating institutions to purchase government securities from BB with a pre-commitment of selling those back to BB upon maturity. Therefore, *repo* injects money in the monetary system while *reverse repo* does the opposite. Besides, auctioning off new TBs leads to withdrawal of liquidity while maturity of TBs leads to injection of liquidity in the system.

[15] It is worth mentioning that since the beginning of the 1990s, RMG exports have contributed the lion's share of about 75 percent in total exports and the periods before that jute and jute goods exports contributed the major share of about 70 percent.

Table 2: Movements in Real and External Sector Indicators

Fiscal Year	Inflation	GDP Growth	Export Growth	Import Growth	Nominal Exchange Rate (Revaluation/Devaluation)
1980-81	12.54	3.80	-2.26	17.38	-19.44
1981-82	16.29	2.38	-11.83	-3.91	-15.67
1982-83	9.93	4.02	9.70	-10.26	-10.76
1983-84	9.67	5.18	18.12	3.67	-2.78
1984-85	10.94	3.22	15.22	10.20	-6.67
Average (1980-81 to 1984-85)	**11.87**	**3.72**	**5.79**	**3.42**	**-11.05**
1985-86	9.95	4.25	-12.33	-10.69	-10.89
1986-87	10.35	3.73	31.07	10.83	-2.18
1987-88	11.42	2.16	14.75	13.97	-1.67
1988-89	8.00	2.61	4.77	13.03	-2.39
1989-90	9.30	5.94	18.02	11.38	-7.54
Average (1985-86 to 1989-90)	**9.80**	**4.26**	**11.26**	**7.70**	**-4.93**
1990-91	8.31	3.34	12.72	-7.69	-2.49
1991-92	4.56	5.04	16.09	-0.20	-8.23
1992-93	2.73	4.57	19.51	17.56	-2.01
1993-94	3.28	4.08	6.34	2.95	-1.12
1994-95	8.87	4.92	37.04	39.20	0.63
Average (1990-91 to 1994-95)	**5.55**	**4.39**	**18.34**	**10.36**	**-2.64**
1995-96	6.65	4.62	11.80	19.08	-4.19
1996-97	2.52	5.39	13.80	3.09	-4.35
1997-98	6.99	5.23	16.81	-5.45	-5.72
1998-99	8.91	4.87	2.94	6.50	-4.54
1999-00	3.41	5.94	8.27	4.91	-4.90
Average (1995-96 to 1999-00)	**5.70**	**5.21**	**10.72**	**5.63**	**-4.74**
2000-01	1.94	5.27	12.43	11.42	-10.53
2001-02	2.79	4.42	-7.44	-8.70	-1.55
2002-03	4.38	5.26	9.39	13.12	0.00
2003-04	5.83	6.27	16.10	13.01	-4.41
2004-05	6.48	5.96	13.83	20.63	-4.86
Average (2000-01 to 2004-05)	**4.28**	**5.44**	**8.86**	**9.90**	**-4.27**

Notes: 1. All figures are percentage changes over end of the last June.
2. Inflation figures are based on 12-month moving average.
3. Growth figures for 'GDP' are on the basis of GDP in constant BDT (base: 1995-96).
4. Percentage changes in 'Exports' and 'Imports' are based on USD values.
5. Negative and positive signs for percentage changes in the 'Exchange Rate (i.e., BDT/USD)' denote devaluation and revaluation up to 2002-03 respectively and figures beyond that denote depreciation and appreciation respectively. Besides, all calculations have been done on the basis of mid-value of buying and selling rates of commercial banks.

Sources: 1. Bangladesh Bank Annual Report (various issues), BB.
2. Annual Report (various issues), Export Promotion Bureau of Bangladesh.
3. Economic Trends (various issues), BB.
4. BBS (2000, 2001, and 2005) and authors' calculation.

In recent years, the level of financial development also signals prospects for future economic growth in Bangladesh.[16] Particularly, during the first five years of the 1980s, *financial deepening* i.e., M2 as percent of GDP was 15.04 percent on average which grew over time and

[16] Levine (1997) mentions that the level of financial development is a good predictor of future economic development of a country since there is a strong and positive link between them.

stood at about 38 percent during FY01 to FY05 (Table 3).[17] On the other hand, private sector advances as percent of GDP has increased continuously from 8.52 on average to 26.39 percent over the same time period.[18] Besides, income velocity of money measured by GDP as percent of M2 has declined gradually from 6.84 percent on average during the first-half of the 1980s to 2.67 percent during the first-half of the 2000s. These patterns suggest higher level of monetization of the economy and increasing financial intermediation of economic activities, therefore, increasing the level of financial development in Bangladesh.

Table 3: Financial Deepening and Income Velocity

Fiscal Year	Financial Deepening (M2 as % of GDP)	Private Sector Advances as % of GDP	Income Velocity (GDP/M2)
1980-81	12.83	5.97	7.79
1981-82	12.29	6.59	8.14
1982-83	13.91	7.69	7.19
1983-84	17.41	9.98	5.75
1984-85	18.75	12.36	5.33
Average (1980-81 to 1984-85)	**15.04**	**8.52**	**6.84**
1985-86	19.50	13.52	5.13
1986-87	19.72	13.18	5.07
1987-88	20.50	13.90	4.88
1988-89	21.42	15.35	4.67
1989-90	22.22	15.83	4.50
Average (1985-86 to 1989-90)	**20.67**	**14.36**	**4.85**
1990-91	21.27	15.40	4.70
1991-92	23.86	15.78	4.19
1992-93	25.15	17.26	3.98
1993-94	26.88	17.78	3.72
1994-95	22.70	18.57	4.40
Average (1990-91 to 1994-95)	**23.97**	**16.96**	**4.20**
1995-96	27.47	20.02	3.64
1996-97	28.02	20.49	3.57
1997-98	27.91	21.69	3.58
1998-99	28.69	22.07	3.49
1999-00	31.53	22.64	3.17
Average (1995-96 to 1999-00)	**28.72**	**21.38**	**3.50**
2000-01	34.38	24.83	2.91
2001-02	36.10	25.55	2.77
2002-03	37.92	25.99	2.64
2003-04	38.95	27.31	2.57
2004-05	40.89	28.28	2.45
Average (2000-01 to 2004-05)	**37.65**	**26.39**	**2.67**

Sources: 1. Banking Statistics Division, Statistics Department, BB.
2. Economic Trends (various issues), BB.
3. BBS (2000, 2001, and 2005) and authors' calculation.

[17] The two most important concepts of measuring the financial sector development are: (i) M2-GDP ratio also known as *financial deepening* and (ii) private sector credit-GDP ratio.

[18] Since private sector advances comprise the major share of private sector credit (i.e., sum of advances and bills) by scheduled banks, private sector advances as percent of GDP has been used as a proxy for private sector credit-GDP ratio in the analysis (Annex Table 2).

On the other hand, investment-GDP ratio in Bangladesh compares poorly with that of the faster growing countries of South East Asia (e.g., Singapore, Malaysia, Hong Kong, and South Korea) where investment as a percentage of GDP has remained within the range of 35 to 40 percent per annum (Islam and Begum, 2005). Investment-GDP ratio in current prices in Bangladesh has steadily risen to 24.43 percent in FY05 as compared to 16.90 percent in FY91 (Table 4). Besides, *public sector investment* as a percentage of GDP remained within the range of 5 to 7-percent since the 1970s.[19] Conversely, *private sector investment* at current prices has increased gradually to 18.53 percent in FY05 from 10.26 percent in FY91. It would thus appear that the private sector has taken the lead following the FSRP of the 1990s.[20] Even though current investment spending in Bangladesh is considerably higher than earlier, it is not enough to attain and maintain an economic growth of 8 to 9-percent per annum as would be consistent with the goals of poverty reduction.[21] Therefore, the major challenge for Bangladesh is to raise investment to at least 30 percent of GDP.[22]

Table 4: Investment as percent of GDP at Current and Constant Prices (base: 1995-96)

Fiscal Year	Constant Prices			Current Prices		
	Total	Private	Public	Total	Private	Public
1990-91	16.62	10.12	6.5	16.90	10.26	6.63
1995-96	19.99	13.58	6.42	19.99	13.58	6.42
1999-00	23.81	16.01	7.80	23.02	15.61	7.41
2001-02	24.78	17.97	6.82	23.15	16.78	6.37
2003-04	26.09	19.11	6.98	24.02	17.83	6.19
2004-05	27.04	20.22	6.82	24.43	18.53	5.90

Note: Figures for constant prices are constructed using sectoral implicit deflators: 1995-96 base (e.g., construction material price index, machinery equipment, transport equipment, and other capital goods).

Source: BBS (2005).

[19] Mahmud (2004) mentions that a short-lived episode of investment boom existed in the country from the late 1970s to the beginning of the 1980s where investment in both public and private sector grew at nearly 15 percent annually in real terms. He also added that it was made possible by depending on increased foreign aid and adopting privatization policy based on lavish dispensation of *directed cheap credit* and provision of other incentives such as highly protected markets for domestic industries.

[20] To enhance overall investment, the government offers generous opportunities under its liberalised Industrial Policy and export-oriented private sector-led growth strategy. In particular, all but four sectors: (i) arms and ammunition and other defence equipment and machinery; (ii) forest plantation and mechanised extraction within the bounds of reserved forests; (iii) production of nuclear energy; and (iv) security printing and mining are open for private (both domestic and foreign) investment in Bangladesh. The Board of Investment (BOI) provides institutional support services to potential investors. The general facilities/incentives include: (i) tax holiday for 5 or 7 years depending on the location of the industrial enterprise; (ii) tax exemption on royalties, technical know-how fees received by any foreign collaborator, firm, company and expert; (iii) exemption of income tax up to 3 years for foreign technicians employed in industries specified in the relevant schedule of the income tax ordinance; (iv) tax exemption on income of the private sector power generation company for 15 years from the date of commercial production; (v) tax exemption on capital gains from the transfer of shares of public limited companies listed with a stock exchange; and (vi) concessionary duty on imported capital machinery. For an elaboration, visit www.bangladeshbank.org.bd.

[21] According to the Poverty Reduction Strategy Paper (PRSP) document, an enhanced economic growth rate of 8 to 9 percent per annum is required to achieve the poverty reduction targets set by the Millennium Development Goals (MDGs) in Bangladesh (GOB, 2005).

[22] The figure is based on the authors' own estimation by the well known capital-output (K/Y) ratio in the *Harrod-Domar* framework. This framework has been used extensively in developing countries to examine the relationship between economic growth and capital requirement, i.e., investment spending (Perkins *et al.*, 2001, pp. 45-46).

The growth rate of broad money, i.e., M2 has remained about 15 percent on average in the first five years of the 2000s which is considerably lower than the period average of the first-half of the 1980s. Besides, the average growth rate in time deposits during the first-half of the 1980s was about 32 percent which is much higher than the average growth of about 9-percent in the first-half of the 1990s. This again gradually increased to 16.18 percent in the first-half of the 2000s partly reflecting the higher opportunity cost of holding money due to attractive returns on different term deposits. An analysis of the RM growth show after the first half of the 1990s, RM started to increase from FY96 at an annual rate of less than 5-percent reaching close to 25 percent growth in FY02. Although, it significantly fell to the 3.31 percent in FY03, the figure in FY05 was about 13 percent.

Table 5: Growth in Monetary Sector Indicators

Fiscal Year	M2	Excess Reserve	Time Deposits	Demand Deposits	Total Deposits	Reserve Money
1980-81	29.86	-33.08	29.63	27.96	29.04	27.91
1981-82	7.54	-15.08	14.55	3.56	10.67	-4.11
1982-83	27.75	-46.61	34.85	15.56	28.49	26.87
1983-84	50.11	300.07	52.64	50.71	52.07	37.64
1984-85	23.56	-37.84	29.35	23.61	27.66	19.66
Average (1980-81 to 1984-85)	**27.76**	**33.49**	**32.20**	**24.28**	**29.59**	**21.59**
1985-86	17.12	179.95	17.58	18.57	17.86	22.28
1986-87	16.33	175.66	22.67	7.16	18.23	14.38
1987-88	14.27	6.35	24.97	-17.42	13.97	35.16
1988-89	16.32	-25.30	19.87	8.07	17.65	8.13
1989-90	16.88	-30.87	16.97	11.79	16.08	15.52
Average (1985-86 to 1989-90)	**16.18**	**61.16**	**20.41**	**5.63**	**16.76**	**19.10**
1990-91	5.44	161.04	-1.42	7.01	-0.01	3.31
1991-92	21.34	46.60	29.07	22.95	27.98	5.90
1992-93	10.55	270.09	10.88	9.51	10.64	30.13
1993-94	15.43	35.16	12.29	25.50	14.53	25.72
1994-95	15.96	-43.36	-6.15	-13.54	-7.52	-5.99
Average (1990-91 to 1994-95)	**13.74**	**93.90**	**8.93**	**10.29**	**9.12**	**11.81**
1995-96	8.24	-35.78	31.85	47.53	34.57	3.51
1996-97	10.81	48.72	13.56	3.49	11.65	12.65
1997-98	10.35	19.57	12.75	1.88	10.83	9.87
1998-99	12.81	30.43	14.50	10.70	13.88	8.26
1999-00	18.62	11.31	19.82	13.73	18.86	15.75
Average (1995-96 to 1999-00)	**12.17**	**14.85**	**18.50**	**15.47**	**17.96**	**10.00**
2000-01	16.60	12.54	18.19	11.61	17.20	10.92
2001-02	13.13	82.12	14.85	6.91	13.71	24.34
2002-03	15.59	-5.93	17.19	10.39	16.27	3.31
2003-04	13.84	-19.63	13.78	13.91	13.80	7.58
2004-05	16.79	-18.14	16.89	15.31	16.69	12.96
Average (2000-01 to 2004-05)	**15.19**	**10.19**	**16.18**	**11.63**	**15.53**	**11.82**

Note: All figures are percentage changes over end of the last June.

Source: Economic Trends (various issues), BB and authors' calculation.

Besides, overnight money market has undergone significant changes in the last few years, particularly; BB has introduced several new instruments to reinforce indirect monetary operation and to manage the day-to-day liquidity position in the market. Table 6 presents the

yearly trend of various direct and indirect policy instruments rates. It is observed that all the nominal rates of indirect policy instruments have increased starting FY05 which continued also in FY06 due to tighter monetary policy pursued by the BB as well as a higher credit demand in the economy. For instance, the high *repo* rate observed in FY05 originated from the tight liquidity situation that prevailed in last quarter of the fiscal year. Simultaneously, as in the case of previous years, the BB had withdrawn excess liquidity through higher r*everse repo* rates starting FY05. The SLR for the scheduled banks excluding IBs and SBs has been raised from 16 percent of their demand and time liabilities excluding inter-bank items to 18 percent in October 2005.[23] While, the SLR for the IBs remained unchanged at 10 percent and SBs continued to remain exempt from maintaining the SLR.

Table 6: Movements in Selected Monetary Policy Instruments

Fiscal Year	Direct Instruments			Rates on Indirect Instruments						
	Bank Rate	CRR	SLR	28-day T-Bills	91-day T-Bills	182-day T-Bills	364-day T-Bills	Repo (1-2 day)	Reverse Repo (1-2 day)	Reverse Repo (3-9 day)
1980-81	8.00	5.00	25.00	-	-	-	-	-	-	-
1981-82	10.50	5.00	25.00	-	-	-	-	-	-	-
1982-83	10.50	5.00	25.00	-	-	-	-	-	-	-
1983-84	10.50	5.00	25.00	-	-	-	-	-	-	-
1984-85	10.50	5.00	25.00	-	-	-	-	-	-	-
1985-86	11.00	5.00	25.00	-	-	-	-	-	-	-
1986-87	11.25	5.00	20.00	-	-	-	-	-	-	-
1987-88	10.75	10.00	20.00	-	-	-	-	-	-	-
1988-89	10.75	10.00	20.00	-	-	-	-	-	-	-
1989-90	9.75	10.00	20.00	-	-	-	-	-	-	-
1990-91	9.25	7.00	20.00	-	-	-	-	-	-	-
1991-92	9.00	6.00	20.00	-	-	-	-	-	-	-
1992-93	7.00	5.00	20.00	-	-	-	-	-	-	-
1993-94	6.50	4.00	20.00	-	-	-	-	-	-	-
1994-95	5.00	4.00	20.00	-	-	-	-	-	-	-
1995-96	5.75	4.00	20.00	-	-	-	-	-	-	-
1996-97	7.00	4.00	20.00	-	-	-	-	-	-	-
1997-98	8.00	4.00	20.00	8.31	-	-	-	-	-	-
1998-99	8.00	4.00	20.00	7.51	8.46	8.87	8.87	-	-	-
1999-00	7.00	4.00	20.00	6.05	6.35	7.06	7.06	-	-	-
2000-01	7.00	4.00	20.00	6.33	6.84	7.10	7.10	-	-	-
2001-02	6.00	4.00	20.00	4.81	5.25	5.50	5.73	-	-	-
2002-03	6.00	4.00	20.00	7.00	8.82	9.27	9.90	12.18	3.83	4.00
2003-04	5.00	4.00	16.00	3.99	5.00	5.99	6.30	4.61	2.50	2.84
2004-05	5.00	4.50	16.00	6.60	5.45*	6.75	7.00	8.00	4.50	4.63
2005-06	5.00	5.00	18.00	7.10	7.43	7.75	8.30	-	6.04	6.29

Notes: 1. Figures regarding 'SLR' excludes IBs and SBs.
2. All figures are as of end June of respective fiscal years.
*3. '-' denotes figures are not available and * denotes as of end March.*

Sources: 1. Bangladesh Bank Annual Report (various issues), BB.
2. Economic Trends (various issues), BB.
3. Monthly Economic Indicators: Monthly Update (various issues), Monetary Policy Department, BB.

[23] Effective from October 2005, CRR has also been set at 5-percent on average on a fortnightly basis but not less than 4-percent on any working day.

3. The Model and the Methodology

3.1 The Theory of Bank Lending and Exchange Rate Channels

3.1.1 The Bank Lending Channel

The *bank lending channel*, an important implication of the *credit view* of monetary transmission arises as a result of information problems (i.e., asymmetric information) between lenders and borrowers in the financial market.[24] According to this channel, banks play a special role in the financial system as they are better capable of and well designed to deal with certain types of borrowers, mainly, small and medium firms who do not have access to credit markets unless they borrow from banks (Mishkin, 2004). If the supply of bank loans to borrowers is interrupted, it is likely that borrowers will face increased external finance premium due to costs associated with finding a new lender, and thus, reducing real economic activities. Therefore, in this channel, monetary policy actions will have a greater impact on small and medium firms that are more dependent on bank loans than on large firms that can directly access credit through stocks and bonds along with banks.

In this channel, as long as there is no perfect substitutability between retail bank deposits and other sources of funds (e.g., stocks and certificates of deposits (CDs)), a contractionary monetary policy $(M \downarrow)$ for instance decreases bank reserves and bank deposits which over time reduces the quantity of bank loans available to borrowers (Mishkin, 2004).[25] Since banks play a special role as a lender to classes of bank borrowers, this reduction in the quantity of loans will cause investment (and possibly consumer spending) to fall which will in turn reduce aggregate output (Y). The effect of monetary policy actions through the *bank lending channel* of monetary transmission can be shown schematically as:

$$M \downarrow \Rightarrow BankDeposits \downarrow \Rightarrow BankLoans \downarrow \Rightarrow I \downarrow \Rightarrow Y \downarrow$$

3.1.2 The Exchange Rate Channel

In an open economy, the *exchange rate channel* plays a pivotal role owing to the increased internalization of economies all over the world (Mishkin, 2004). Particularly, this channel is concerned with the interrelationships between net private capital inflows and monetary policy following liberalizations in the financial market which is evident in literature (e.g., Bryant *et al.* (1993) and Taylor (1993)). The transmission process operates from the domestic real interest rates to the exchange rate through the uncovered interest rate parity condition involving the differentials in real interest rate and subsequent exchange rate movements (Kuttner and Mosser, 2002).

Under a flexible exchange rate regime and perfect capital mobility, a contractionary monetary policy $(M \downarrow)$ raises the domestic real interest rate (i_r) and this leads to an inflow of capital (i.e., deposits denominated in domestic currency become more attractive compared to deposits denominated in foreign currencies).[26] As a result, domestic currency appreciates $(E \uparrow)$ and this appreciation of domestic currency makes domestic goods more expensive for foreigners, therefore exports fall. Simultaneously, imports become cheaper and thus domestic imports

[24] The idea of the *bank lending channel* of monetary transmission has been pioneered by Bernanke and Blinder (1988).

[25] This is an important condition for the existence of the *bank lending channel* of monetary transmission since there are doubts about the channel in economies with highly developed financial markets where full-fledged stock and bond market exists (e.g., United States). For details, see Ramey (1993), Meltzer (1995), etc.

[26] Inflow of capital requires that the domestic real interest rate must rise above its foreign counterpart.

increase. Overall, a contractionary monetary policy leads to a fall in net exports (*NX*) and aggregate output (*Y*). The schematic illustration of the *exchange rate channel* of monetary transmission is given below.

$$M \downarrow \Rightarrow i_r \uparrow \Rightarrow E \uparrow \Rightarrow NX \downarrow \Rightarrow Y \downarrow$$

On the other hand, under a fixed exchange rate regime, a contractionary monetary policy primarily increases the domestic real interest rate and lowers income. This leads to an inflow of capital as well as a current account surplus position. As a result, the attempt to contract money supply becomes ineffective since the withdrawal of domestic bonds by the monetary authority through OMOs is balanced by its gains of having additional foreign exchange reserves.

3.2 The Empirical Model

In the early 1970s, the tasks of providing macroeconomic forecasts and delivering structural inferences as well as guidance for appropriate policy prescriptions were basically performed using diverse econometric approaches. These ranged from large scale models to single-equation models focused on interactions of a few variables to simple univariate time series models. Following the ground breaking *Lucas critique* (1976), almost all of these approaches appeared to be less reliable, especially in making forecasts with large non-structural models.[27] In this connection, Sims (1972, 1980) developed a new macro-econometric framework known as vector autoregressions (VARs), which provides a simple and systematic way to capture the rich dynamics that exist in the univariate or multivariate time series models engaged in forecasting and policy analysis. Generally, an *n*-equation VAR is an *n*-variable linear system in which each variable is in turn explained by its own lagged values and past values of the remaining *n-1* variables. Besides, in an *n*-variable unrestricted VAR, each and every concerned variable in the system is assumed to be endogenous and no a priori restrictions are imposed (Enders, 1995).

Considering advantages of the VAR approach, the paper employs unrestricted VARs to investigate whether *bank lending* and *exchange rate channels* exist in Bangladesh. Basically, the paper examines the existence of both of these channels separately using quarterly data for the period: (i) July-September 1979 to April-June 2005 (i.e., full-sample period) and (ii) January-March 1990 to April-June 2005 (i.e., sub-sample period). In this connection, it is important to mention that the existence of other channels (if any) of monetary transmission in the country has not been empirically explored in the paper because of non-availability of relevant data set.

Before estimation of VARs, time series properties of all concerned variables have been identified by Dicky-Fuller (DF, 1979), Augmented Dickey-Fuller (ADF, 1981), Phillips-Perron (PP, 1988) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS, 1992) tests. All of these tests have been performed in the levels. The paper has estimated all of the unrestricted VAR models in levels; even though, some of the relevant time series variables in the respective models are likely to be non-stationary and contain unit roots, I(1). This has been motivated by a considerable number of empirical literature (e.g., Christiano and Eichenbaum (1992), Eichenbaum (1992), Sims (1980), Sims *et al*. (1990), and Strongin (1992)) on unrestricted VARs employed in levels. In particular, Sims (1980) argues that since the objective of VAR

[27] The *Lucas critique* points out not only that conventional econometric models cannot be used for policy evaluation, but also that the public's expectations about a policy will influence the response to that policy (Miskin: 2004, p. 660).

analysis is to explore the interrelationships that exist among the time series variables, first differencing the variables purges away relevant information concerning the comovements in the data even if the variables contain a unit root, I(1).[28] The following unrestricted VAR models regarding the existence of *bank lending* and *exchange rate channels* of monetary transmission in Bangladesh have been estimated in the paper with the order of given variables:

- Bank Lending Channel (1979:3–2005:2): *RM*, *TOD*, *PSA*, *CPI*, *RGDP*[29]
- Bank Lending Channel (1990:1–2005:2): *RM*, *TOD*, *PSA*, *CPI*, *RGDP*
- Exchange Rate Channel (1979:3–2005:2): *RM*, *CPI*, *NEXR*, *EPR*, *IMP*, *RGDP*[30]
- Exchange Rate Channel (1990:1–2005:2): *RM*, *CPI*, *NEXR*, *EPR*, *IMP*, *RGDP*

where

RM = reserve money;
TOD = total deposits (i.e., sum of time and demand deposits);
PSA = private sector advance;
NEXR = nominal exchange rate (i.e., BDT/USD);
EPR = exports;
IMP = imports;
CPI = consumer price index; and
RGDP = real GDP.

All of the above VAR models have been identified using a Choleski decomposition, which isolates the structural errors by recursive orthogonalization. A Choleski decomposition requires that the concerned variables be placed on the basis of the speed at which the variables act in response to shocks. In particular, the variables placed higher in the ordering have contemporaneous impact on the variables lower in the ordering, but the variables placed lower in the ordering do not have contemporaneous impact on the variables higher in the ordering

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[28] Similarly, Disyatat and Vongsinsirikul (2003) mention that since economic theory is mostly based on the relationship between variables in levels, therefore, a VAR in first difference fails to capture such dynamics.

[29] The system of equations of the VAR model regarding the *bank lending channel* of monetary transmission can be represented as

$$RM_t = \varphi_{10} + \sum_{j=1}^{s} \varphi_{11\,j} TOD_{t-j} + \sum_{i=1}^{q} \varphi_{12\,i} PSA_{t-i} + \sum_{k=1}^{m} \varphi_{13\,k} CPI_{t-k} + \sum_{l=1}^{n} \varphi_{14\,l} RGDP_{t-l} + e_{1t}$$

$$TOD_t = \varphi_{20} + \sum_{j=1}^{s} \varphi_{21\,j} TOD_{t-j} + \sum_{i=1}^{q} \varphi_{22\,i} PSA_{t-i} + \sum_{k=1}^{m} \varphi_{23\,k} CPI_{t-k} + \sum_{l=1}^{n} \varphi_{24\,l} RGDP_{t-l} + e_{2t}$$

$$PSA_t = \varphi_{30} + \sum_{j=1}^{s} \varphi_{31\,j} TOD_{t-j} + \sum_{i=1}^{q} \varphi_{32\,i} PSA_{t-i} + \sum_{k=1}^{m} \varphi_{33\,k} CPI_{t-k} + \sum_{l=1}^{n} \varphi_{34\,l} RGDP_{t-l} + e_{3t}$$

$$CPI_t = \varphi_{40} + \sum_{j=1}^{s} \varphi_{41\,j} TOD_{t-j} + \sum_{i=1}^{q} \varphi_{42\,i} PSA_{t-i} + \sum_{k=1}^{m} \varphi_{43\,k} CPI_{t-k} + \sum_{l=1}^{n} \varphi_{44\,l} RGDP_{t-l} + e_{4t}$$

$$RGDP_t = \varphi_{50} + \sum_{j=1}^{s} \varphi_{51\,j} TOD_{t-j} + \sum_{i=1}^{q} \varphi_{52\,i} PSA_{t-i} + \sum_{k=1}^{m} \varphi_{53\,k} CPI_{t-k} + \sum_{l=1}^{n} \varphi_{54\,l} RGDP_{t-l} + e_{5t}$$

where $e_{1t}, e_{2t}, e_{3t}, e_{4t}, e_{5t}$ are the random disturbance terms, and *s*, *q*, *m*, and *n* are the number of lag lengths.

[30] While empirically investigating the existence of *exchange rate channel*, real interest rate has been excluded and the ordering of the variables deviates from the actual theory of *exchange rate channel* described in the preceding section. There are several reasons behind this. Firstly, since independence, the monetary authority followed a fixed exchange rate with a narrow band and subsequently a wider band of buying and selling rates for commercial banks, and finally, a floating exchange rate system in 2003. Secondly, although current account is convertible since 1994, capital account is still not convertible in Bangladesh. Lastly, foreign exchange market is limitedly open in terms of volume transactions.

(Rahman, 2005). Since the main objective of the paper is to empirically investigate whether monetary policy changes are propagated in the economy through *bank lending* and *exchange rate channels* (i.e., whether one or both of these channels exits), policy variable, i.e., reserve money has been placed first in all the corresponding VAR models and the order of the other variables follows the theory of respective channels. As aggregate output, i.e., real GDP is expected to be influenced by monetary policy changes at the end if either or both of these channels exist, the variable *RGDP* has been placed last in the ordering of all the VAR models.

Finally, variance decompositions (VDCs) and impulse response functions (IRFs) derived from VARs estimation have been used to look at the relative impact of monetary policy actions (i.e., money supply changes) on aggregate output and prices.[31] Basically, the IRFs show the response of each concerned variable in the linear system to a shock from system variables and the VDCs show the portion of the variance in the forecast error for each variable due to innovations to all variables in the system (Enders, 1995).

4. Data and Empirical Evidence

4.1 Data Specification

The VAR models estimated in the paper have used a quarterly data set on: (i) real GDP at producer prices (base year: 1995-96);[32] (ii) total deposits (i.e., sum of time and demand deposits of the banking system); (iii) private sector advances (by all scheduled banks); (iv) consumer price index (base year: 1995-96); (v) reserve money; (vi) nominal exchange rate (i.e., BDT/USD); (vii) exports; and (viii) imports for the period of July-September 1979 to April-June 2005. In particular, the data on total deposits *(TOD)*, private sector advances *(PSA)* and reserve money *(RM)* are outstanding amounts as of the end of each quarter while consumer price index *(CPI)* is as of the end of each quarter. Besides, *NEXR* is the mid-value of buying and selling rates of commercial banks at the end of each quarter and exports *(EPR)* and imports *(IMP)* are total *EPR* and *IMP* in BDT in each respective quarter. These data have been retrieved from the Bangladesh Bureau of Statistics (BBS) and various publications of BB.

In the empirical estimation, the VAR model regarding the: (i) *bank lending channel* for both full and sub-sample periods has used quarterly data set on *RM*, *TOD*, *PSA*, *CPI*, *RGDP* and (ii) *exchange rate channel* for both full as well as sub-sample periods has used *RM*, *CPI*, *NEXR*, *EPR*, *IMP*, and *RGDP*. All the above mentioned time series variables have been adjusted for seasonality and used in log form.[33]

[31] Enders (1995) mentions that IRF analysis and VDCs together known as *innovation accounting* is a useful tool to investigate the relationships among macroeconomic variables.

[32] Till now GDP in Bangladesh has been calculated only on a yearly basis by BBS. However, to get parsimonious results on the existence of *bank lending* and *exchange rate channels*, quarterly *RGDP* (base year: 1995-96) at producer prices has been calculated from the available annual data. Since GDP in Bangladesh comprises of agriculture, industry, and services, quarterly contributions of these sectors have been estimated where seasonal factors are taken into accounts to reflect the agricultural as well as industrial production cycles. For the service sector, since there is very little seasonality in annual output, and therefore, it has been distributed equally into four quarters of each year in order to construct the quarterly *RGDP* series of Bangladesh for the period of July-September 1979 to April-June 2005. Details on the quarterly GDP estimation procedure are available from the authors on request.

[33] The seasonal adjustment has been done using *Census X12* procedure in *Econometric Views 4* package. This procedure has been developed by the U.S Census Bureau.

4.2 Empirical Evidence

The results of the unit root tests on the relevant macroeconomic variables have been reported in Table 7. Based on these results, it can be concluded that the variables, *RM*, *TOD*, *PSA*, *NEXR*, *IMP*, *RGDP*, and *CPI* are non-stationary and contain unit roots I(1). Conversely, the unit root tests suggest that the variable *EPR* is stationary, I(0). Finally, the estimated results of all the VAR models in terms of VDCs and IRFs have been presented in the next section.

Table 7: Unit Root Tests

	DF		**ADF**		**PP**		**KPSS**		**Decision**
Variables (in log levels)	Without trend	With trend	Without trend	With trend	Without trend	With trend	Without trend	With trend	
RM	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
TOD	I(0)	I(1)	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)	I(1)
PSA	I(1)	I(1)	I(0)	I(0)	I(0)	I(1)	I(1)	I(1)	I(1)
NEXR	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
EPR	I(0)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(0)
IMP	I(0)	I(1)	I(1)	I(1)	I(1)	I(0)	I(1)	I(0)	I(1)
RGDP	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
CPI	I(0)	I(0)	I(0)	I(1)	I(0)	I(1)	I(1)	I(1)	I(1)

Notes: 1. Lag length for DF tests have been decided on the basis of Schwartz's Information Criteria (SIC).
2. Lag length for ADF tests have been decided on the basis of Akaike's Information Criteria (AIC).
3. Maximum Bandwidth for PP and KPSS tests have been decided on the basis of Newey-West (1994).
4. All tests have been performed on the basis of 5-percent significance level using Econometric Views 4 Package.
5. The DF, ADF and PP tests are based on the null hypothesis of unit roots while the KPSS test assumes the null hypothesis of stationarity.

4.2.1 Bank Lending Channel (1979:3–2005:2)

The 5-variable VAR model regarding the existence of *bank lending channel* in Bangladesh has been estimated using quarterly data set for the period between July-September 1979 to April-June 2005 (i.e., full-sample period). Alongside, 6 lags of each variable have been used in the estimation as the optimal lag length that makes all the residuals of the model white noise (Annex 1.1).[34] The estimated VDCs and IRFs presented in Table 8 and Figure 3 have been generated through 1000 *Monte Carlo* random draws from the orthogonalized residuals.[35] In this connection, it is important to mention that the estimates of the forecast error variance are considered to be statistically significant if the point estimate is at least twice as large as the respective standard error. Besides, each IRF has been reported with a two-standard-deviation

[34] Although, AIC and *Likelihood Ratio* (LR) tests indicate 15 and 14 lags respectively as the optimal lag length, 6 lags have been considered in the estimation that make the residuals of the VAR model white noise, i.e., zero mean, constant variances, and individually serially uncorrelated. Besides, recursive residuals suggest stability in general in the parameters of the equations in the model although there are some minor episodes of instability (Annex 1.5).

[35] The standard errors of VDCs and the confidence bands of IRFs are generated using *Monte Carlo* simulations where 1000 random draws have been employed.

confidence interval (i.e., 95 percent confidence interval) level and a response is considered to be significant if it does not contain the zero line within its confidence bands (i.e., ± 2 s. e.).

VDCs presented in Table 8 for each variable at forecast horizons of 1 quarter through 16 quarters, i.e., 4 years, give the share of fluctuations in a given variable that are caused by shocks in other relevant variables as well as itself. The columns give the percentage of forecast error variance due to each shock, with each row adding up to 100 percent. The results indicate that the *RM* shock does not have any statistically significant explanatory power of predicting the movements in other variables (i.e., *TOD*, *PSA*, *CPI*, and *RGDP*) at any time horizon except for its own future path. Conversely, the shock in *PSA* has a statistically significant explanatory power of forecasting the movement in *TOD* starting with time horizon 8, i.e., year-2. In particular, *PSA* shock alone explains 19.35 percent of the forecast error variance of *TOD* at time horizon 16, i.e., year-4. Besides, *PSA* shock explains about 30 percent of the forecast error variance of *CPI* at time horizon 16, i.e., year-4. Finally, analysis of these results obtained from the VDCs for the full-sample period suggests that the existence of the overall *bank lending channel* in Bangladesh is *weak*, and therefore, not discernible in the empirical estimation of the paper.

Table 8: Variance Decompositions-Bank Lending Channel (1979:3–2005:2)

Quarter	*RM*	*TOD*	*PSA*	*CPI*	*RGDP*
Variance Decomposition of *RM*					
1	100.00*	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
4	85.03*	2.20	4.69	6.47	1.61
	(8.28)	(3.61)	(5.38)	(5.75)	(2.58)
8	72.06*	7.41	5.59	13.46	1.48
	(11.48)	(7.79)	(7.19)	(9.97)	(2.77)
12	63.92*	7.62	12.19	14.02	2.25
	(11.89)	(8.27)	(9.16)	(8.97)	(2.74)
16	51.42*	8.68	17.61	18.13	4.16
	(11.67)	(7.89)	(10.26)	(9.87)	(3.08)
Variance Decomposition of *TOD*					
1	0.00	100.00*	0.00	0.00	0.00
	(1.45)	(1.46)	(0.00)	(0.00)	(0.00)
4	1.22	85.72*	9.70	2.10	1.26
	(3.38)	(7.34)	(5.84)	(3.54)	(2.76)
8	2.73	77.40*	12.62*	4.50	2.75
	(3.98)	(7.85)	(5.83)	(4.28)	(3.17)
12	2.66	71.52*	16.90*	4.82	4.10
	(4.07)	(8.44)	(6.89)	(4.51)	(3.47)
16	2.75	68.25*	19.35*	4.74	4.91
	(4.31)	(9.13)	(7.86)	(4.69)	(3.73)
Variance Decomposition of *PSA*					
1	0.01	5.15	94.84*	0.00	0.00
	(1.47)	(4.59)	(4.79)	(0.00)	(0.00)
4	0.06	14.24	78.83*	3.36	3.51
	(2.90)	(9.18)	(10.01)	(3.66)	(3.30)
8	0.10	16.41	74.01*	5.04	4.44
	(4.50)	(12.36)	(13.68)	(6.95)	(4.45)
12	0.48	14.51	74.71*	4.28	6.02
	(5.56)	(12.69)	(14.59)	(8.03)	(5.18)
16	1.72	13.72	71.96*	5.20	7.40
	(6.47)	(12.64)	(14.88)	(8.43)	(5.45)

Variance Decomposition of *CPI*					
Quarter	*RM*	*TOD*	*PSA*	*CPI*	*RGDP*
4	3.82	2.06	7.61	86.26*	0.25
	(4.68)	(4.86)	(6.77)	(8.98)	(1.87)
8	6.64	3.54	9.82	77.19*	2.81
	(7.34)	(7.56)	(8.76)	(12.18)	(2.71)
12	7.07	4.53	16.95	68.42*	3.03
	(7.95)	(8.24)	(10.84)	(13.31)	(2.86)
16	6.17	6.44	29.83*	54.19*	3.37
	(7.72)	(8.60)	(12.46)	(13.26)	(2.96)
Variance Decomposition of *RGDP*					
1	0.65	0.39	6.26	2.15	90.55*
	(2.21)	(1.69)	(4.57)	(2.91)	(5.60)
4	2.38	6.83	5.61	4.74	80.44*
	(4.29)	(5.10)	(4.65)	(4.08)	(7.59)
8	4.08	5.38	10.83	5.47	74.24*
	(4.84)	(5.01)	(6.25)	(4.72)	(8.46)
12	3.47	5.29	10.29	6.64	74.31*
	(4.98	(5.64)	(7.07)	(6.37)	(9.66)
16	3.07	4.94	8.75	9.72	73.52*
	(5.36)	(6.08)	(7.06)	(8.43)	(10.77)
Cholesky Ordering: *RM TOD PSA CPI RGDP*					

Notes: 1. The first entry in each cell is the point estimate of the percentage of forecast error variance of variable 'i' as explained by shocks to variable 'j'. Monte Carlo simulated standard errors are reported in the parenthesis by employing 1000 random draws.

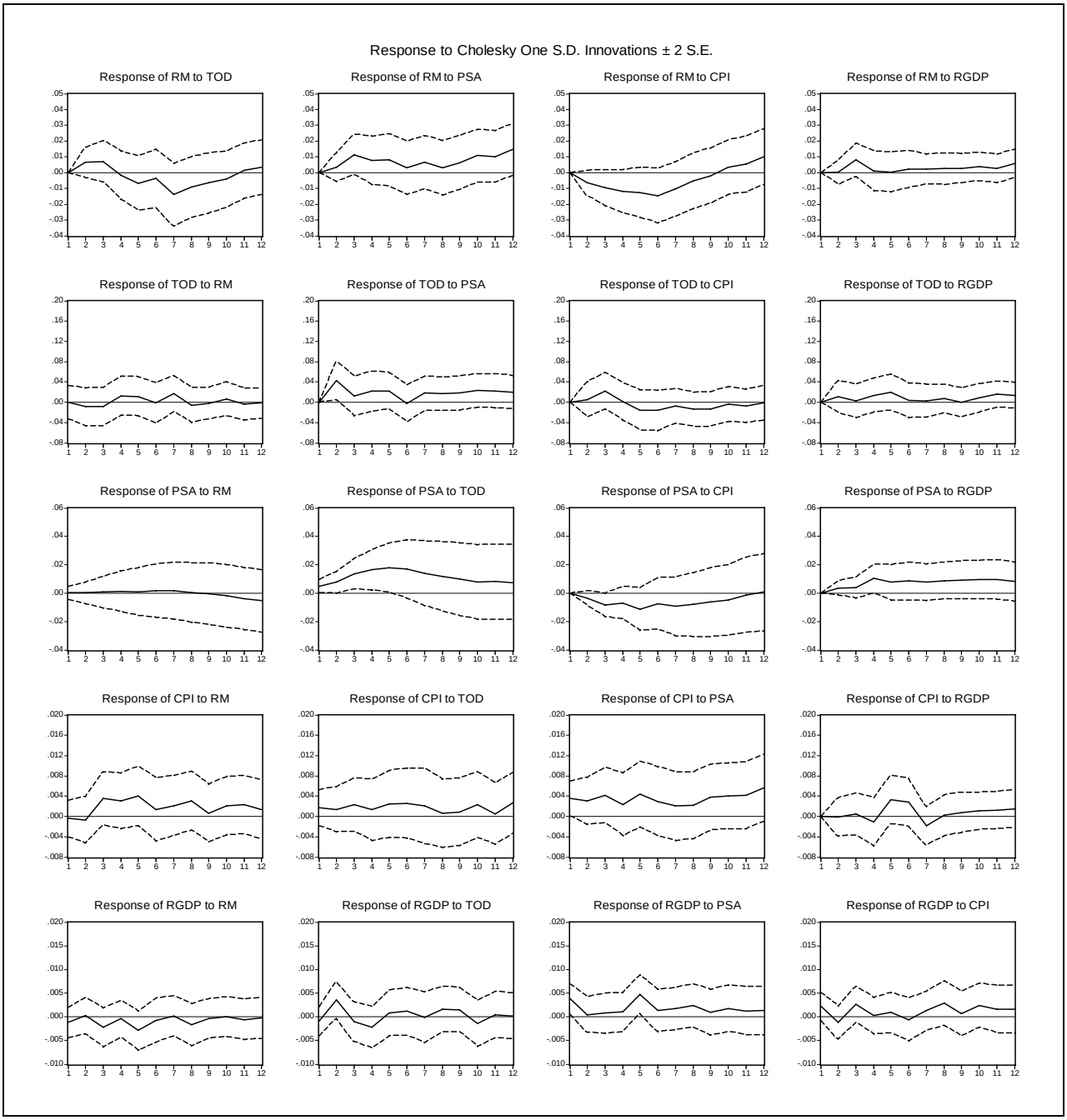
*2. * denotes the statistical significance of point estimates at 5-percent level assuming that the estimates are asymptotically normally distributed.*

The estimated IRFs presented in Figure 3 for the full-sample period show that the shock in *RM* has no statistically significant impact on *TOD* and *PSA* as well as *CPI* and RGDP which is very much in line with the outcome of VDCs. This in turn, indicates that the impact of reserve money shock has not been transmitted to aggregate output and prices through the portfolio (i.e., total deposits and private sector advances) of the scheduled banks in the country. The probable reasons could be excess liquidity position in the banking system which neutralizes the impact of reserve money shock on credit (Annex Table 1). Besides, bank lending (i.e., sum of advances and bills) by 4 NCBs as well as 5 SBs are not fully related to the shock in reserve money rather historically dispensed as *directed credit* at a *concessional rate*, especially, to the public sector. This is important, since their combined share in total credit is significant though declining in recent years (Annex Table 2). Moreover, the share of net government credit in the reserve money is significant over the years especially in the early 1980s and 2000s which causes *weak* policy response to the portfolio of the scheduled banks due to reserve money shock (Annex Table 3).

On the other hand, the shock in *PSA* has a significant and positive impact on *TOD* only up to the 2nd quarter and then dissipates over the rest of the periods indicating a short-run positive influence on *TOD*. Likewise, it is also noticeable that the shock in *TOD* has a significant and positive impact on *PSA* from 2nd to 5th quarter and then dissipates suggesting a short-run positive influence on *PSA*. It appears that private sector advances have risen in the face of increased availability of total deposits (i.e., sum of demand and time deposits) in the banking system of the country, a supply side phenomenon from the lenders' (i.e., scheduled banks) side. Moreover, *PSA* shock has a positive and significant impact on *CPI* only in the 1st quarter and then dissipates over the rest of the periods suggesting a very short-run positive influence on

CPI. It is therefore, noticeable that there is no *price puzzle* in the empirical model of the paper.[36]

Figure 3: Impulse Responses: Bank Lending Channel (1979:3–2005:2)



The response of *RGDP* to *PSA* shock is positive and significant only in the 1st quarter and then turns insignificant in the 2nd quarter, again becoming positive and significant only in the 5th quarter. Therefore, a very short-run positive relationship between *private sector investment* (as proxied by private sector advances) and aggregate output can be confirmed for the economy.

[36] The *price puzzle* arises when a contractionary or tight monetary policy shock is followed by a rise in the price level where the effect is small and temporary (i.e., hardly statistically significant) but still puzzling (Walsh, 2003, p. 29).

Since the private sector has been growing faster due to the economic liberalization policy adopted by the Government of Bangladesh (GOB) from the late 1980s, a positive and significant relationship between *private sector investment* and aggregate output is expected to exist in the economy.

In conclusion, the results derived from the IRFs for the full-sample period suggest that the existence of the overall *bank lending channel* in the economy is *weak* due to reasons already explained before.[37] Besides, although most of the financial data (i.e., reserve money, total deposits, and private sector advances etc.) are well structured in time frequency (e.g., monthly, quarterly, and yearly) but real sector data (i.e., aggregate output, *CPI* inflation) are not well structured in time frequency, which may have caused a *weak* existence of the overall *bank lending channel* in Bangladesh. These results have some important policy implications with respect to the restrained or accommodative policy stance in controlling inflation, the prime objective of the BB. Generally, tight monetary policy shrinks the volume of private sector credit, though credit demand has been found to be *weakly* responsive to respective real rates from the lenders' point of view in the short-run (Ahmed and Islam, 2006).

4.2.2 Bank Lending Channel (1990:1–2005:2)

To further examine the presence of *bank lending channel* in the Bangladesh economy, the above 5-variable VAR model has also been estimated using quarterly data set for the period between January-March 1990 to April-June 2005 (i.e., the sub-sample period).[38] Estimated VDCs (i.e., for each variable at forecast horizons of 1 through 16 quarters) and IRFs presented in Table 9 and Figure 4, respectively, have been generated through 1000 *Monte Carlo* random draws from the orthogonalized residuals.[39] The results of the empirical analysis for the sub-sample period again suggest that the movement in *RM* does not contain any information about the movements in other variables (i.e., *TOD*, *PSA*, *CPI*, and *RGDP*) at any time horizon except for its own future path.

Table 9: Variance Decompositions-Bank Lending Channel (1990:1–2005:2)

Variance Decomposition of *RM*					
Quarter	*RM*	*TOD*	*PSA*	*CPI*	*RGDP*
1	100.00*	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
4	74.80*	3.87	7.66	9.66	4.01
	(11.69)	(5.50)	(7.92)	(8.25)	(4.51)
8	64.52*	5.42	18.13	7.67	4.26
	(14.63)	(7.72)	(12.66)	(8.48)	(5.16)
12	53.11*	4.55	22.81	16.15	3.38
	(14.44)	(7.80)	(13.83)	(11.15)	(4.79)
16	47.50*	4.59	20.34	24.13	3.44
	(14.42)	(8.18)	(13.63)	(13.51)	(4.86)

[37] The results regarding the existence of *bank lending channel* for the full-sample period remain the same as those of alternative ordering of the relevant variables including some radical ones such as reversing the order completely.

[38] Though, AIC and LR tests indicate 8 and 3 lags respectively as the optimal lag length, 5 lags have been considered in the estimation that make the residuals of the 5-variable VAR model white noise (Annex 1.2). In addition, recursive residuals suggest stability in general in the parameters of the equations in the model even though there are some minor episodes of instability (Annex 1.6).

[39] The standard errors of VDCs and the confidence bands of IRFs are generated using *Monte Carlo* simulations with 1000 random draws.

Quarter	*RM*	*TOD*	*PSA*	*CPI*	*RGDP*
Variance Decomposition of *TOD*					
1	0.96	99.04*	0.00	0.00	0.00
	(3.57)	(3.57)	(0.00)	(0.00)	(0.00)
4	2.05	70.55*	11.49	15.25	0.66
	(5.33)	(9.85)	(7.65)	(8.06)	(3.69)
8	4.15	63.59*	14.38	15.59*	2.29
	(6.34)	(10.05)	(7.69)	(7.76)	(4.94)
12	4.37	61.47*	16.09*	15.40	2.67
	(6.84)	(10.36)	(8.04)	(7.88)	(5.35)
16	5.27	59.95*	16.36	15.69	2.72
	(7.51)	(11.04)	(8.55)	(8.34)	(5.87)
Variance Decomposition of *PSA*					
1	0.54	1.89	97.57*	0.00	0.00
	(3.09)	(3.86)	(4.90)	(0.00)	(0.00)
4	2.21	1.32	88.59*	5.64	2.24
	(6.19)	(6.03)	(10.45)	(6.98)	(3.81)
8	6.64	1.33	82.11*	4.83	5.09
	(9.39)	(7.47)	(13.30)	(8.18)	(6.04)
12	16.71	0.94	71.68*	3.70	6.97
	(12.89)	(7.48)	(15.18)	(8.91)	(7.27)
16	21.39	1.14	66.35*	3.06	8.06
	(14.35)	(8.11)	(16.64)	(9.37)	(8.19)
Variance Decomposition of *CPI*					
1	0.06	1.35	2.54	96.05*	0.00
	(2.55)	(3.61)	(3.90)	(5.85)	(0.00)
4	1.01	3.00	5.94	89.26*	0.79
	(5.76)	(6.39)	(8.25)	(11.09)	(2.75)
8	1.96	2.87	5.38	85.58*	4.21
	(7.86)	(7.12)	(9.02)	(12.89)	(4.39)
12	4.86	2.77	10.33	76.28*	5.76
	(8.99)	(7.18)	(9.94)	(12.95)	(5.07)
16	5.73	2.86	13.05	71.74*	6.62
	(9.37)	(7.43)	(10.94)	(13.17)	(5.57)
Variance Decomposition of *RGDP*					
1	3.11	1.89	11.41	0.34	83.25*
	(4.69)	(4.26)	(7.14)	(2.25)	(8.72)
4	5.38	13.99	12.80	5.45	62.38*
	(6.37)	(8.07)	(7.18)	(6.30)	(9.44)
8	6.17	10.84	20.08*	9.82	53.09*
	(6.62)	(7.48)	(8.78)	(7.43)	(9.39)
12	7.18	9.39	23.18*	9.73	50.52*
	(7.80)	(7.94)	(10.39)	(8.48)	(10.16)
16	7.62	8.05	28.89*	8.53	46.91*
	(8.82)	(8.47)	(12.00)	(9.14)	(10.91)
Cholesky Ordering: *RM TOD PSA CPI RGDP*					

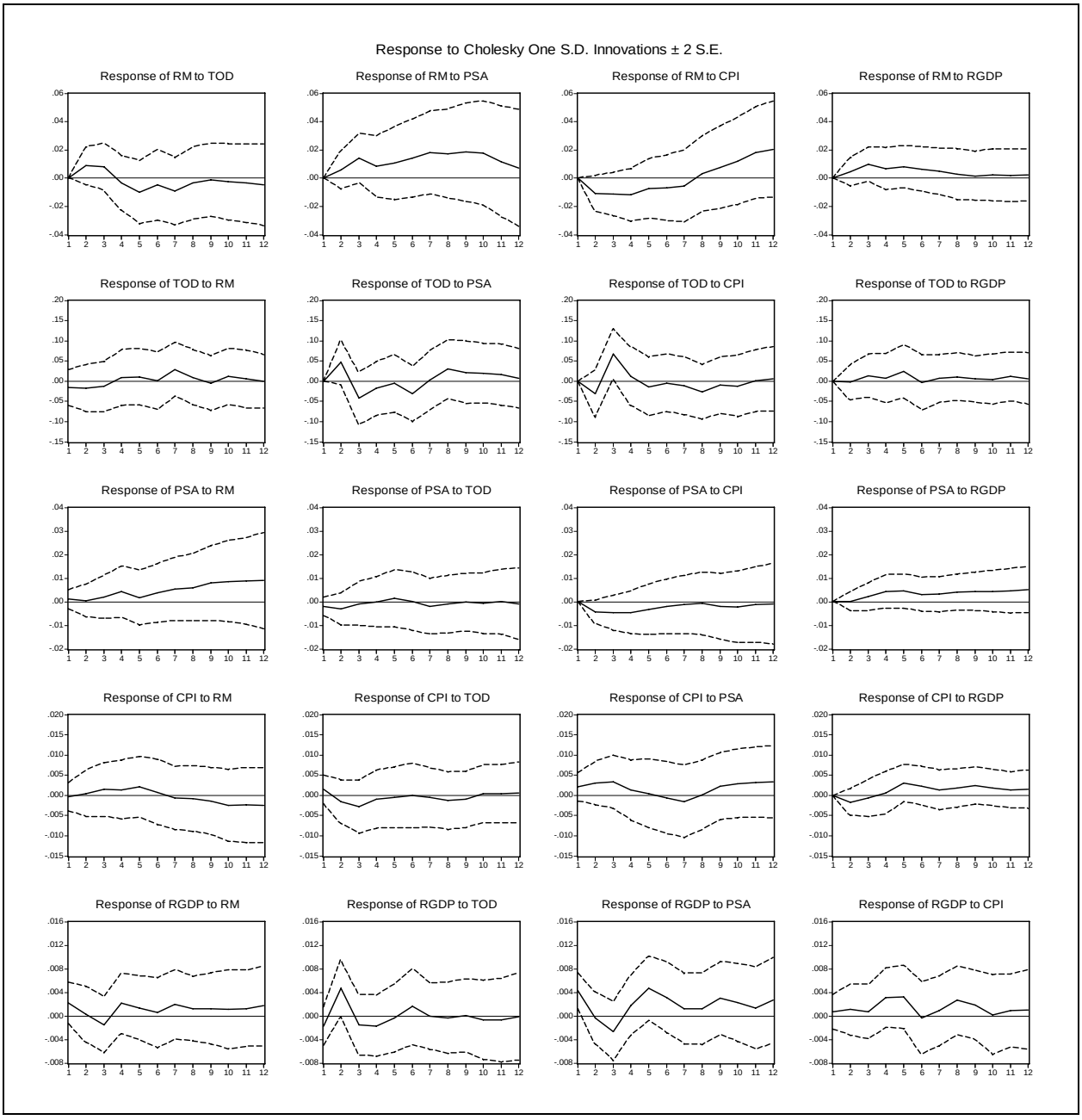
Notes: 1. The first entry in each cell is the point estimate of the percentage of forecast error variance of variable 'i' as explained by shocks to variable 'j'. Monte Carlo simulated standard errors are reported in the parenthesis by employing 1000 random draws.

*2. * denotes the statistical significance of point estimates at 5-percent level assuming that the estimates are asymptotically normally distributed.*

On the other hand, the shock in *PSA* has a statistically significant explanatory power of predicting the movement in *TOD* only at year-3, explaining about 16 percent of the forecast error variance of total deposits. Besides, *CPI* shock significantly explains about 16 percent of the forecast error variance of *TOD* only at time horizon 8, i.e., year-2. Furthermore, *PSA* shock

has a statistically significant influence over predicting the movement in *RGDP* starting time horizon 8, i.e., from year 2 to 4. In particular, *PSA* shock alone explains about 29 percent of the forecast error variance of aggregate output in year-4. These results derived from the VDCs for the sub-sample period again confirm that the overall *bank lending channel* in Bangladesh is *weak*.

Figure 4: Impulse Responses: Bank Lending Channel (1990:1–2005:2)



Estimated IRFs for the sub-sample period (i.e., January-March 1990 to April-June 2005) presented in Figure 4 show that the *RM* shock has no statistically significant impact on *TOD*, *PSA*, *CPI*, and finally, *RGDP*. This again suggests that the reserve money shock has no influence on aggregate output and prices through the portfolio of the scheduled banks due to reasons already explained for the full-sample period in the preceding section. On the other hand, the shock in *CPI* has a positive and significant impact on *TOD* only in the 3rd quarter and

then dissipates suggesting a very short-run positive influence on total deposits. This is expected since increases in the price level lead to increases in nominal income (i.e., nominal wages) which in turn are likely to raise total deposits in the scheduled banks of the country.

Besides, the shock in *PSA* has a significant and positive impact on *RGDP* only in the 1st quarter and then dissipates over the rest of the periods. Hence, a very short-run positive relationship between *private sector investment* as proxied by private sector advances and aggregate output exists in the economy. Lastly, these results derived from the IRFs for the sub-sample period also suggest that the existence of the overall *bank lending channel* in the economy is *weak*.[40]

4.3.1 Exchange Rate Channel (1979:3–2005:2)

In order to investigate the existence of *exchange rate channel* in Bangladesh, the 6-variable VAR model has been estimated using quarterly data set for the period between July-September 1979 to April-June 2005 (i.e., full-sample period) with an optimal lag of 6 for each variable in the model.[41] The estimated VDCs and IRFs reported in Table 10 and Figure 5 have been generated through 1000 *Monte Carlo* simulations from the orthogonalized residuals.[42] The empirical results for the full-sample period suggest that the shock in *RM* has no statistically significant influence over predicting the movements in other variables (i.e., *CPI*, *NEXR*, *EPR*, *IMP*, and *RGDP*) at any time horizon except for its own future path.

Table 10: Variance Decompositions-Exchange Rate Channel (1979:3–2005:2)

Quarter	*RM*	*CPI*	*NEXR*	*EPR*	*IMP*	*RGDP*
Variance Decomposition of *RM*						
1	100.00*	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
4	92.82*	1.42	2.48	1.74	1.03	0.51
	(7.18)	(3.49)	(4.10)	(3.70)	(2.67)	(2.30)
8	88.54*	3.49	2.27	3.69	1.48	0.53
	(11.55)	(6.99)	(5.19)	(7.32)	(4.95)	(2.73)
12	79.83*	3.78	9.79	3.51	2.09	1.00
	(12.19)	(7.69)	(7.44)	(8.26)	(5.63)	(2.76)
16	67.87*	11.69	12.86	3.32	3.12	1.14
	(11.77)	(9.89)	(7.99)	(8.69)	(5.77)	(2.68)
Variance Decomposition of *CPI*						
1	0.03	99.97*	0.00	0.00	0.00	0.00
	(1.45)	(1.45)	(0.00)	(0.00)	(0.00)	(0.00)
4	2.79	84.64*	9.66	0.99	1.34	0.58
	(4.00)	(8.39)	(6.45)	(2.62)	(2.26)	(2.35)
8	6.16	79.65*	9.46	1.05	2.74	0.94
	(7.12)	(11.93)	(7.85)	(5.41)	(4.13)	(2.58)
12	7.81	75.91*	10.58	1.54	3.27	0.89
	(8.31)	(14.37)	(9.52)	(8.29)	(6.08)	(2.80)
16	9.39	70.67*	12.23	2.31	4.54	0.86
	(8.94)	(15.39)	(10.52)	(10.57)	(7.29)	(2.95)

[40] The results for the sub-sample period remain the same as those of alternative ordering of the relevant variables including some radical ones such as inverting the order of the variables completely.

[41] Although, AIC and LR tests indicate 12 and 9 lags respectively as the optimal lag length, 6 lags have been considered in the estimation that makes the residuals of the 6-variable VAR model almost white noise (Annex 1.3). Besides, recursive residuals suggest stability in general in the parameters of the equations in the model while there are some minor episodes of instability (Annex 1.7).

[42] The standard errors of VDCs and the confidence bands of IRFs are generated using *Monte Carlo* simulations where 1000 random draws have been employed.

Variance Decomposition of *NEXR*						
Quarter	*RM*	*CPI*	*NEXR*	*EPR*	*IMP*	*RGDP*
1	5.33	0.89	93.78*	0.00	0.00	0.00
	(4.41)	(2.27)	(4.89)	(0.00)	(0.00)	(0.00)
4	9.93	2.96	79.09*	4.25	3.39	0.38
	(7.98)	(3.51)	(9.83)	(4.95)	(3.63)	(1.99)
8	9.10	13.29	59.33*	3.48	14.34	0.46
	(8.17)	(9.39)	(12.69)	(5.78)	(9.61)	(2.40)
12	6.71	31.39*	43.04*	2.97	14.33	1.56
	(7.34)	(13.61)	(12.43)	(7.11)	(9.94)	(2.88)
16	5.94	36.69*	37.57*	2.65	13.72	3.43
	(7.19)	(14.32)	(12.03)	(8.87)	(9.52)	(3.66)
Variance Decomposition of *EPR*						
1	0.01	1.958	3.09	94.92*	0.00	0.00
	(1.50)	(2.93)	(3.87)	(4.89)	(0.00)	(0.00)
4	0.54	1.74	6.77	88.97*	0.91	1.07
	(3.68)	(3.45)	(4.91)	(7.61)	(3.02)	(3.31)
8	0.73	2.39	6.95	86.25*	1.86	1.82
	(4.74)	(5.24)	(5.30)	(9.67)	(4.39)	(3.40)
12	0.94	3.51	6.89	84.25*	1.84	2.57
	(5.44)	(7.54)	(5.99)	(11.47)	(5.05)	(3.81)
16	0.91	4.20	6.68	82.86*	2.06	3.29
	(5.69)	(8.74)	(6.35)	(12.50)	(5.43)	(4.17)
Variance Decomposition of *IMP*						
1	0.02	3.10	0.00	12.11*	84.77*	0.00
	(1.39)	(3.69)	(1.48)	(5.71)	(6.76)	(0.00)
4	2.35	2.22	9.58	28.95*	56.35*	0.55
	(4.39)	(3.49)	(6.81)	(9.63)	(9.04)	(2.49)
8	9.46	3.11	11.87	30.05*	41.95*	3.56
	(7.55)	(4.99)	(7.74)	(10.51)	(8.17)	(3.24)
12	9.97	3.73	11.67	27.97*	42.15*	4.51
	(7.47)	(5.86)	(7.45)	(10.36)	(8.35)	(3.67)
16	9.99	4.22	12.29	27.47*	41.14*	4.89
	(7.15)	(6.78)	(7.23)	(10.58)	(8.37)	(3.87)
Variance Decomposition of *RGDP*						
1	0.14	4.14	0.49	0.32	0.42	94.49*
	(1.63)	(4.03)	(1.90)	(1.77)	(1.73)	(5.05)
4	1.92	4.53	7.24	0.93	3.90	81.48*
	(3.88)	(4.35)	(5.69)	(3.45)	(4.42)	(8.05)
8	4.29	4.24	6.73	8.68	6.48	69.58*
	(4.99)	(4.86)	(5.60)	(6.72)	(5.77)	(9.18)
12	3.84	3.86	8.50	14.10	7.55	62.15*
	(5.39)	(5.59)	(6.95)	(9.94)	(6.67)	(10.56)
16	3.50	3.21	10.15	19.26	6.92	56.96*
	(5.78)	(6.48)	(8.12)	(12.79)	(7.07)	(11.99)
Cholesky Ordering: *RM CPI NEXR EPR IMP RGDP*						

Notes: 1. The first entry in each cell is the point estimate of the percentage of forecast error variance of variable 'i' as explained by shocks to variable 'j'. Monte Carlo simulated standard errors are reported in the parenthesis by employing 1000 random draws.

*2. * denotes the statistical significance of point estimates at 5-percent level assuming that the estimates are asymptotically normally distributed.*

However, the shock in *CPI* has a statistically significant explanatory power of forecasting the movement in *NEXR* (i.e., BDT/USD) starting time horizon 12, i.e., year-3. Particularly, *CPI* shock alone explains about 37 percent of the forecast error variance of nominal exchange rate in year-4. Conversely, the shock in *EPR* has a statistically significant influence over predicting

the movement in *IMP* over all time horizons though not vice versa. For instance, the *EPR* shock alone explains about 30 percent of the forecast error variance of imports in year-2 with the magnitude remaining stable between the 4 quarters on. Analysis of the results derived from the VDCs for the full-sample period suggests that the existence of the overall *exchange rate channel* in the country is *weak*, and thus, not captured in the empirical estimation of the paper.

The estimated IRFs presented in Figure 5 for the full-sample period (i.e., July-September 1979 to April-June 2005) show that the shock in *RM* has no statistically significant impact on *CPI* as well as *EPR*, *IMP*, and *RGDP* except for *NEXR*. This in turn, suggests that prices and aggregate output in the economy have not been influenced by the reserve money shock. The contributing reason behind these results would appear that the monetary policy framework under the fixed exchange rate regime for a considerable length of time in the full-sample period (i.e., up to 31 May, 2003) where reserve money as a policy variable has been unable to explain the monetary transmission mechanism through the *exchange rate channel* in Bangladesh. However, *RM* shock has a negative and significant impact on *NEXR* (i.e., BDT/USD) only in the 1st quarter and then dissipates over the rest of the periods. This is an interesting finding since it partly confirms the claims by many economists as well as policy makers regarding the overvalued exchange rate under the fixed exchange rate regime in Bangladesh (Ahmed, 2006).[43]

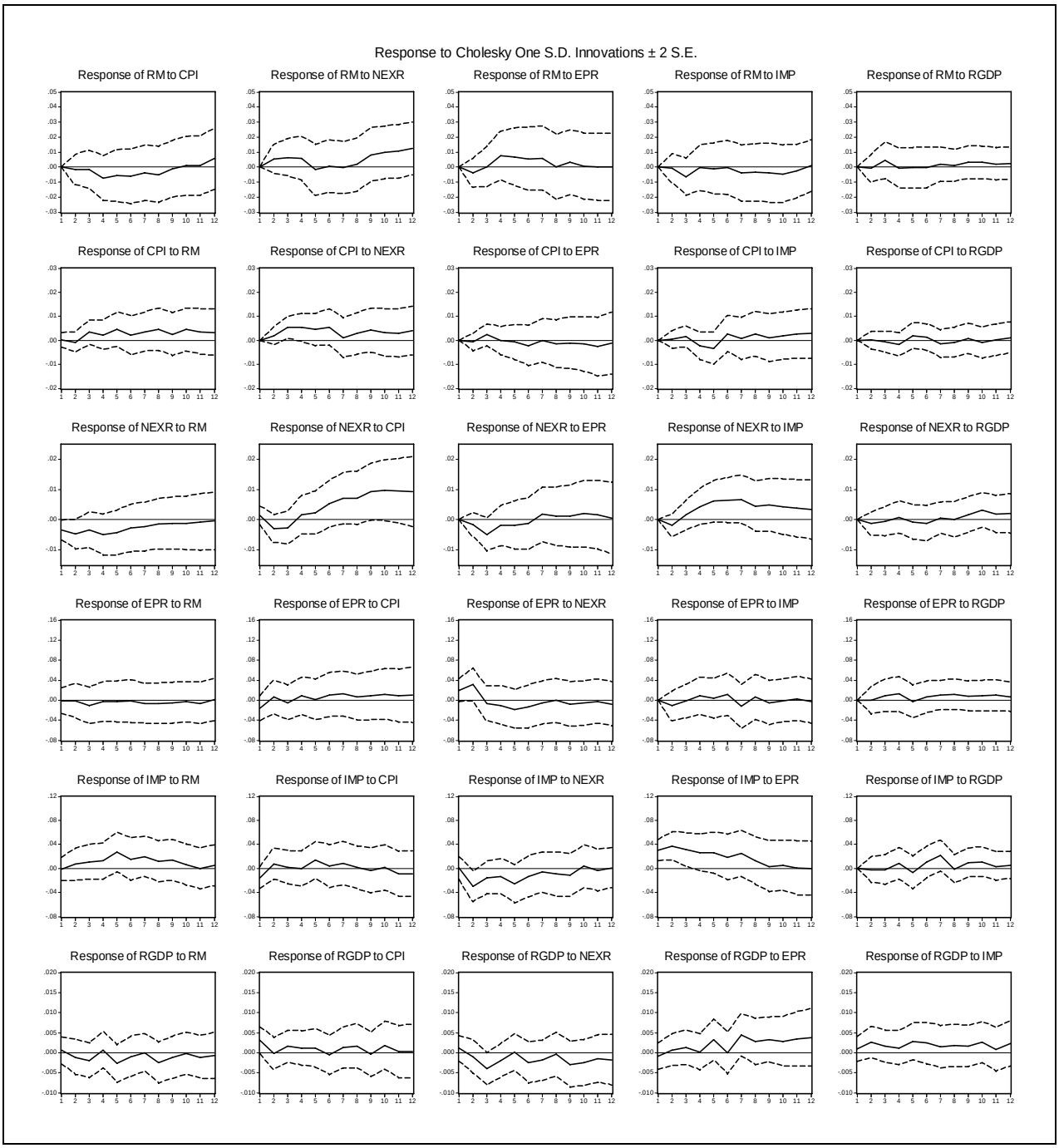
On the other hand, the shock in *NEXR* has a significant and positive impact on *CPI* only in the 3rd quarter indicating a very short-run positive influence on *CPI*. Besides, the response of *IMP* to *NEXR* shock is insignificant in the 1st quarter and then turns negative and significant in the 2nd quarter and then becomes insignificant over the rest of the periods. This confirms the existence of the general relationship between the appreciation/depreciation of nominal exchange rates and imports in Bangladesh. It is also observable that the shock in *EPR* has a significant and positive impact on *IMP* from 1st to 3rd quarter and then dissipates suggesting a short-run positive influence on *IMP*. It matches the actual export-import structure of Bangladesh where exports mostly depend on imported capital machineries, raw materials, etc. In conclusion, the IRFs obtained for the full-sample period (i.e., July-September 1979 to April-June 2005) suggest that the existence of the overall *exchange rate channel* in Bangladesh is *weak* due to reasons already explained above.[44] However, following the move from a fixed exchange rate to floating regime, the recent experience of volatility in the foreign exchange market perhaps indicates the working of the overall *exchange rate channel* in the economy under the monetary policy framework pursued by the BB.[45]

[43] Overvalued exchange rate of domestic currency in a small open economy hurts exports and tends to increase imports (Ahmed, 2006).

[44] The results for the full-sample period remain the same as those of alternative ordering of the relevant variables including some radical ones such as inverting the order completely.

[45] The existence of the overall *exchange rate channe*l in an economy mainly depends on the degree of openness, the responsiveness of the exchange rate to monetary policy shocks, and the sensitivity of net exports to exchange rate fluctuations.

Figure 5: Impulse Responses: Exchange Rate Channel (1979:3–2005:2)



4.3.2 Exchange Rate Channel (1990:1–2005:2)

The above 6-variable VAR model regarding the overall *exchange rate channel* in the country has also been re-examined using quarterly data for the period between January-March 1990 to April-June 2005 (i.e., the sub-sample period) with an optimal lag of 5 for each variable.[46] The

[46] Even though, AIC and LR tests indicate 8 and 7 lags respectively as the optimal lag length, 5 lags have been considered in the estimation that makes the residuals of the VAR model almost white noise. In addition, recursive residuals suggest stability in general in the parameters of the equations in the model although there are some minor episodes of instability (Annex 1.8).

computed VDCs and IRFs presented in Table 11 and Figure 6 have been generated through *Monte Carlo* simulations from the orthogonalized residuals.[47] The results obtained for the sub-sample period again indicate that the *RM* shock does not have any statistically significant explanatory power of predicting the movements in *CPI*, *EPR*, and *RGDP* at any time horizon. However, the shock in *RM* has a significant influence over predicting the movement in *NEXR* (i.e., BDT/USD) only at time horizon 8 and *IMP* starting time horizon 8 as well as its own future path starting the very first quarter. For instance, *RM* shock alone explains about 35 percent and more than 50 percent of the forecast error variances of nominal exchange rates in year-2 and of imports in year-3 respectively.

The movement in *RGDP*, on the other hand has a statistically significant explanatory power of forecasting the future path of *CPI* starting time horizon 8 as well as *NEXR* starting time horizon 12. Specifically, the shock in *RGDP* explains about 16 percent and 14 percent of the forecast error variances of price level and nominal exchange rate in year-4, respectively. Besides, the movement in *CPI* alone significantly explains 26.06 percent of the forecast error variance of *NEXR* only in year-4. Analysis of these results obtained from the VDCs for the sub-sample period again implies that the existence of the overall *exchange rate channel* in Bangladesh is *weak*.

Table 11: Variance Decompositions-Exchange Rate Channel (1990:1–2005:2)

Quarter	*RM*	*CPI*	*NEXR*	*EPR*	*IMP*	*RGDP*
Variance Decomposition of *RM*						
1	100.00*	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
4	89.87*	4.79	2.14	0.47	0.74	1.99
	(11.13)	(7.93)	(5.24)	(4.14)	(3.85)	(3.31)
8	80.35*	7.38	3.75	2.96	3.87	1.69
	(15.20)	(10.71)	(7.16)	(8.97)	(6.89)	(3.58)
12	75.71*	7.63	5.16	5.69	3.88	1.93
	(15.29)	(10.86)	(7.54)	(11.52)	(6.99)	(3.78)
16	67.08*	10.58	4.99	10.04	4.29	3.02
	(15.58)	(11.65)	(7.24)	(13.18)	(7.25)	(4.22)
Variance Decomposition of *CPI*						
1	1.02	98.98*	0.00	0.00	0.00	0.00
	(3.18)	(3.18)	(0.00)	(0.00)	(0.00)	(0.00)
4	0.97	74.46*	5.42	2.77	11.99	4.39
	(5.79)	(11.46)	(6.99)	(4.21)	(8.38)	(4.19)
8	3.49	57.91*	2.95	5.66	16.85	13.14*
	(9.99)	(14.84)	(6.37)	(8.92)	(10.33)	(6.42)
12	3.19	55.39*	2.68	8.35	15.19	15.20*
	(11.56)	(14.87)	(6.49)	(12.16)	(9.14)	(6.62)
16	4.48	53.94*	2.57	8.14	14.99	15.88*
	(13.29)	(14.59)	(7.01)	(13.16)	(8.99)	(6.49)
Variance Decomposition of *NEXR*						
1	4.76	3.83	91.41*	0.00	0.00	0.00
	(5.50)	(5.07)	(7.14)	(0.00)	(0.00)	(0.00)
4	16.62	8.04	59.31*	1.98	3.80	10.25
	(11.96)	(8.70)	(13.14)	(4.79)	(5.54)	(5.90)
8	34.51*	8.99	39.28*	3.43	3.84	9.95
	(16.32)	(8.78)	(11.82)	(7.26)	(5.74)	(5.67)

[47] The standard errors of VDCs and the confidence bands of IRFs are generated using 1000 *Monte Carlo* simulations.

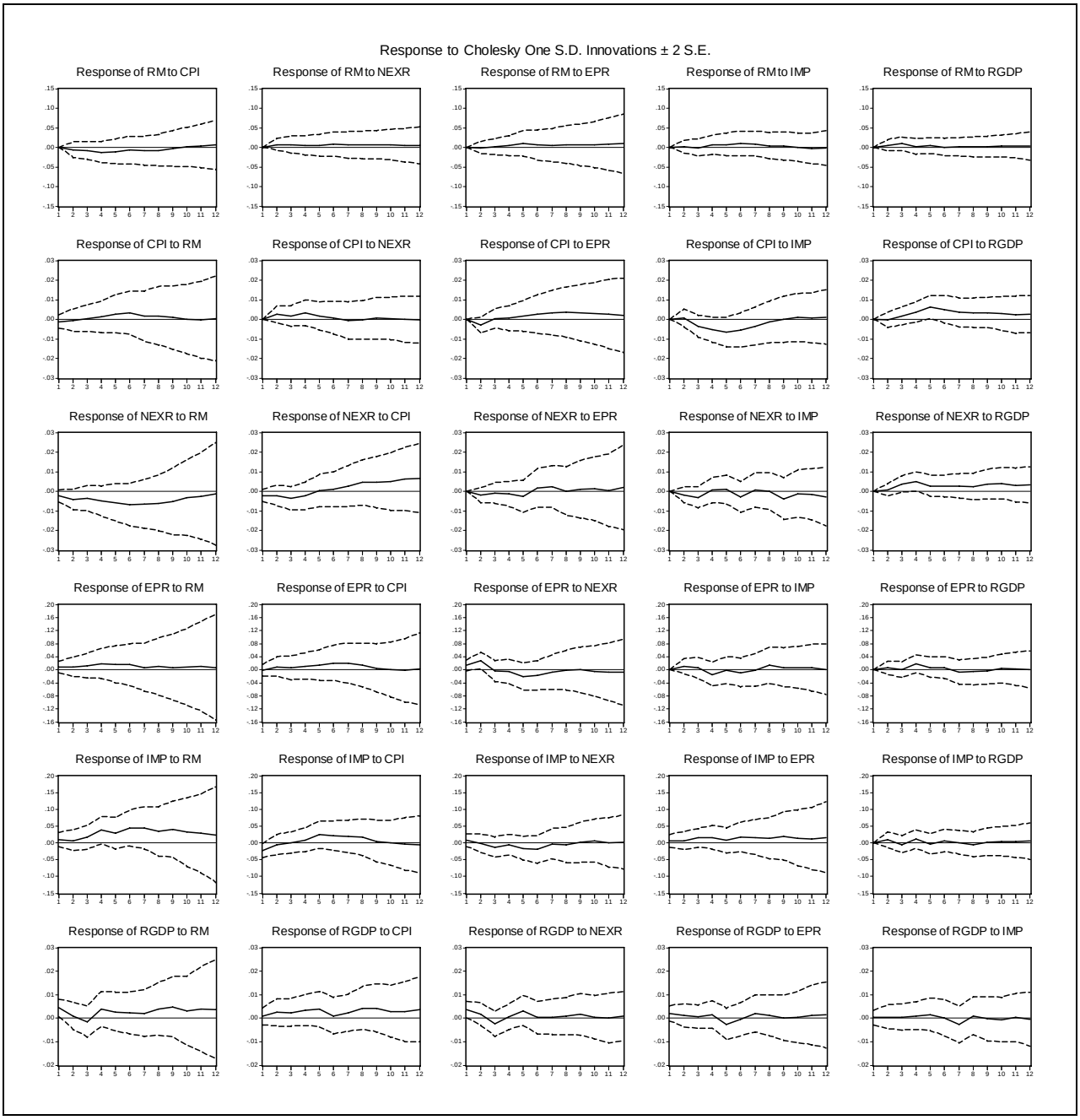
Quarter	*RM*	*CPI*	*NEXR*	*EPR*	*IMP*	*RGDP*
12	29.86	20.46	28.30*	3.18	5.69	12.51*
	(16.13)	(12.53)	(9.60)	(9.30)	(6.85)	(5.93)
16	27.52	26.06*	24.18*	3.52	4.88	13.84*
	(15.44)	(13.02)	(8.98)	(11.39)	(6.96)	(5.86)
Variance Decomposition of *EPR*						
1	1.98	0.16	4.82	93.04*	0.00	0.00
	(4.43)	(2.45)	(5.28)	(6.93)	(0.00)	(0.00)
4	5.86	2.24	9.36	76.27*	3.18	3.09
	(8.98)	(6.17)	(6.53)	(12.29)	(4.67)	(4.39)
8	5.67	6.65	8.11	74.59*	2.69	2.29
	(11.02)	(9.81)	(6.45)	(14.68)	(5.50)	(3.76)
12	5.53	5.47	7.07	77.34*	2.62	1.97
	(13.06)	(10.55)	(7.02)	(16.36)	(6.45)	(4.33)
16	5.69	4.67	6.02	78.74*	3.04	1.82
	(14.65)	(11.43)	(7.44)	(17.59)	(7.04)	(4.94)
Variance Decomposition of *IMP*						
1	1.67	9.37	1.19	0.57	87.22*	0.00
	(3.82)	(6.96)	(3.19)	(2.63)	(8.09)	(0.00)
4	20.99	7.01	3.07	6.27	60.17*	2.49
	(10.66)	(6.39)	(5.04)	(6.83)	(10.20)	(4.32)
8	42.36*	12.68	5.32	7.19	30.77*	1.68
	(14.18)	(8.62)	(6.16)	(8.03)	(8.77)	(3.66)
12	50.03*	10.07	4.34	9.91	24.10*	1.55
	(15.89)	(9.04)	(6.39)	(10.65)	(8.87)	(4.18)
16	48.46*	9.55	4.45	12.95	23.15*	1.44
	(15.89)	(10.19)	(6.94)	(12.93)	(9.49)	(4.71)
Variance Decomposition of *RGDP*						
1	10.00	0.31	6.74	2.02	0.04	80.89*
	(6.97)	(2.53)	(5.90)	(3.71)	(1.85)	(8.60)
4	14.81	9.22	8.65	3.02	0.61	63.69*
	(8.95)	(8.05)	(6.22)	(4.69)	(4.73)	(9.32)
8	17.13	15.72	8.26	5.00	3.16	50.73*
	(10.23)	(9.30)	(6.62)	(5.88)	(5.72)	(8.66)
12	23.15	19.88	6.62	4.24	2.47	43.64*
	(13.08)	(10.69)	(7.08)	(7.89)	(6.23)	(9.35)
16	26.49	21.49	5.73	4.26	2.04	39.99*
	(14.59)	(11.65)	(7.59)	(10.38)	(7.06)	(9.97)
Cholesky Ordering: *RM CPI NEXR EPR IMP RGDP*						

Notes: 1. The first entry in each cell is the point estimate of the percentage of forecast error variance of variable 'i' as explained by shocks to variable 'j'. Monte Carlo simulated standard errors are reported in the parenthesis by employing 1000 random draws.

*2. * denotes the statistical significance of point estimates at 5-percent level assuming that the estimates are asymptotically normally distributed.*

The computed IRFs presented in Figure 6 for the sub-sample period (i.e., January-March 1990 to April-June 2005) show that the shock in *RM* has no statistically significant impact on *CPI*, *EPR*, *IMP* as well as *NEXR* except for *RGDP*. In particular, the response of aggregate output to reserve money shock is positive and significant only in the 1st quarter and then turns insignificant over the rest of the periods. Thus, aggregate output in the economy has been influenced by the reserve money shock (i.e., monetary policy shock) for a short while. However, the price level remains independent of the reserve money shock partially due to supply side bottlenecks other than monetary phenomenon in the empirical estimation.

Figure 6: Impulse Responses: Exchange Rate Channel (1990:1–2005:2)



The shock in *RGDP* has a significant and positive impact on *CPI* only in the 5th quarter indicating a very short-run positive influence (with lag effect) on *CPI*. Besides, the response of *CPI* to *IMP* shock is negative and significant in the 1st quarter and then becomes insignificant over the rest of the periods. It is also noticeable that the shock in *NEXR* has a significant and positive impact on *EPR* only in the 2nd quarter suggesting a very short-run positive impact on *EPR*. This supports the existence of the general relationship between the appreciation/depreciation of nominal exchange rates and export competitiveness in the economy. Finally, the IRFs for the sub-sample period again confirm that the existence of the

overall *exchange rate channel* in Bangladesh is *weak* mainly due to reasons already explained for the full-sample period in the preceding section.[48]

5. Conclusion

In view of changes in legal, institutional and policy frameworks in the financial system of Bangladesh under the FSRP initiated in the early 1990s, the paper attempted to empirically investigate whether *bank lending* and *exchange rate channels* exist in the economy through which monetary policy changes can influence aggregate output and prices. An assessment of the empirical evidence has been performed through a sophisticated macro-econometric framework, namely, the unrestricted VARs approach using a quarterly data set in the relevant time series variables. Major findings are summarized as follows:

- *Bank Lending Channel (1979:3–2005:2)*: VDCs indicate that reserve money has no explanatory power of forecasting the movements in other variables while private sector advances is an important variable for predicting the movements in total deposits as well as prices starting year 2-and year-4 receptively. On the other hand, IRFs show that total deposits, private sector advances, aggregate output and prices are non-responsive to reserve money which is very much in line with the outcome of VDCs. Besides, total deposits respond positively to private sector advances only up to the 2nd quarter and private sector advances reacts positively to total deposits from 2nd to 5th quarter. Moreover, prices respond positively to private sector advances only in the 1st quarter and then dissipate. The response of aggregate output to private sector advances is positive in the 1st and 4th quarters.

- *Bank Lending Channel (1990:1–2005:2)***:** The results from VDCs again suggest that the movement in reserve money does not contain any information about the movements in other variables. Conversely, private sector advances and prices have significant explanatory power of predicting the movement in total deposits only at year-3 and year-2 respectively. Moreover, private sector advances has a significant influence in predicting the movement in aggregate output starting year-2. The IRFs show that total deposits, private sector advances, aggregate output and prices are non-responsive to reserve money. On the other hand, total deposits respond positively to prices in the 3rd quarter and private sector advances responds positively to aggregate output only in the 1st quarter.

- *Exchange Rate Channel (1979:3–2005:2)*: Estimated VDCs suggest that reserve money has no influence in predicting the movements in other variables. However, price level has a significant explanatory power of forecasting the movement in nominal exchange rate (i.e., BDT/USD) starting year-3. Besides, exports have a significant influence in predicting the movement in imports over all time periods. On the other hand, IRFs show that nominal exchange rate reacts negatively to reserve money only in the 1st quarter and prices respond positively to nominal exchange rate in the 3rd quarter. Imports respond negatively to nominal exchange rate in the 2nd quarter and positively to exports from 1st to 3rd quarters.

- *Exchange Rate Channel (1990:1–2005:2)*: VDCs indicate that reserve money has a significant explanatory power of predicting the movements in nominal exchange rate

[48] The results for the sub-sample period remain the same as those of alternative ordering of the relevant variables including some radical ones such as reversing the order completely.

only in year-2 and imports starting year-2. The movement in aggregate output, on the other hand has a significant explanatory power of forecasting the future path of prices starting year-2 as well as nominal exchange rate starting year-3. Besides, the movement in prices explains the future path of nominal exchange rate only in year-4. Conversely, IRFs show that aggregate output responds positively to reserve money in the 1st quarter and prices react positively to aggregate output in the 5th quarter. The response of prices to imports is negative and significant in the 1st quarter and exports respond positively to nominal exchange rate only in the 2nd quarter.

The results of the empirical analysis suggest *weak* existence of both *bank lending* and *exchange rate channels* in the economy for the full-sample period (i.e., July-September 1979 to April-June 2005) as well as in the sub-sample period (i.e., January-March 1990 to April-June 2005). Recall that the country adopted the FSRP in the early 1990s. Therefore, the observation regarding the existence of *bank lending channel* is partly consistent with the empirical evidence of Younus (2004), that is, the channel is non-existent in Bangladesh. However, the analysis of historical data presented in Tables 1 and 5 indicate discernible success of monetary policy in the long-run in terms of the growth-money-inflation nexus. Economic growth picked up, actual monetary expansion was more or less within the s*afe limit* and inflation converged to a moderate level over time.

Several explanations may be put forward to support the findings obtained of the paper. Firstly, though the data set includes observations for the period July-September 1979 to April-June 2005, most of the reforms under the FSRP were fully in effect only from the late 1990s (e.g., interest rate liberalization of 1997). Secondly, monetary policy framework in the sample period was mainly under the fixed exchange rate and fiscal dominance. Thirdly, although less relevant in recent years, the existence and continuation of *directed credits* at *concessional rates* by NCBs as well as SBs and the consequent high non-performing loans (NPLs) of these banks partially distort the channels of monetary transmission in the economy. Finally, the excess liquidity position in the banking system as well as a significant share of net government borrowing in reserve money in most years partly neutralize the efficacy of monetary policy actions.

The empirical findings of the paper have important implications with respect to the operation of monetary policy. Specifically, knowing the distinct active channels of monetary transmission in the economy would guide the monetary authority in formulating and conducting monetary policy pursuant to its objectives under the current regime, i.e., floating exchange rate and market based monetary policy instruments.

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Annex Table 1: Liquidity Position in the Banking System

Fiscal Year	Total Liquid Assets	Required Liquid Assets	Excess Liquidity	Excess Liquidity as % of Required Level
1986-87	33.60	25.00	8.60	34.40
1987-88	42.20	37.44	4.75	12.69
1988-89	46.03	43.67	2.36	5.40
1989-90	49.57	48.49	1.08	2.23
Average (1986-87 to 1989-90)	**42.85**	**38.65**	**4.20**	**13.68**
1990-91	54.57	51.07	3.50	6.85
1991-92	59.76	51.33	8.43	16.42
1992-93	64.24	57.23	7.01	12.25
1993-94	88.60	64.67	23.93	37.00
1994-95	86.77	69.54	17.23	24.78
Average (1990-91 to 1994-95)	**70.79**	**58.77**	**12.02**	**19.46**
1995-96	93.40	80.08	13.32	16.63
1996-97	105.90	88.81	17.09	19.24
1997-98	117.19	97.46	19.73	20.24
1998-99	138.10	104.74	33.35	31.84
1999-00	178.39	124.96	53.44	42.77
Average (1995-96 to 1999-00)	**126.60**	**99.21**	**27.39**	**26.14**
2000-01	188.75	144.13	44.62	30.96
2001-02	228.28	162.41	65.87	40.56
2002-03	266.56	186.85	79.71	42.66
2003-04	286.90	169.36	117.54	69.40
2004-05	305.71	196.29	109.42	55.74
Average (2000-01 to 2004-05)	**255.24**	**171.80**	**83.43**	**47.86**
2005-06	351.47	255.56	95.91	37.53

Note: All figures are in billion BDT (outstanding amounts) as of end June of respective fiscal years.
Source: Department of Off-site Supervision, BB and authors' calculation.

Annex Table 2: Scheduled Bank Credit Pattern

Year	NCBs		SBs		FCBs		PCBs (including IBs)		IBs		All Banks	NCB & SB as % of All Banks
	Advance	Bills	Advance	Bills	Advance	Bills	Advance	Bills	Advance	Bills		
1999	278.66	8.22	97.37	0.54	30.27	2.85	157.69	8.76	32.85	2.28	584.35	65.85
2000	297.95	14.00	102.06	0.69	35.03	1.70	196.68	12.50	42.97	1.76	660.61	62.78
2001	327.73	13.65	108.28	0.77	37.77	3.36	253.72	14.79	56.24	1.54	760.05	59.26
2002	355.86	20.85	109.22	0.74	50.92	2.10	314.31	15.18	73.19	2.45	869.17	55.99
2003	361.68	22.94	99.63	0.54	61.64	2.20	372.42	20.27	92.04	4.19	941.31	51.50
2004	381.09	23.61	107.95	1.40	69.05	2.44	466.27	26.17	137.32	7.71	1077.99	47.69
2005	423.86	69.81	110.41	1.14	78.80	4.36	589.41	42.61	171.41	8.37	1500.17	40.34

Note: Figures for advances and bills are in billion BDT (outstanding amounts) at the period end.
Source: Banking Statistics Division, Statistics Department, BB.

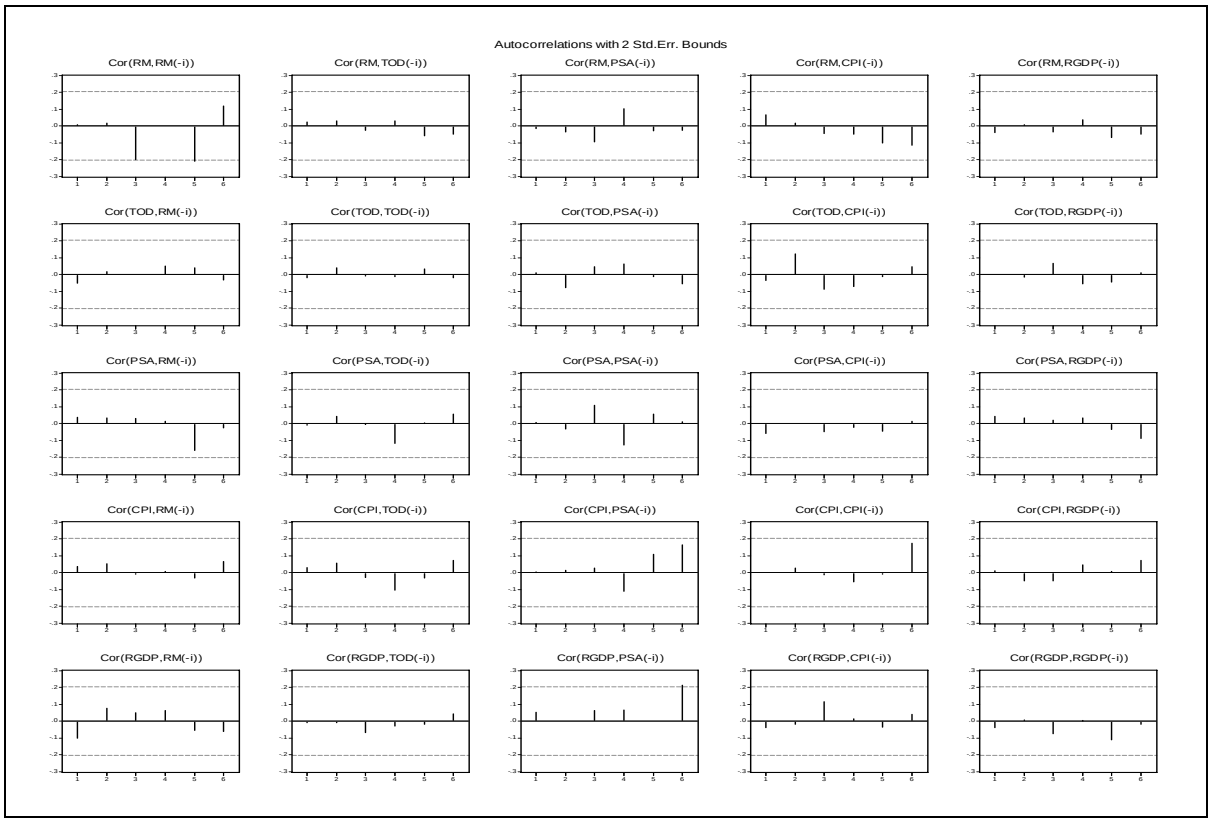
Annex Table 3: Reserve Money and Net Government Credit from the Bangladesh Bank

Fiscal Year	Reserve Money	Net Government Borrowing from BB	Net Government Credit as % of Reserve Money
1980-81	13.35	14.77	110.64
1981-82	12.80	15.81	123.52
1982-83	16.23	18.20	112.14
1983-84	22.35	13.51	60.45
1984-85	26.75	14.24	53.23
Average (1980-81 to 1984-85)	**18.30**	**15.31**	**91.99**
1985-86	32.71	17.89	54.69
1986-87	37.41	19.63	52.47
1987-88	50.57	22.45	44.39
1988-89	54.68	9.86	18.03
1989-90	63.17	16.78	26.56
Average (1985-86 to 1989-90)	**47.71**	**17.32**	**39.23**
1990-91	65.00	16.77	25.80
1991-92	68.20	12.00	17.60
1992-93	89.50	14.50	16.20
1993-94	113.10	10.10	8.93
1994-95	106.30	12.50	11.76
Average (1990-91 to 1994-95)	**88.42**	**13.17**	**16.06**
1995-96	110.00	30.40	27.64
1996-97	124.00	44.90	36.21
1997-98	136.20	53.00	38.91
1998-99	147.40	63.60	43.15
1999-00	170.70	81.00	47.45
Average (1995-96 to 1999-00)	**137.66**	**54.58**	**38.67**
2000-01	189.30	101.10	53.41
2001-02	235.30	128.30	54.53
2002-03	243.10	102.50	42.16
2003-04	262.60	119.00	45.32
2004-05	295.50	157.20	53.20
Average (2000-01 to 2004-05)	**245.16**	**121.62**	**49.72**
2005-06	378.63	246.62	65.13

Note: Figures for 'Reserve Money' and 'Net Government Credit from BB' are in billion BDT (outstanding amounts) as of end June of respective fiscal years.

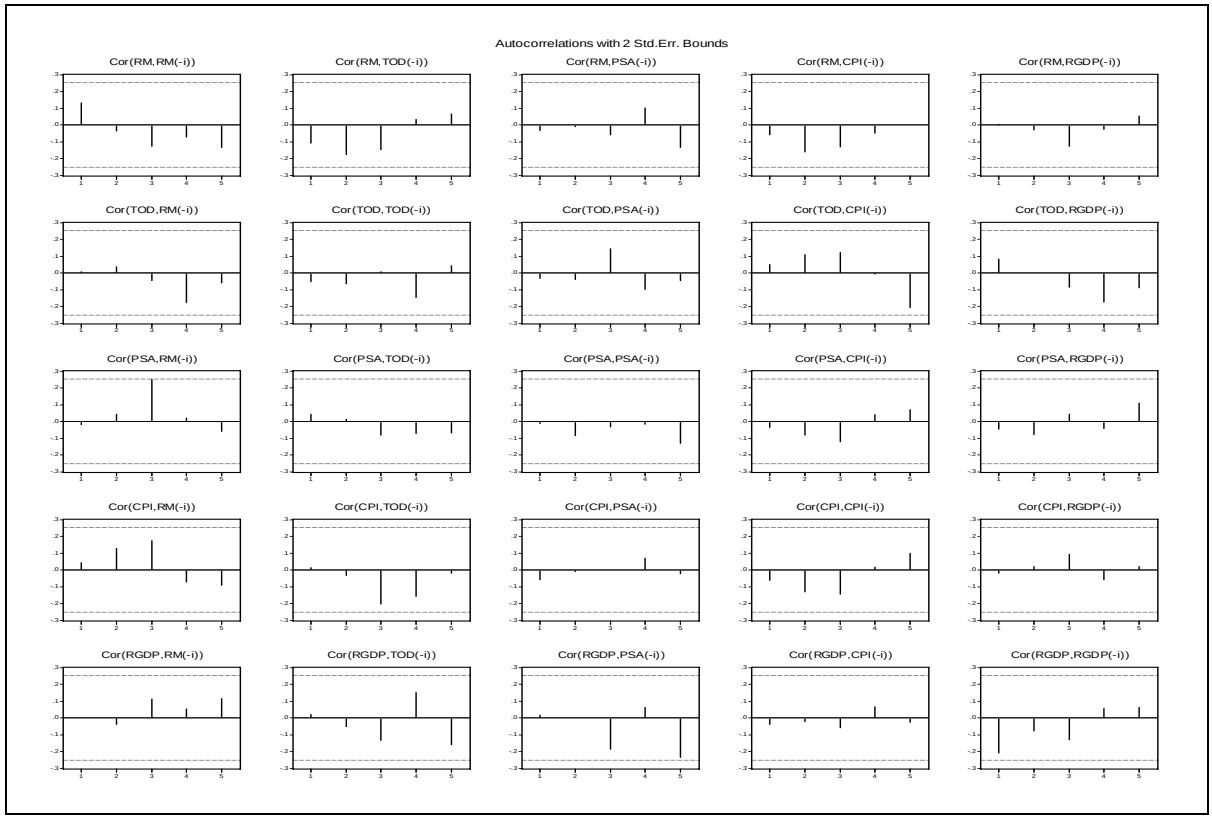
Sources: 1. Bangladesh Bank Annual Report (various issues), BB.
2. Economic Trends (various issues), BB.
3. Authors' calculation.

Annex 1.1: Correlogram of Residuals: Bank Lending Channel (1979:3–2005:2)



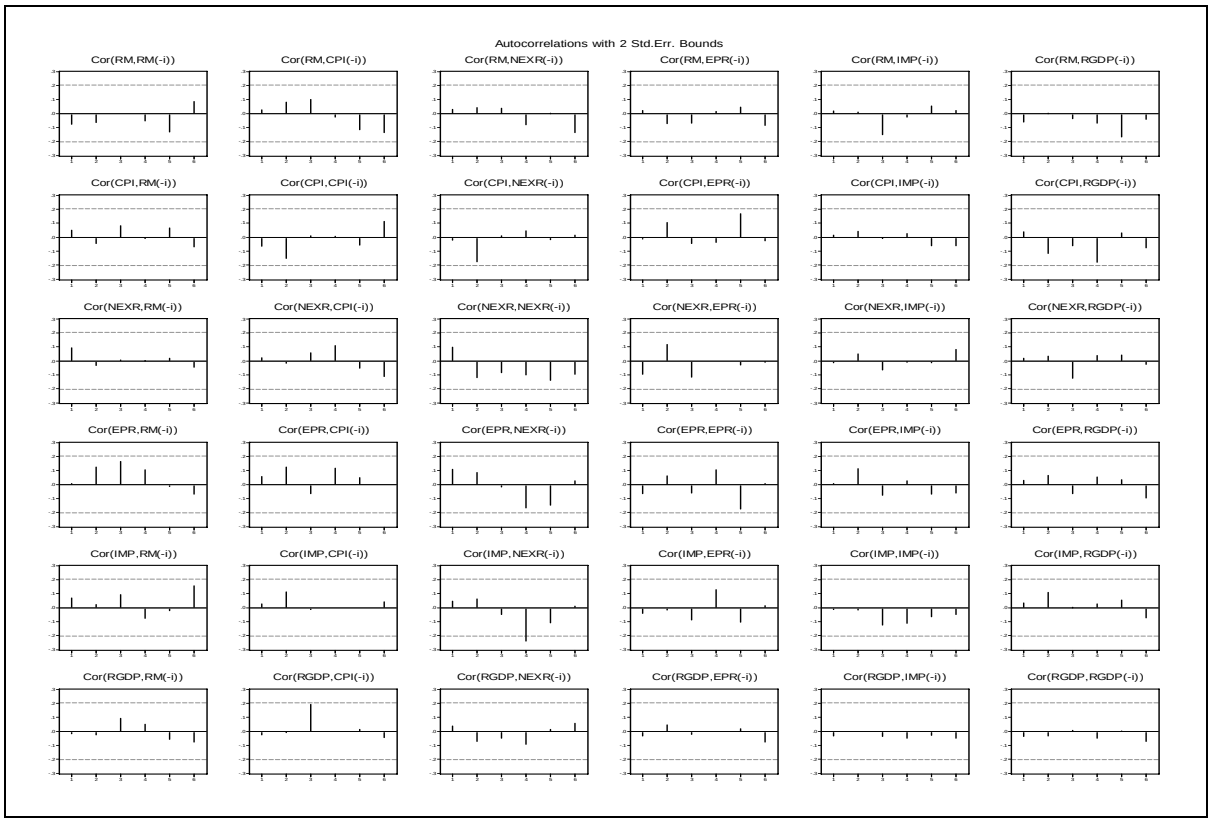
Note: Optimal lag length 6 has been used to make the residuals white noise.

Annex 1.2: Correlogram of Residuals: Bank Lending Channel (1990:1–2005:2)



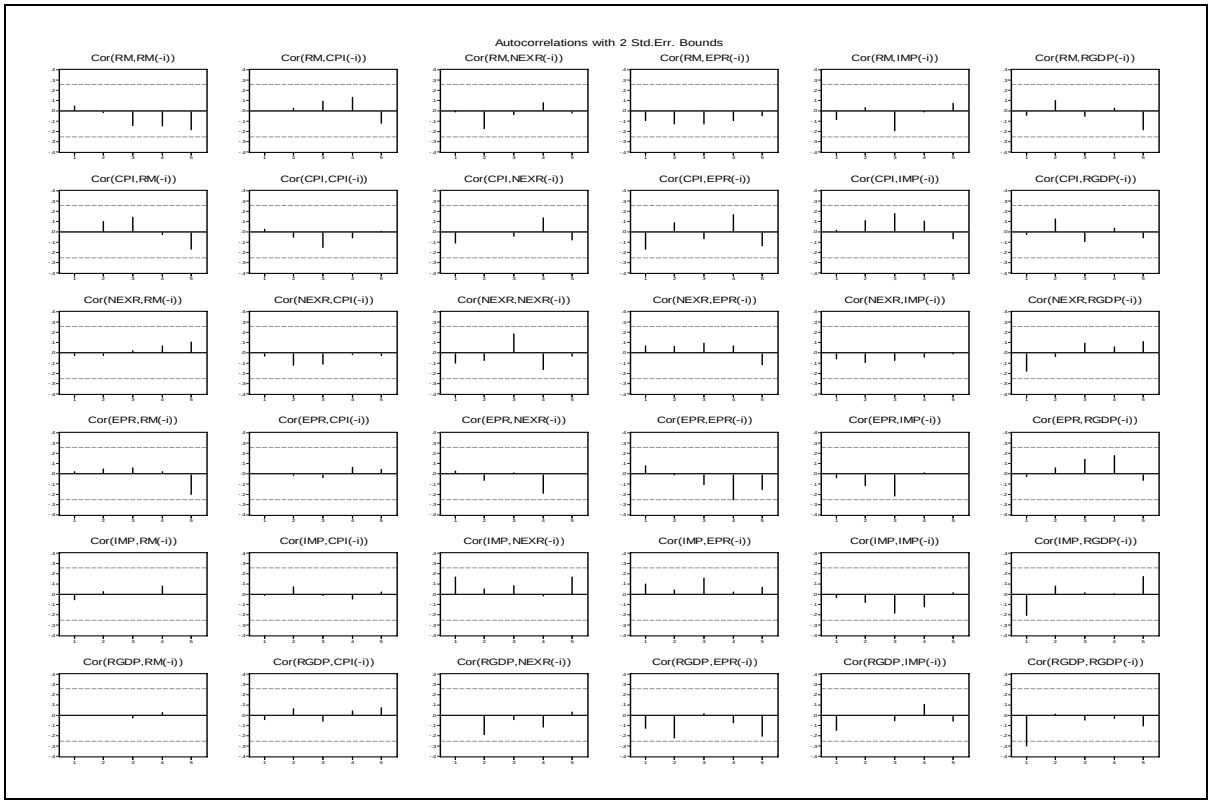
Note: Optimal lag length 5 has been used to make the residuals white noise.

Annex 1.3: Correlogram of Residuals: Exchange Rate Channel (1979:3–2005:2)



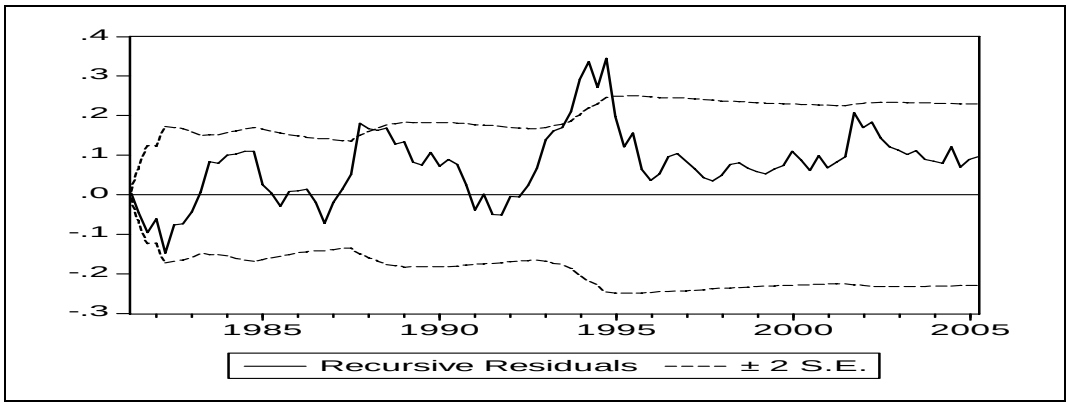
Note: Optimal lag length 6 has been used to make the residuals almost white noise.

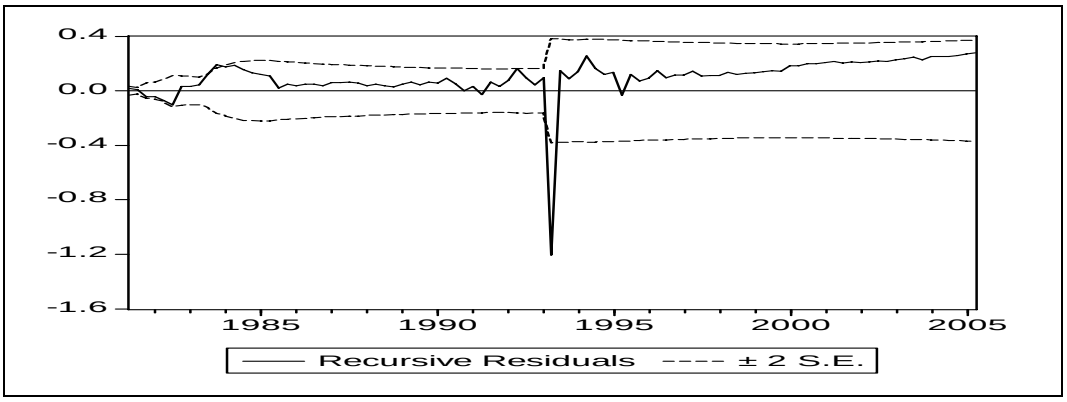
Annex 1.4: Correlogram of Residuals: Exchange Rate Channel (1990:1–2005:2)

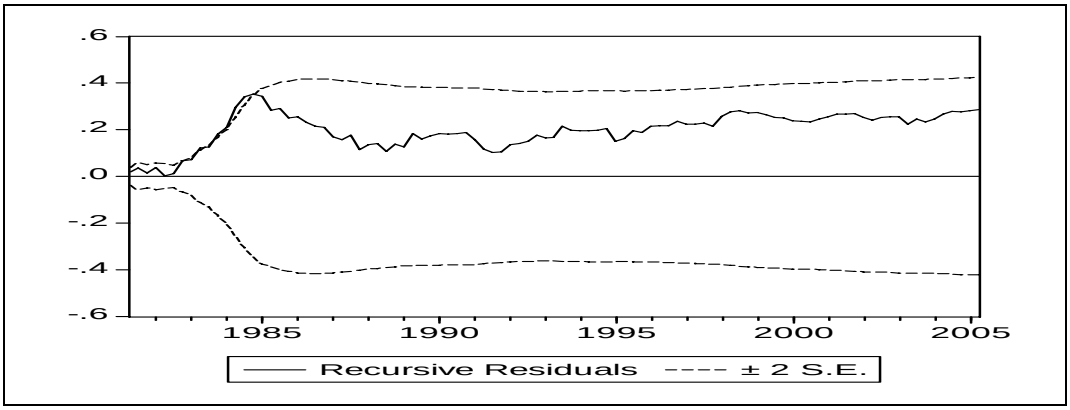


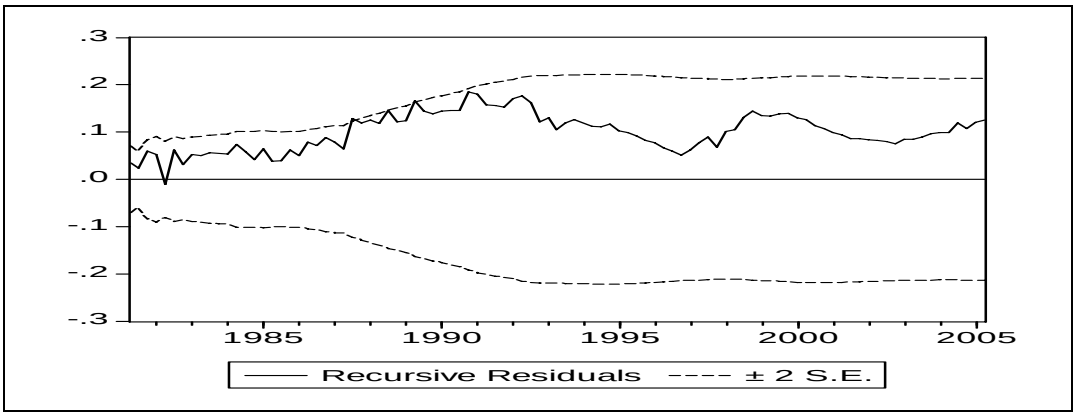
Note: Optimal lag length 5 has been used to make the residuals almost white noise.

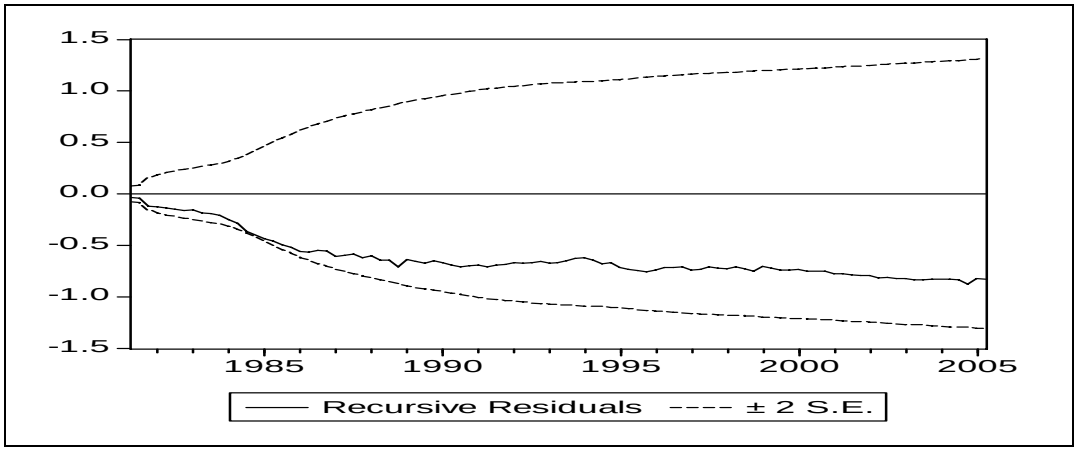
Annex 1.5: Stability Test-Recursive Residuals: Bank Lending Channel (1979:3–2005:2)





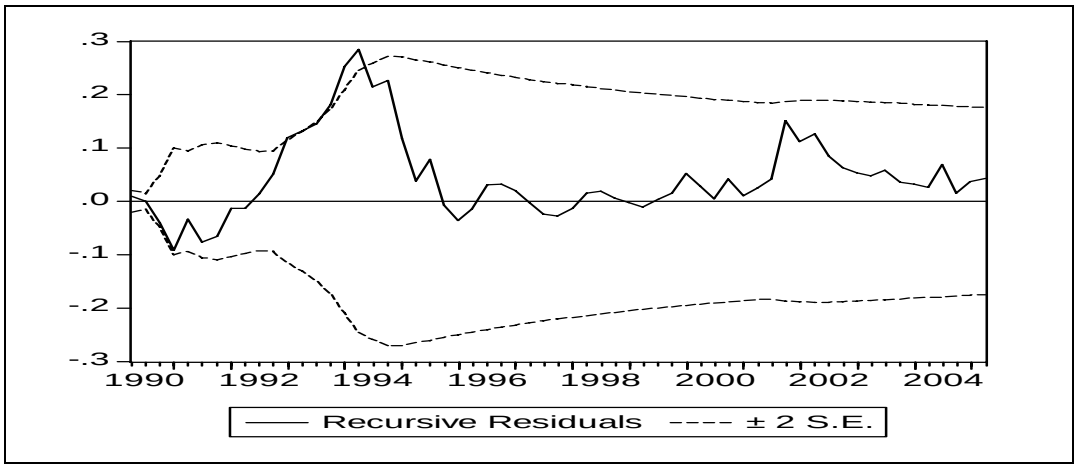


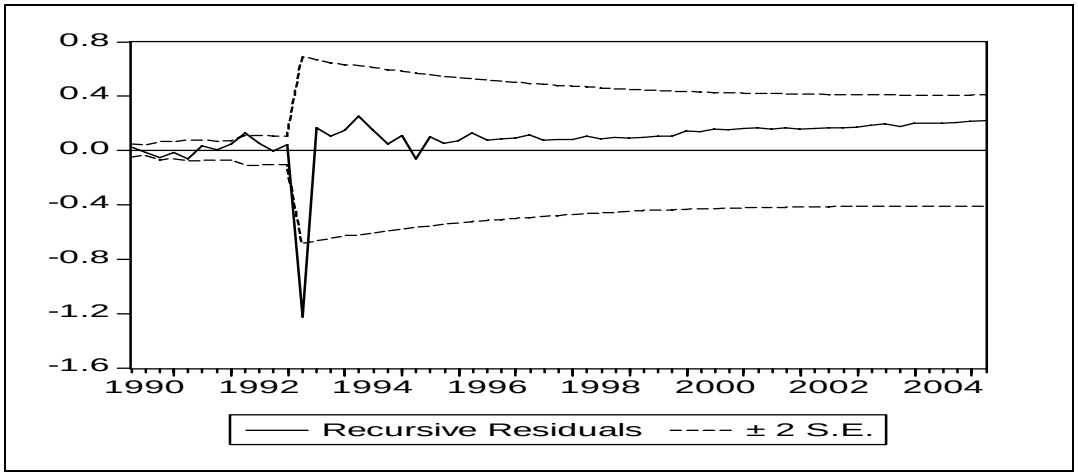


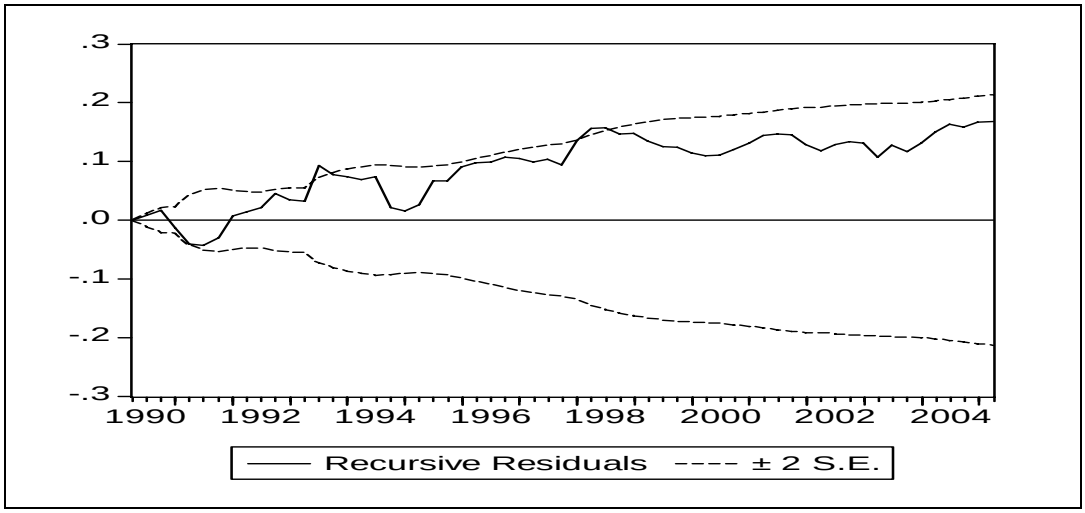


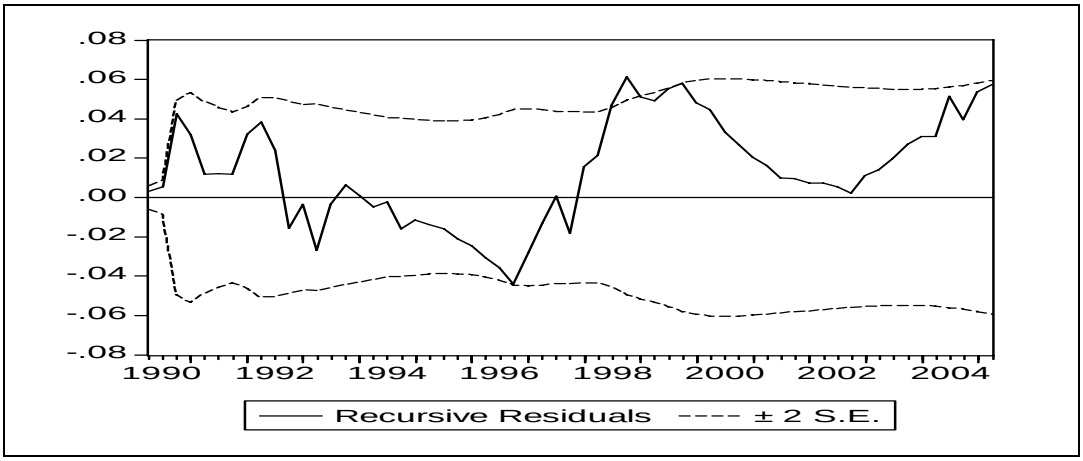
Note: Residuals outside the standard error bands (i.e., ±2 s. e.) suggest instability in the parameters of the equation in the VAR model.

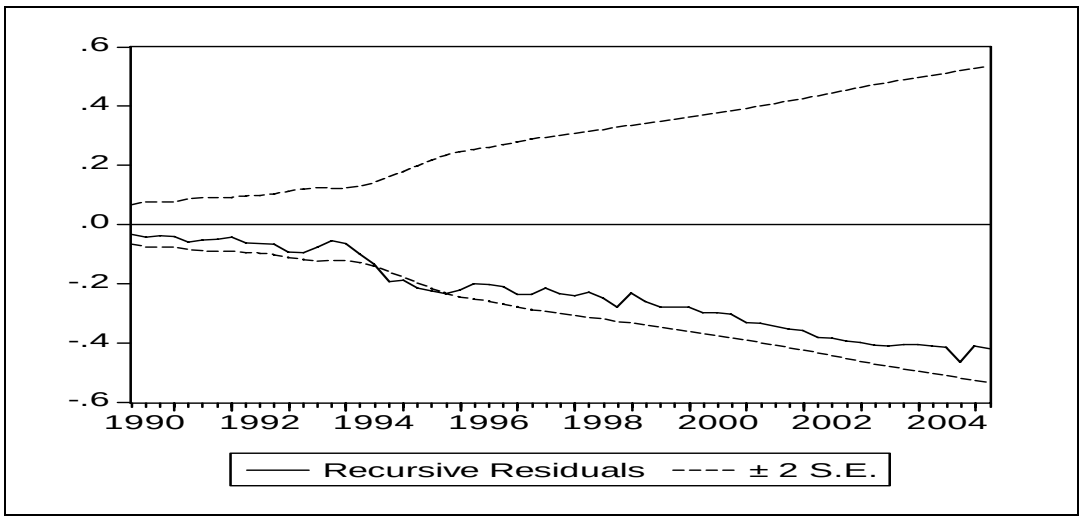
Annex 1.6: Stability Test-Recursive Residuals: Bank Lending Channel (1990:1–2005:2)





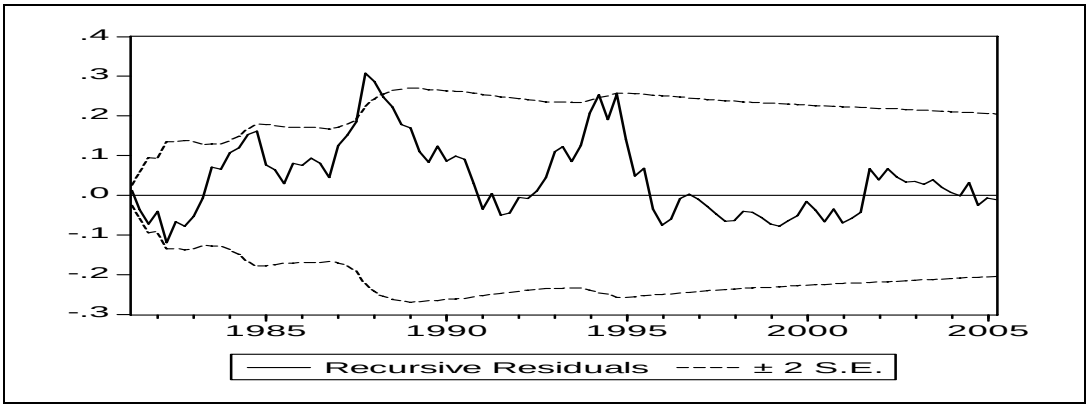


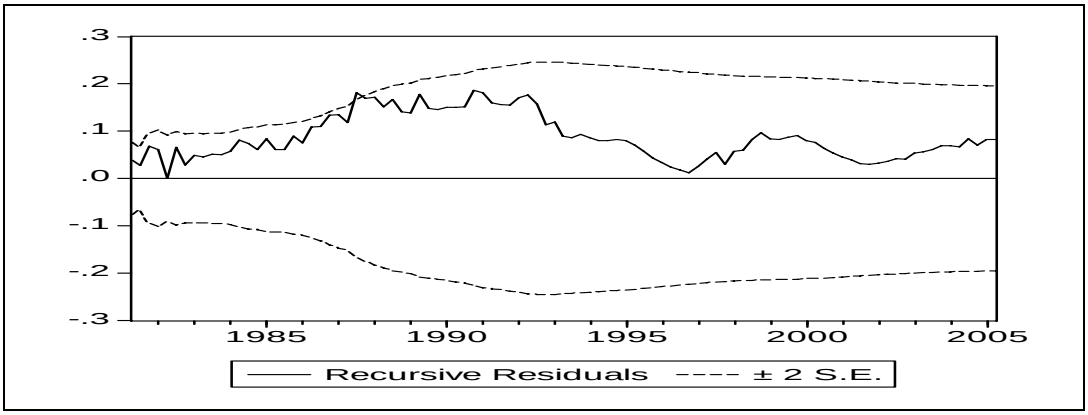


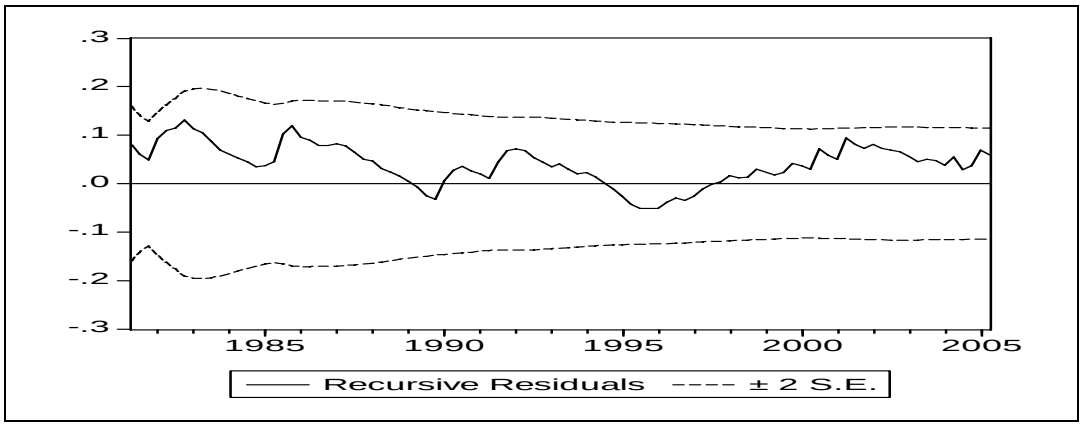


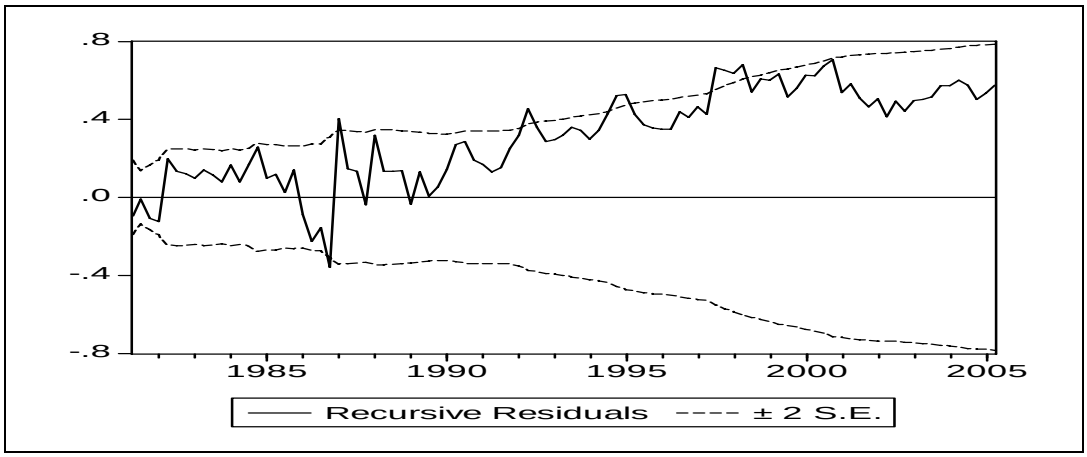
Note: Residuals outside the standard error bands (i.e., ±2 s. e.) suggest instability in the parameters of the equation in the VAR model.

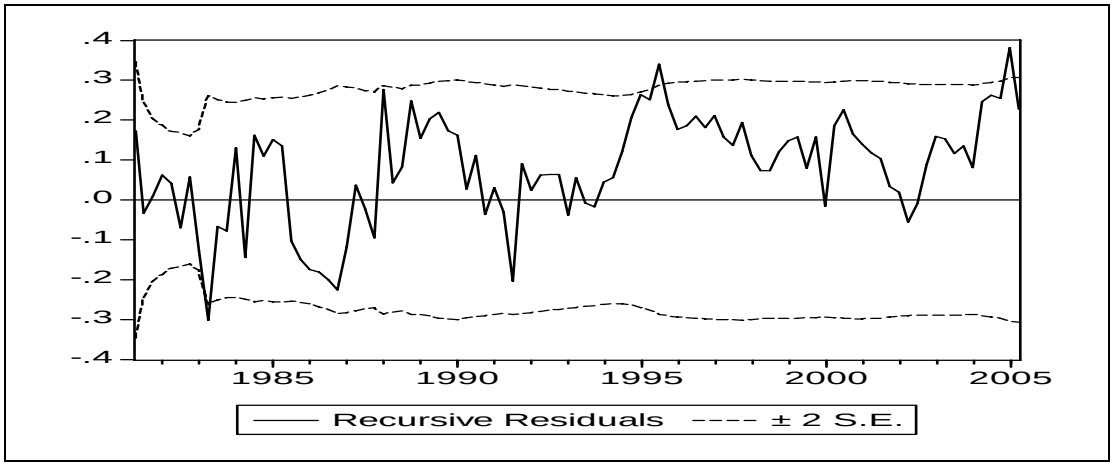
Annex 1.7: Stability Test-Recursive Residuals: Exchange Rate Channel (1979:3–2005:2)

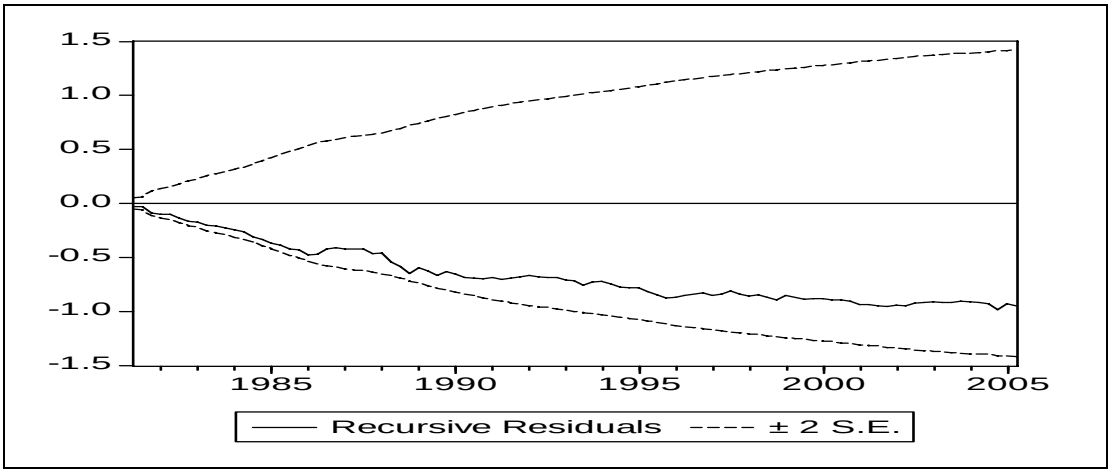






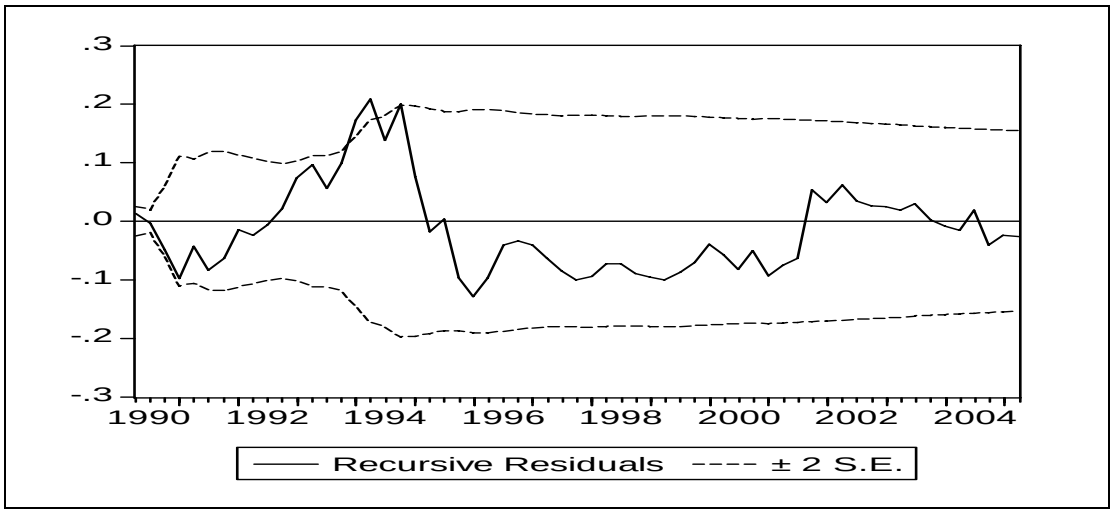


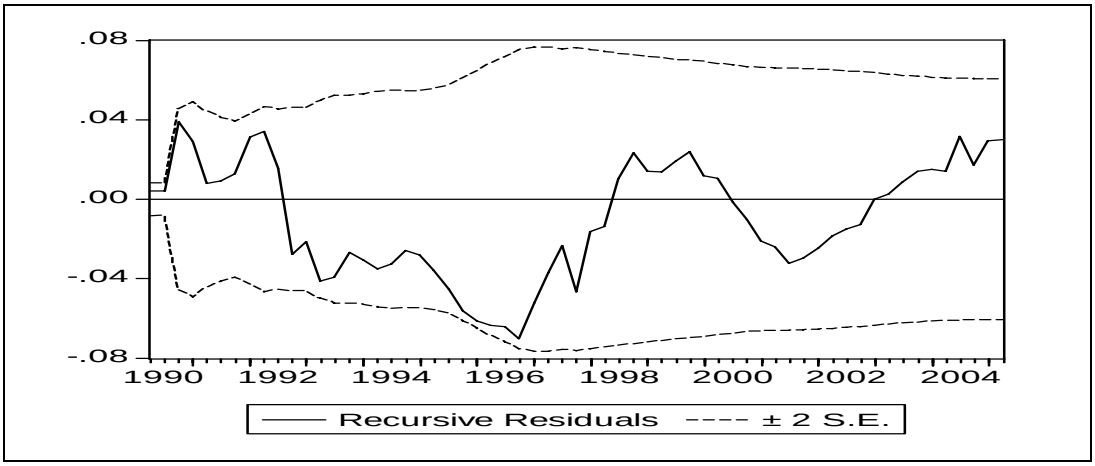




Note: Residuals outside the standard error bands (i.e., ±2 s. e.) suggest instability in the parameters of the equation in the VAR model.

Annex 1.8: Stability Test-Recursive Residuals: Exchange Rate Channel (1990:1–2005:2)

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.00
-.04
-.08
1990
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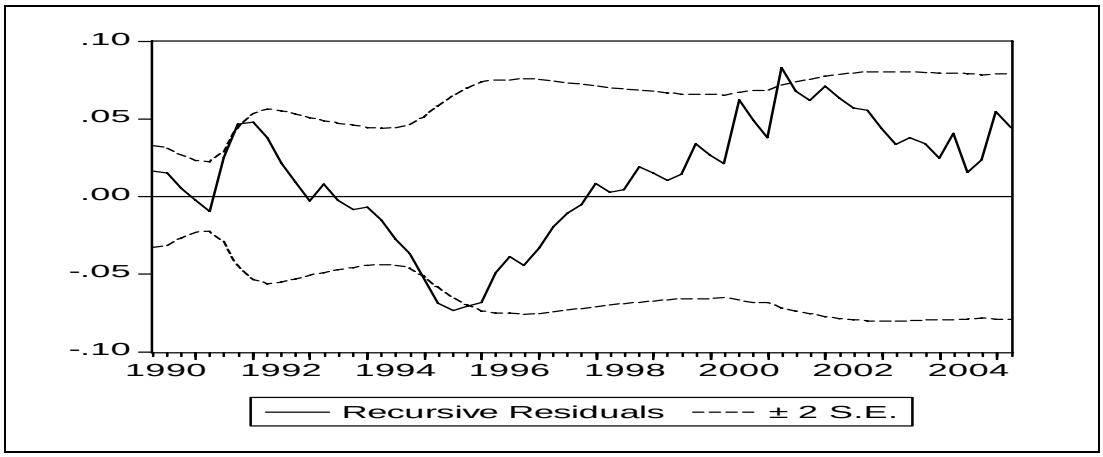
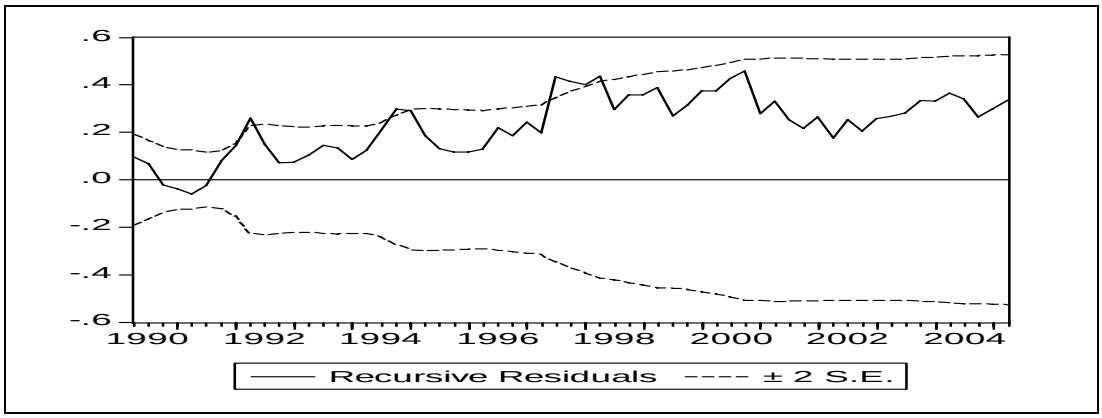
1996
1998
2000
2002
2004
Recursive Residuals
± 2 S.E.


.10
.05
.00
-.05
-.10
1990
1992
1994
1996
1998
2000
2002
2004
Recursive Residuals
± 2 S.E.


.6
.4
.2
.0
-.2
-.4
-.6
1990
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1994
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1998
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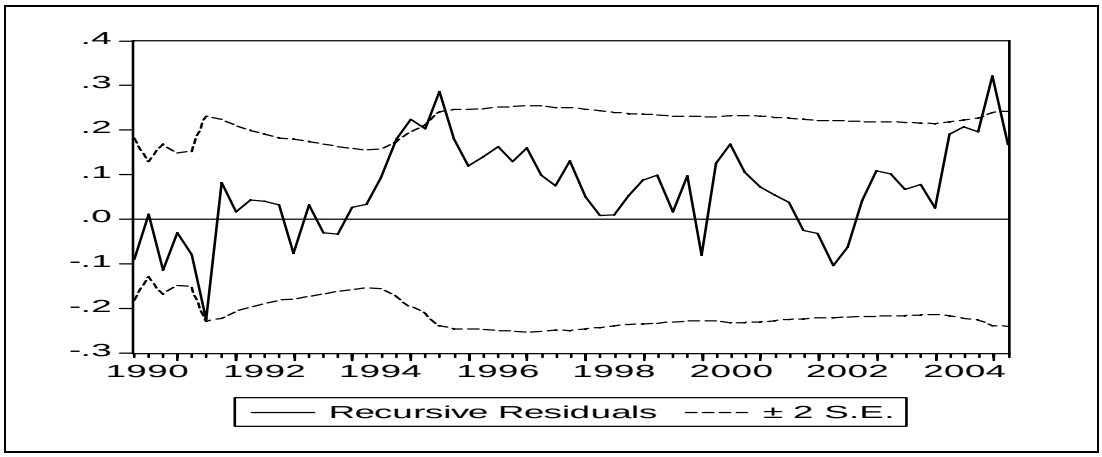
2004
Recursive Residuals
± 2 S.E.


.4
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1990
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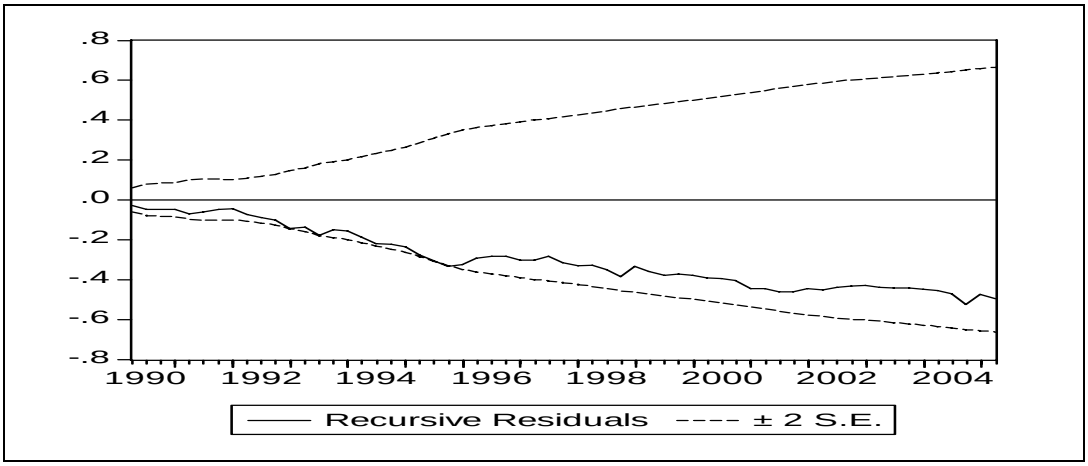
Recursive Residuals
± 2 S.E.



Note: Residuals outside the standard error bands (i.e., ±2 s. e.) suggest instability in the parameters of the equation in the VAR model.