12-2000

The money-output relationship : a disaggregated approach

Gazi Hamdallah Shbikat

To the Graduate Council:

I am submitting herewith a dissertation written by Gazi Hamdallah Shbikat entitled "The money-output relationship : a disaggregated approach." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Economics.

Charles Garrison, Major Professor

We have read this dissertation and recommend its acceptance:

Charles Noon, Jean Gauger, Hui Chang

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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The Money – Output Relationship: A Disaggregated Approach

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee

Gazi H. Shbikat

December 2000

DEDICATION

This dissertation is dedicated to my mother, Amenah

ACKNOWLEDGMENTS

I would like to express my deep gratitude to my advisor, Charles Garrison, to whom I have incurred an enormous debt in the course of writing this dissertation. Dr. Garrison's comments and guidance have helped me to better understand macroeconomics and by editing my manuscripts he has gone far beyond the call of his duty as an advisor. Also, I would like to thank the other members of my committee, Jean Gauger, Hui Chang, and Charles Noon for their invaluable comments.

I am also very appreciative for many useful discussions with my colleagues at the Department of Economics especially, Sanelà Porcia, Tricia Coxwell and Cezar Botel, and my friend, Adel Sharkas at the University of New Orleans. I would like to thank also Dr. Nozar Hashemzada from Radford University and David Vogt from the Oak Ridge National Laboratory for their support and encouragement. Special thanks to Dianne Sutton for her sweet words and advice and to Dr. Richard Sutton for reviewing some of my manuscripts.

My greatest gratitude is to my mother who has been my guidance and the deep source of my inspiration throughout my life. Finally, I would like to thank my best friend and beloved wife, Jennifer, for her unlimited support and patience. She was always there for me. Undoubtedly, I could not have done this without her.

ABSTRACT

This dissertation addresses two issues related to identifying the impact of money on economic activity using disaggregated monetary and real variables. The first is the negative impact of money on interest rates (the liquidity effect). The first step in doing so is to distinguish between exogenous and endogenous money movements. The second is identifying the transmission mechanism by which interest rates affect economic activity. Recent empirical work on the relationship between money and economic activity using the Vector Auto Regression (VAR) method has focused on relationships between aggregate monetary and aggregate real variables. The difficulty in using aggregated data is that some aggregate variables consist of components that have different determinants or different time patterns in their interaction with other variables. The positive correlation between money and interest rates, and between interest rates and investment that have been found by many empirical studies are inconsistent with theories of the liquidity effect of money and the transmission mechanism with interest rate channels. The main argument in this dissertation is that distinguishing between outside and inside money and between residential and nonresidential investment is crucial for identifying the impact of money and interest rates on economic activity.

Following the recent trend in studying the relationship between money and output, the VAR method is applied here. This dissertation, however, departs from most of the previous work specifically by dealing with the problem of nonstationarity and cointegration in the data series. The presence of nonstationarity and cointegration found in the data requires the use of the Error Correction (EC) model to estimate the dynamic short-run relationships between the

variables.

The main conclusion of this study is that exogenous money shocks are correctly measured by nonborrowed reserves (NBR). Movements in NBR produce the expected negative impact of money on interest rates (the liquidity effect) and reflect, to a large extent, the Fed's "leaning against the wind" policy. Disaggregating investment, on the other hand, helps to detect the transmission mechanism by which interest rates affect economic activity. Particularly, the transmission mechanism works through the effect of interest rates on the residential component of investment. Further, the evidence presented in this dissertation underscores the role of residential investment in explaining business cycle fluctuations.

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CHAPTER ONE

INTRODUCTION

In general, there are two empirical facts about the relationship between money and economic activity upon which most macroeconomists agree. The first is the comovement of money and output in economic time series. The second is that money changes precede changes in output. However, these facts tell nothing about the origin of changes or the direction of influence. "The monetary changes might be produced by independently originating changes in output (endogenous money); the changes in output might be produced by independently originated changes in money (exogenous money); the two might be mutually interacting (two-way influence), each having some elements of independence; or both might be reacting to a common change in a third set of influences" [Friedman and Schwartz (1963a), p. 686].

This issue of the direction of influence between money and economic activity has attracted a great deal of attention among macroeconomists and has been one of the most controversial issues in the macroeconomic literature. Theoretical disagreement among different schools of thought has led economists of these schools to use different approaches and statistical techniques to examine this issue empirically. The empirical findings have been dependent, to a large extent, on techniques used, data form, and models' specifications. Hence, no widely held consensus has been reached.

The purpose of this dissertation is to investigate empirically the relationship between money and output using a disaggregated approach. It is important to decompose monetary and real variables for two reasons. First, disaggregated variables have different cyclical timing patterns than the aggregate variables. Second, the factors governing movements in the aggregate variable may differ or may have different quantitative impacts on the components of the aggregate. By decomposing money and output into their important components, this approach allows for identifying the channels through which money and output interact. Therefore, this study distinguishes between outside and inside money as well as between residential and nonresidential investment.

A Vector Auto Regression (VAR) technique is used here as the main method of analyzing the short-term relationships between the variables. Employing this method is of special importance for the approach used in this study. Identifying the role of time patterns and testing the dynamic aspects in the relationship between the disaggregated variables are two of the main objectives of this study. The nature of the VAR structure helps to track the time factor and account for all the potential interactions and feedback between the variables. Issues related to applying the VAR method and its usefulness in investigating the causality between the variables are addressed in this research.

Variance Decomposition and Impulse Response Functions from the VAR model are utilized to test the directions and the channels of influence between the variables. Quarterly data on the U.S. economy are used to capture the short-term relationship between the variables. The full sample covers the period 1959.3-1998.4. Two sub-periods, 1959.3-1979.3 and 1983.3-1998.4, are used to examine structural changes that might have occurred as a result of changing operating regimes and deregulation and financial innovations that took place in the early eighties.

Throughout this research, the terms multiplier and inside money will be used interchangeably as they both refer to the deposit component of money. Also, the monetary base or any measure of reserves will be referred to as outside money or high-powered money.

1.1 Exogenous Monetary Shocks and the Liquidity Effect of Money

1.1.1 Outside and Inside Money: Definitions

The money supply is decomposed into outside and inside money. The terms outside money, high-powered money, and monetary base refer to the same concept, those assets that can serve as the base for a multiple quantity of bank deposits. When held by banks, those assets are called bank reserves and can be used directly by banks to extend credit. When held by the public in the form of currency, the assets hold the potential to be used by banks to extend credit. On the other hand, those assets are liabilities in the Federal Reserve's (the Fed) balance sheet. They are considered to be under the direct control of the Fed because they constitute a part of its liabilities. High-powered money, outside money or monetary base (MB), therefore, includes bank reserves and currency held by the public. That is,

$$\text{MB} = \text{Total Reserves} + \text{Currency in Circulation}$$

The above definition of outside money is a broad one. Different measures of reserves can be used as a measure of outside money. That is, the monetary base can be further decomposed into other less aggregated reserve concepts. Total Reserves (TR) is one of the measures of outside money. It consists of required reserves and excess reserves held by banks. The required reserve ratio is the percentage of deposits that banks have to keep in the form of cash or deposits at the Fed. Excess reserves are what banks decide voluntarily to keep in the form of reserves. Another way to look at TR is to examine the source of reserves available for banks. In this case, TR consists of borrowed reserves (borrowed through the discount window) and nonborrowed reserves. That is,

TR = Required Reserves + Excess Reserves

or

TR = Borrowed Reserves + Nonborrowed Reserves

The terms inside money and money multiplier (when expressed in a growth rate form), on the other hand, refer to the part of the money supply that is produced by the private sector. Some models identify inside money as bank deposits. In this research, movements in inside money are identified as movements in the money multiplier.

1.1.2 Nonborrowed Reserves and the Liquidity Effect of Money

The negative impact of money on interest rates (the liquidity effect) is the first step in identifying the impact of money on economic activity in many analyses. In monetarist and Keynesian models, monetary changes are expected to have a negative effect on interest rates. However, many previous studies have reported a positive relationship between broad measures of money and nominal and real interest rates [see for example Chari, Christiano, and Evan (1995), Gordon and Leeper (1994), Sims (1992), and Mishkin (1982)]. As argued by Bernake and Mihov (1998), the endogenous part of money is responsible for producing this positive relationship with interest rates. Innovations to outside money reflect exogenous shocks to monetary policy, while innovations to broader monetary aggregates reflect a combination of shocks to money demand and policy shocks.

A possible implication of the failure to distinguish between outside and inside money in examining the relationship with interest rates is the conclusion that changes in money supply are neutral. In the Real Business Cycle (RBC) model, for example, the observed positive comovement of money and interest rates is explained as a response of both variables to productivity shocks; a positive productivity shock leads to a rise in interest rates, which in turn leads to an increase in deposits [Champ and Freeman (1994)]. A negative effect of outside money on interest rates, therefore, would be at odds with the RBC model predictions and consistent with the new Keynesian model.

In light of the failure to find a negative impact of money on interest rates, a more recent wave of research has focused on identifying monetary shocks using less aggregated data such as nonborrowed reserves and the monetary base [Guirguis (1999), Fackler and McMillin (1998), Chari et. al. (1995), Gorden and Leeper (1994), Bernanke and Blinder (1992)]. Other studies focus on the federal funds rate as a measure of the stance of monetary policy [see for example Bernanke and Mihov (1998) and (1995) and Bagliano and Favero (1998)]. In these studies the authors are trying to separate exogenous policy actions from endogenous money responses to developments in the economy. A number of these studies have found evidence consistent with the liquidity effect of money.

In this dissertation, nonborrowed reserves (NBR) is used as the measure of exogenous monetary policy shocks. The rationale for choosing NBR as a measure of the Fed's monetary policy is based on the findings in this dissertation, as well as the findings by other studies, that NBR is the measure of outside money that produces a liquidity effect (NBR has a negative relationship with nominal interest rates). The correlation of the innovations of the variables presented in chapter four of this dissertation (Table 4.2) shows that NBR innovations have the highest correlation with the interest rate (Tbr) among the monetary aggregates and that NBR is the only reserve aggregate that shows a negative relationship with Tbr. Chari et al. (1995) choose NBR based on a similar result. Another important justification for using NBR as the policy variable is the fact that under the federal funds rate targeting policy, the Fed adjusts the supply of nonborrowed reserves available for banks, through open market operations, to attain the federal funds target. That is, NBR is under the direct control of the Fed. As such, innovations in NBR are more likely to reflect shocks to monetary policy rather than to money demand as in the case of broader monetary aggregates such as M1 or M2 [Guirguis (1999)].

1.1.3 Disaggregating Investment and the Transmission Mechanism of Money

In this study, economic activity is measured by the real Gross Domestic Product (GDP) and by real fixed investment. Fixed investment is decomposed into residential (RI) and nonresidential (Business) fixed investment (NRI). RI consists of the production of private structures and of residential producers' durable equipment —equipment owned by landlords and rented to tenants. NRI consists of the production of both nonresidential structures and producers' durable equipment [US Department of Commerce (1998)].

According to the traditional monetary transmission mechanism with interest rate channels, an expansionary monetary policy leads to a fall in interest rates, which in turn lowers the cost of capital, causing a rise in investment and output [Mishkin (1996]. When assessing the final impact of money on economic activity, most of the recent studies use aggregate measures of output, such as GDP or the index of industrial production, to measure economic activity. A lag in the effect of money and interest rates on such aggregates has been found by many studies. For example, Gordon and Leeper (1994) find a delay of six months before output (measured by the industrial production) responds significantly to monetary policy shocks. Also, interest rates have a puzzling procyclical behavior with output [see Christiano (1991), Blanchard and Fisher (1989) and Fiorito and Kollintzas (1994)]. Such findings might be due to the absence of important variables in the analysis. The positive comovement of interest rates and aggregate investment (and output) during business cycles challenges the transmission mechanism by which interest rates have a negative effect on investment. Proponents of the RBC model, therefore, explain investment fluctuations as being due to productivity shocks.

In an effort to determine whether monetary policy affects real variables through an interest rate channel, this dissertation disaggregates investment in a VAR model. The main argument of this study is that previous empirical work using the VAR method has ignored RI as a main variable explaining economic fluctuations during business cycles. The difference in behavior of the two components, RI and NRI, is a stylized fact of business cycles. Whereas RI leads the cycle, NRI lags it [Kydland and Prescott (1990)]. Further, a number of authors argue that RI is more sensitive to the interest rate than is NRI. When aggregate investment is used in empirical studies, it has a positive contemporaneous relationship with interest rates. Garrison (1991) finds that RI is more responsive to long-term interest rates, but that NRI is more responsive to output. Using Granger causality tests Green (1997) finds that RI Granger causes GDP, but is not caused by GDP, while NRI does not Granger cause GDP but is caused by GDP.

The focus of this research is to disaggregate investment into residential and nonresidential investment in an effort to discover a leading negative influence of the interest rate on the residential part of investment (which in turn leads to an increase in output) and gives a possible explanation for the cyclical behavior of both residential and nonresidential investment during business cycles.

1.2 The Importance and the Objectives of the Study

1.2.1 Importance of the Study

The difficulty of using aggregated data in studying the relationship between money and real economic activity is that some aggregate variables consist of components that have different determinants or different time patterns in their interaction with other variables. The behavior of such aggregates may not show significant relationships with other variables even if their components do. An example of the problem using aggregate data is the lead-lag relationship. In studying cyclical behavior, if one component of a particular variable is a lead variable while the other is a lag variable, then the aggregate variable may show coincidental movements over the cycle. Money and investment are examples of such aggregates.

To illustrate the problem of using aggregate data, let us assume that movements in outside money represent the exogenous part of the movements in money supply, while movements in the multiplier represent the endogenous part. If the contributions of these two components are different in different periods of time, then it could be possible that any conclusions reached by empirical studies are due to the failure to distinguish between exogenous and endogenous movements in money. A study that uses quarterly data, for example, could show that money is endogenous if the quarterly fluctuations in money are driven by the fluctuations in the multiplier. In this case, decomposing the aggregates enables the researcher to follow the chain of influence between the variables.

Many empirical studies focus on decomposing money supply into outside money and inside money and relate them to one *aggregate* variable for economic activity, such as the GNP. Other studies that focus on disaggregating investment, on the other hand, use *aggregate* monetary variables. The only study the author is aware of that includes RI in studying the dynamic relationship between money and output is Daniell (1991). However, Daniell relates the real variables to an *aggregate* measure of money and does not incorporate NRI into his empirical analysis. No previous study has used components of money with components of output in one model. Therefore, the advantage of this study over previous research on the money-output relationship is that it brings all those disaggregated variables together in a VAR model in an effort to account for all the chain of influence and to incorporate potential feedback between the variables. Employing the

VAR method is of special importance for the approach used in this study. Identifying the role of time and testing the dynamic aspects in the relationships among the disaggregated variables are two of the main objectives of this study. The nature of the VAR structure helps to track the time factor and account for all the potential interactions and feedback between the variables.

This dissertation also departs from most previous work specifically by dealing with the problem of cointegration in the data series. The presence of nonstationarity and cointegration found in the data requires the use of the Error Correction (EC) model to estimate the dynamic short-run relationships between the variables. In the EC model, the short-run dynamics of the variables are influenced by the deviation from an equilibrium relationship between the group of variables.

1.2.2 Objectives of the Study

This research will try to contribute to the applied work of the unresolved issue on the direction of influence between money and economic activity using a disaggregated empirical approach and employing a VAR method. That is, the study attempts to identify the dynamic relationship between money and economic activity using *disaggregated* rather than *aggregated* monetary and real variables.

The first objective of this study is to address the liquidity effect of money, that is, to identify and track the effects of different components of money on interest rates. The purpose is to show that using the correct measure of exogenous monetary changes will produce a negative effect of money on interest rates during business cycles. The relationship between less aggregated money and reserve measures and interest rates is investigated using correlation and VAR analysis.

The second objective is to assess the influence of the interest rate on the two components of investment, RI and NRI. More specifically, this research is designed to determine whether the main transmission mechanism of interest rates is through their effect on residential fixed investment.

The third objective is to compare empirically and evaluate the propositions of different macroeconomic models regarding the money-output relationship, and to see which model or models are supported by the empirical results of this research. Most of the theoretical macroeconomic models distinguish between different components of money and incorporate investment in their analysis of the transmission mechanism between money and output. However, most of the empirical work has focused on investigating the empirical relationships between *aggregate* monetary and real variables. The Monetarist, the Real Business Cycle (RBC), and the post Keynesian models distinguish between outside and inside money but have different views regarding their relationship with economic activity. The RBC model emphasizes the role of productivity shocks (real shocks) as the source of economic fluctuations, while the post Keynesian model emphasizes exogenous movements in "animal spirits." The new Keynesian model attributes most fluctuations to demand shocks (especially monetary shocks). According to some proponents of the new Keynesian model, productivity fluctuations are not exogenous and could be explained by monetary shocks [see Gali (1999), Hairault and Portier (1993), Evan (1992), Standler (1990), and Mankiw (1989)]. When considering output on the other hand, most of the macroeconomic models focus on the investment component of output as the main source of output fluctuations. Also, the interest rate is mentioned in the literature of most of those models as a transmission variable. Empirically, it has been found that the two components of investment, RI and NRI, react differently to variables such as interest rates, income or output. Further, RI is the part of investment that frequently leads fluctuations in output. Although most of the theoretical models have investment as one of their basic elements, most of the recent empirical work on the relationship between money and output using the VAR method has ignored the distinction between RI and NRI.

CHAPTER TWO

MACROECONOMIC VIEWS

2.1 The Monetarist View

Monetarists explain the observed comovement between money and output as reflecting a causal relationship running from money to economic activity. They admit, however, the existence of a reverse causation from economic activity to money in the short run. The basic model used by the monetarists is the multiplier model of the money supply.[1] In this model, money supply is a multiple of the monetary base. The monetary base is the sum of currency in circulation and bank reserves. It is under the direct control of the central bank (according to this view) and a constraint on the ability of banks to create inside money. Movements in the multiplier represent the endogenous part in the money supply process. However, according to the monetarist view, fluctuations of the multiplier have minor contributions in the long-run growth of money supply. The monetarists employ the following simple model to describe the money supply process:

$$M = C + D$$

$$H = R + C$$

Where M is money supply, H is high-powered money, R is bank reserves, C is currency held by the public, and D is deposits at commercial banks and other financial institutions.

[1] This model, originally developed by Brunner (1961), has become the standard approach to explain how the policy of the Federal Reserve influences the money stock. It also has been used in empirical analyses of the impact of monetary policy actions on other economic variables.

As argued by Cagan (1965) the government, including the Federal Reserve, controls the issuance of high-powered money. Given the level of high-powered money, the public and commercial banks determine its division between currency holdings and bank reserves. The public affects the division by changing the ratio of currency to total money, C/M. Banks change the ratio R/D to affect the division of H between banks and the public. From the above definitions of M and H, Cagan derives the following identities:

$$H/M = (C/M) + (R/D) - (C/R)*(R/D) \text{ or}$$

$$M = H/[(C/M) + (R/D) - (C/M)*(R/D)]$$

The second identity expresses the money supply in terms of the quantity of high-powered money and the currency and reserve ratios. The quantity of money is determined jointly by these three variables. Holding the amount of high-powered money constant, a rise in either ratio reduces the total money stock. Likewise, holding the two ratios constant, a rise in high-powered money increases the aggregate money supply.

By adjusting the monetary base, the central bank creates a surplus or a shortage in reserves available for banks. Increasing reserves induces banks to expand credit. The excess credit and money supply, given a fixed demand for money, spills over into excess demand for other goods and services in the economy. As a result, nominal income spending expands. Friedman and Schwartz (1963a) and Cagan (1965) show that high-powered money is the major factor accounting for changes in the money supply and that changes in high-powered money are mainly produced by government (including the Federal Reserve) actions. On the other hand, the currency and reserve ratios, which are determined by the behaviors of the public and the banks, are minor influences on the money supply. These ratios are a major importance only during periods of financial difficulties in which the public loses confidence in banks.[2] In the short-run, however, monetarists find a clear influence running the other way- from output to money. They refer to the cyclical fluctuations in the reserve ratio as an example of this influence. Cagan (1993) confirms the two-way influence between money and output found by Friedman and Schwartz (1963a) and Cagan (1965). Their final conclusion regarding the direction of influence is that "changes in money are a consequence as well as an independent source of change in income and prices. Mutual interaction, but with money rather clearly the senior partner in the longer-run movements and in major cyclical movements, and more nearly an equal partner with money income and prices in the shorter-run and milder movements" [Friedman and Schwartz (1963a). p. 695]

The monetarist view has been subject to empirical investigation by many economists. Sims (1972) applies Granger causality analysis to test the direction of causality between money and output. Using time series regressions including income and money variables, his main empirical finding is that causality is unidirectional from money to income. However, in a later article, Sims (1980) reexamines the monetarist proposition using a VAR model that includes an interest rate variable in addition to money and income variables. The evidence from this model contradicts his conclusion

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[2] Cagan (1965) finds that, during the period of his study, high-powered money accounted for 90% of the secular changes in the stock of money. The remaining 10% was accounted for by changes in the two ratios. During cyclical fluctuations, the currency ratio was the main contributor to changes in money supply. It was the proximate source of 50% of the variations in the stock of money. High-powered money and the reserve ratio were each responsible for 25% of the overall variation.

from his previous work. He shows that the shocks to the money supply are far from being the primary determinant of short-run movement of real output. Both output and money respond to shocks in interest rates. This common response to interest rates, he argues, explains the empirical correlation between fluctuations in money and output.

Litterman and Weiss (1985) present a dynamic IS-LM model with rational expectations to study the relationship between money, interest, and output. They argue that economic agents have some information about future real activity, which shows up first in the equilibrium price of financial assets, particularly nominal interest rates. The observed comovement between money and output is consistent with a Fed reaction function, which attempts to offset the movements in expected inflation rates arising from anticipated output shocks. Applying a VAR method to test the data, they conclude that the real interest rate is an exogenous variable governed only by its own past history. They confirm the results reached by Sims regarding the dominant role of the interest rate. This conclusion is also confirmed by Tylor (1993), Sims (1992), and Bernake and Blinder (1992).

However, Davis and Tanner (1997), reemphasize the role played by the quantity of money as the main factor influencing output fluctuations. The results of a VAR using yearly data for the 119-year period 1874-1993 show that lagged innovations in money explain output variations at a low level of significance and that interest rates innovations are not significant determinants of output. These results also hold when they run the model using quarterly data.

2.2 The RBC View

A different view on the issue of the correlation between money and output that employs the base-multiplier approach is that of the Real Business Cycle model (RBC). The work of Champ and Freeman (1994), Freeman and Huffman (1991), Plosser (1989), and King and Plosser (1984) capture the main features of the RBC model. The RBC model distinguishes between inside and outside money movements in examining the direction of influence between money and real output. The proponents of this model argue that movements in *outside* money affect only the price level, while the observed correlation between money and output is due to the role of *inside money* [King and Plosser (1984)]. The direction of influence runs from a third real variable (technology shocks) to both inside money and output. In responding to the arrival of new information concerning future technology shocks, innovations in money occur before the innovations in output. The reason for this timing pattern is the fact that money is an intermediate product that can be produced more rapidly than the final products.

Money is an endogenous variable in the RBC model. According to this model, fluctuations in the multiplier (inside money) are determined by fluctuations of the currency ratio, which is outside the control of the central bank. The factors that determine the currency ratio consist of anything that might cause the rate of return on deposits or currency to change. Since deposits -inside money- are used by borrowers to invest in capital, deposits and the multiplier are linked to events in the real economy. An intermediate productivity shock increases all rates of return including the rates on deposits (so that the RBC model predicts interest rates to move procyclically). As a result, the multiplier will increase because individuals will use more deposits and less fiat money (currency ratio will decrease). On the other hand, the productivity shock at time *t* will encourage more investment in period *t*, so output in period *t+1* will increase [Champ and Freeman (1994)].

According to the RBC model, the monetary base is subject to central bank control. Also, variation in the monetary base -outside money- is responsible for variation in prices. Therefore, real activity is neutral with respect to changes in the monetary base [Plosser (1984)].

Other economists have built models that have RBC features. Mossetti (1990) presents a dynamic general equilibrium model that has RBC aspects with a storable good and cash in advance constraint. The main results of his model are that inside money, output, investment, and employment are positively and serially correlated, with inside money and employment changes preceding output and investment fluctuations; inside money changes before output as firms borrow more funds to finance a higher level of production and investment. All these variables respond to unexpected shocks in labor productivity. The model also highlights the different roles played by inside and outside money. The former is used to finance production and investment, the latter is used for transaction purposes and it affects only prices.

Hartely (1998) relates investment to inside money by using a general equilibrium model that emphasizes the role of bank liabilities rather than bank lending. In his model, households demand bank deposits for liquidity service and to finance future consumption. On the other hand, bank liabilities enable banks to finance investment. According to this model, in an economy in which all money is outside money, the equilibrium capital stock reflects the desire of consumers to save for future consumption. When inside money is used, however, the demand for the medium of exchange is harnessed by banks to finance investment. In effect, indirect claims to production capital circulate in place of outside money.

Hartely concludes that an economy with inside money would support extra capital and produce more output. Changes in demand for inside money, or the cost of intermediation, would affect the supply of bank loans and therefore the aggregate level of investment. He shows that when households face borrowing constraints, the stationary equilibrium interest rate on loans to firms is substantially below households' rate of time preference. As a result, the capital stock is constantly higher than the same economy without banks. A shift from inside money to outside money or an increase in banks' cost reduces the total supply of loans to firms.

2.3 The Post Keynesian View

Post Keynesians have developed the view that the money supply is completely endogenous. There are two distinct theories of money supply endogeneity within the post Keynesian model: The first is the accommodative view, which is represented by the work of Wray (1992), Moore (1988), and Kaldor (1985). The other is the structural view whose contributors include Minsky (1986), and Rousseas (1986). Both views share a common starting point in the relationship between money and output: money supply growth is determined by changes in the demand for credit, which reflect changes in real variables. The difference between them is how and where banks obtain the needed reserves to extend more credit.

According to the accommodative view, both outside and inside money are endogenous. The direction of influence runs from credit (investment demand) to deposits (inside money) and from deposits to the monetary base (outside money). Banks supply whatever volume of credit the borrowers in the economy demand. On the other hand, the central bank, being the lender of last resort, must necessarily accommodate the needs of banks for reserves to insure the viability of the financial structure [Wray (1992)].[3] Moore (1988) argues that, while it is possible for the central bank to increase the money supply at its initiative by providing banks with excess reserves, it generally is unable to decrease the money stock at its initiative by withdrawing reserves from the banking system. If it attempts to decrease reserves, the liquidity of the banking system would be imperiled and the interest rate would fluctuate more.

The structural view is distinguished from the accommodative view in that the structural view does not recognize a full accommodation on the part of the central bank in providing reserves. The structuralists emphasize the role played by liability management by banks to provide the reserves needed to extend credit. Banks can attract funds out of demand deposits, which have high reserve requirements, into instruments within the short-term money market such as CD's and federal funds market. The result therefore of

[3] To test the above propositions, Moore relates the monetary base to some macroeconomic variables. Applying the Granger causality test for four monetary aggregates (M1A, M1B, M2 and M3), the monetary base, and bank lending, he presents evidence of unidirectional causality from bank lending to each of the four aggregates. Each monetary aggregate in turn has been shown to Granger-cause the monetary base unidirectionaly. The exception is the feedback relationship found to exist between the monetary base and M2.

liability management is that a large volume of deposits is supported by a given volume of reserves, and more loans are supported by a given level of deposits [see Minsky (1986)].

2.4 The Non-Market-Clearing (NMC) View

The last model presented here is the new Keynesian model, which is the second competing approach (besides the RBC) model of business cycles that arose in the eighties. The new Keynesian model is the principal current theory that incorporates non-market-clearing. That is, in this model, prices do not move to maintain continuous clearing of goods and labor markets. Consequently, changes in aggregate demand cause changes in real output. Further, the NMC approach has the feature that both the demand for labor and the demand for fixed capital depend on the level of output. This implies that fixed investment is an increasing function of output and a decreasing function of interest rates.

The new Keynesian economics shares with the RBC theory the incorporation of microfoundations into macroeconomic models. However, the two models disagree on the source of economic fluctuations. While RBC theory attributes fluctuations in economic activity to technology shocks, the new Keynesian model attributes them to changes in the demand for goods. Consequently, the predictions of the two models regarding the behavior of some economic variables (including interest rates) over the cycle are different. According to the new Keynesian model, the money supply is not neutral and money supply shocks (aggregate demand fluctuations in general) affect output because of the existence of nominal rigidities in the short-run. The model relies on imperfect competition in goods market, the existence of menu costs, and staggered price setting to explain the nonneutrality of money [for an explanation of these features, see Fairise and Longot (1992), Dantine and Donaldson (1990), Cho and Cooly (1990), Ball, Mankiwi and Romer (1988), and Akerlof and Yellen (1985)].[4]

In this view, money affects demand for goods through interest rates. That is, the model predicts that (in contrast with the RBC), at least for a portion of a business cycle movement, interest rates are countercyclical. Another difference between the new Keynesian and the RBC views that is of particular interest for this dissertation regards the determinants of investment. In the non-market clearing new Keynesian model investment is specified as a function of interest rates and output. The former determinant has a negative impact while the latter has a positive impact on investment. In the RBC model, the interest rate and shocks to productivity are the only variables that affect investment.

A few of recent studies focus on comparing real and monetary business cycles models. Gali (1999) compares the new Keynesian and the RBC models and empirically evaluates their different implications regarding the response of hours and productivity to technology and nontechnology shocks using a VAR method.[5] Gali finds that the correlation of hours and productivity are negative for technology shocks, positive for demand shocks. Measured productivity increases temporarily in response to a positive

[4] Greenwald and Stiglitz (1993) present a second stand of new Keynesian thought. They argue that, in the absence of perfect price flexibility, an increase in nominal flexibility would not be stabilizing. Tobin (1993) argues in support of this view.

[5] Gali identifies variation in labor productivity caused by technology and demand shocks. By assuming that only technology shocks can have a permanent effect on labor productivity, he identifies the technology shocks by the unit root in labor productivity.

demand shock, and movements in output and hours attributed to demand shocks are strongly positively correlated and account for the bulk of postwar business cycles. In explaining these results, he argues that the demand constraints and the stickiness of the price level lead technology shocks to generate a negative comovement between hours and productivity, while unobserved effort variations can account for the positive comovement of hours and productivity induced by demand shocks. Overall, his evidence seems to be at odds with the RBC model and largely consistent with the new Keynesian model.

Evans (1992) asks if productivity shocks, which play the central role in RBC models as the impulse to macroeconomic fluctuations, can survive simple exogeneity tests. Using a VAR method to investigate the source of economic fluctuations, he finds that Solow residuals do not behave as an exogenous variable. Rather, the econometric evidence he presents indicates that money, interest rates, and government spending (demand shocks) Granger-cause productivity and that a substantial component of the variance of the impulses in productivity is attributable to variations in aggregate demand.

Stadler (1990) criticizes the conventional monetary and real business cycle models for assuming that evolution of technology is exogenous to the economic system. He presents three models in which technology is modeled as an endogenous variable: a pure monetary model that contains no real shock, an RBC model, and a model that includes both monetary and real shocks. He shows that monetary shocks have a permanent impact on output, and output is nonstationary, even in the absence of exogenous shocks to the supply side. The reason is that changes in demand that raise output can, through a number of channels, exert a permanent influence on the supply side. Stadler gives as an example the effect of demand changes on the utilization of factor input through reorganization and acquisition of new skills [for other studies addressing the issue of the exogeneity of Solow residuals [see Mankiw (1989), Hall (1989), and Summers (1986)]. For another study addressing the issue of the relation between short-run demand fluctuations and long-run growth of the supply-side, see Garrison and Lee (1995).

Hairault and Portier (1993) present a monopolistic competition model with price adjustment cost that contains technology and monetary shocks to answer some empirical puzzles within the RBC methodology.[6] Using data on the US and France, they show that their model better mimics the economic fluctuations and that monetary shocks are necessary to reproduce the money-output correlation.

2.5 Previous Empirical Work Using Disaggregated Variables

Many researchers have focused on disaggregating money into its components, inside and outside money, to examine the propositions of macroeconomic model regarding the source of the correlation between money and output. However, the empirical tests of these propositions have yielded mixed results. Manchester (1989) investigates the role played by components of the money stock in the determination of real output. Her main empirical findings are that changes in the money multiplier (inside money) rather than the monetary base (outside money) are important in determining real

[6] Following Hall (1989), they use adjusted Solow residuals that purge Solow residuals from the monetary shocks. Hall (1989) demonstrates that Solow residuals are *contaminated* by demand shocks in imperfectly competitive models.

output growth and that interest rates do not act as mediators in this process. Shaghil and Radha (1994) confirm some propositions of the RBC model. Using data on the Canadian economy, they conclude that an important source of money-output correlation is the output shocks that affect inside money in the short-run. They further conclude that outside money does not have a causal influence on output. In their model, they impose a long run restriction of neutrality of money. Their results do not support the proposition that outside money is an exogenous variable. Rather, outside money responds primarily to inside money shocks rather than real shocks.

Using different econometric techniques, Thoma (1992) examines the money-income causality issue by using band spectral filtering techniques. His central finding is that relatively low frequency movements in outside money are responsible for the relationship between money and real economic activity. Thoma's results are not supportive of a strong feedback from income to inside money. However, he finds evidence of strong feedback from income to outside money. This result contradicts the prediction of the RBC model that income is more highly correlated with inside money than with outside money. Lacker (1990 and 1988) presents an example in which the same correlation between inside money and output observed by the RBC model results from the arrival of information concerning future monetary policy. He finds that inside money is positively correlated with subsequent innovations in outside money and economic activity. Outside money movements that follow inside money innovations represent policy actions, anticipation of which sparks the inside money innovations.[7] Mossetti (1990) argues that shocks both to productivity and to outside money seem to cause fluctuations in monetary aggregates preceding output movements (because of the production lag). However, he argues that the two types of shocks would imply different time series properties for inside and outside money.

Pollin (1991) establishes empirical criteria to evaluate the two views of the post Keynesian model. These criteria are the proportionality between loans and reserves, the substitutability between borrowed and nonborrowed reserves, and causality in interest rate movements.[8] His overall results are supportive of the structural view over the accommodative view. Palley (1994) compares the two post Keynesian views along with the monetarist view regarding the determination of money supply.[9] Applying Granger causality tests, bank loans were found to Granger-cause the M1 money multiplier and the monetary base was found to Granger-cause bank lending. These are the only directions of causality found. Therefore, Palley's results seem to be more consistent with the structural view.

Other studies using a disaggregated approach decompose movements in outside money into movements due to changes in reserve requirements and changes due to other policy actions such as open market operations or discount window borrowings. Studying

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[7] The finding of Lacker is supported by Garfinkel and Thornton (1991) who point to an interdependence between the actions of the Fed (reflected by the movements in the adjusted monetary base) and the money multiplier. Using a money supply process model, they show that induced changes in the monetary base by the Fed affect the currency to deposit ratio and the multiplier.

[8] Borrowed and nonborrowed reserves are supposed to be strongly substitutable according to the accommodative view. The central bank either provides nonborrowed reserves through open market operations or forces the banks to obtain reserves through the discount window.

[9] He labels these view as the "portfolio approach "for the orthodox monetarist view, the " pure loan demand approach" for the accommodative view and the "mixed portfolio approach" for the structural view.

the relationships between these components with economic activity using a VAR model, Plosser (1991) provides some evidence suggesting that changes in the reserve requirement ratio have real output effects while other monetary policy actions do not. Haslag and Hein (1992) find that both sources of changes temporally lead changes in nominal GNP in a similar fashion. However, the difference in policy action appears when nominal GDP is decomposed into output and price level effects. They find that only shocks to reserve requirements precede changes in real GNP. Rush and Loungani (1995) argue that the increase in reserve requirements not only significantly affects bank profitability but also influences the amount of financial intermediation and aggregate real investment. Using reduced form equations of GNP and private investment as functions of current and lagged values of reserve requirements and certain other macroeconomic variables, they provide evidence that supports the results of Plosser (1991) regarding the real effect of changes in reserve requirements.

On the output side, most of the empirical work on the direction of influence between money and economic activity has not focused on investment and its components. The only study that includes RI in examining the dynamic relationship between money and output is Daniell (1991). The result from his study that includes both RI and GDP along with money supply and interest rates, is that interest rates are strongly causally prior to RI and RI is strongly causally prior to GNP. Green (1997) examines the causal relationship between GDP and the two components of investment, RI and NRI, using Granger-causality tests. He finds that RI Granger causes GDP, but is not caused by GDP, while NRI does not Granger cause GDP but is caused by GDP. Chowdhury, Fackler and

McMillin (1985) estimate individual VAR models analogous to the traditional St. Louis model for each investment component. They find that money supply M1 Granger-causes RI as well as the other components of investment. They also find that when an interest rate is added to the system, there is an indirect causality from M1 to aggregate investment through the effect of M1 on interest rates. Lawrence and Siow (1985) examine the impact of interest rates on investment. Using a VAR model that includes an interest rate, investment, the inflation rate, and GNP, they analyze the dynamic relationship between the variables. They find that the nominal interest rate has a strong and persistent negative effect on aggregate investment spending. In the unrestricted model, they find that the interest rate affects GNP a quarter after affecting aggregate investment. In the restricted model, the interest rate affects both GNP and investment in the same quarter.

As we noticed from reviewing the previous empirical work, the results of the studies are inconclusive regarding the causal relationship between money and real economic activity or the role played by outside and inside money. The main criticism of previous work is that no study has incorporated all the relevant disaggregated variables. Most of the studies focus on disaggregating money into outside and inside money. However, the authors of these studies have ignored the importance of including the disaggregated components of investment (or even aggregate investment) in their analysis. Additionally, the timing factor has not been addressed. Furthermore, except for a few studies, outside money has been measured by the monetary base. This broad definition of outside money may not be an accurate representation of exogenous monetary changes. One objective of this study is to determine whether outside money as measured by nonborrowed reserves produces the expected negative effect of money fluctuations on interest rates, while using the monetary base does not provide this evidence. The failure to use an accurate measure of exogenous money might be responsible for the mixed and contradictory results reached by earlier studies regarding the roles of inside and outside money.

The few studies that disaggregate investment, on the other hand, do not study money and investment in the context of the dynamic relationship (within a VAR approach) between money and output defined in this research. Their focus is strictly on studying the behavior of investment. Furthermore, they do not disaggregate the monetary variables. Another possible problem with earlier studies is the econometric technique employed. The VAR model should not be applied if the series are cointegrated. However, the cointegration test applied in this research shows that the series of data used here are cointegrated, in which case the Error Correction model should be applied. The studies reviewed here do not address this issue.

CHAPTER THREE

THE VECTOR AUTOREGRESSION METHOD

3.1 The Nature of the VAR Method

Nonstructural Vector Autoregression (VAR) techniques are used here as the main methods to examine short-term relationships between the variables.[10] Variance Decomposition and Impulse Response Functions from the VAR model are utilized to test the directions and the channels of influence between the variables. Issues related to applying the VAR method and the usefulness of it in investigating the source of causation between the variables are addressed in this chapter.

Traditionally, empirical macroeconomic research begins with the use of theory to construct a structural econometric model to describe the dynamic relationships between economic variables. These models are highly restricted and require complicated econometric techniques to be estimated. Also, the use of structural models would bias the results in favor of the theory they are designated to reflect; Cooley and Le Roy (1985). An alternative approach to modeling macroeconomic time series has come into wide use. This alternative, introduced by Sims (1980), suggests the use of vector autoregression (VAR) models to analyze time series relationships among macroeconomic variables. VARs are atheoretical, nonstructural models, that require few theoretical assumptions or restrictions to be placed on the individual regression equations. The VAR

[10] Strongin (1992) and (1995), Christiano and Eichenbaum (1991) and Guirguis (1999) employ a similar method.

approach is thus believed to be largely free of the spurious specification assumptions and consequent specification errors necessitated by traditional macroeconometric procedures.

In VARs, all variables can be considered endogenous. Each equation in the model includes lagged values of all the variables in the system. The following example is the model used by Sims (1980).

$$r_t = k_r + \sum_{i=1}^{12} a_{ri} r_{t-i} + \sum_{i=1}^{12} b_{ri} m_{t-i} + \sum_{i=1}^{12} c_{ri} p_{t-i} + \sum_{i=1}^{12} d_{ri} y_{t-i} + e_{rt}$$

$$m_t = k_m + \sum_{i=1}^{12} a_{mi} r_{t-i} + \sum_{i=1}^{12} b_{mi} m_{t-i} + \sum_{i=1}^{12} c_{mi} p_{t-i} + \sum_{i=1}^{12} d_{mi} y_{t-i} + e_{mt}$$

$$p_t = k_p + \sum_{i=1}^{12} a_{pi} r_{t-i} + \sum_{i=1}^{12} b_{pi} m_{t-i} + \sum_{i=1}^{12} c_{pi} p_{t-i} + \sum_{i=1}^{12} d_{pi} y_{t-i} + e_{pt}$$

$$y_t = k_y + \sum_{i=1}^{12} a_{yi} r_{t-i} + \sum_{i=1}^{12} b_{yi} m_{t-i} + \sum_{i=1}^{12} c_{yi} p_{t-i} + \sum_{i=1}^{12} d_{yi} y_{t-i} + e_{yt}$$

Where t is time; r, m, p, and y are the interest rate, money supply, price level, and output, respectively; the k, a, b, c, and d terms are the unknown coefficients that determine how the variables interact; and the e's are the error terms. The error terms in the VAR model capture the unexpected or surprise movements in each variable. The number of lags chosen by Sims, i, is twelve (he uses monthly data). The only restrictions imposed are the variables included in the model, the number of lags and the ordering of the variables. The unknown parameters, which are 49 in each equation, can be estimated by applying ordinary least squares regression to each equation separately.

VAR models, like the one described above, can be used for causality tests and innovation accounting analysis. These two applications will be the focus of the analysis of this research. Hence, they will be briefly described in the following paragraphs. Other uses of VARs are forecasting, test of theories, hypothesis seeking, data characterization, and policy analysis. For more details on these uses, see Cooley and LeRoy (1985).

3.2 Granger Causality Tests

If we have two time series $\{m_t\}$ and $\{y_t\}$ interacting according to the following model:

$$m_t = \pi_{11}\, m_{t-1} + \pi_{12}\, y_{t-1} + u_{mt} \quad \text{3.1}$$

$$y_t = \pi_{21}\, m_{t-1} + \pi_{22}\, y_{t-1} + u_{yt} \quad \text{3.2}$$

The series $\{y_t\}$ fails to Granger-cause $\{m_t\}$ according to the Granger test if, in a regression of m_t on lagged m and lagged y_t, the latter takes on a - not significantly different from- zero coefficient. That is, the coefficient π_{12} in the first equation must equal zero. Similarly, $\{y_t\}$ fails to Granger-cause $\{m_t\}$ according to Sims (1972) if, in a regression of y_t on lagged y_t and future m_t (if we add m_{t+1} to the right hand sides of 3.2), the latter takes on a - not significantly different from- zero coefficient. In these cases, it is said that m_t is exogenous with respect to y_t. If on the other hand, the coefficient π_{21} is nonzero, then m_t does Granger-cause y_t.

This test is criticized on the ground that it does not imply a cause-and-effect relationship. It implies the existence of empirical correlation between the variables. To show that, consider again the above two-variable VAR model. It is a reduced form of the following structural model:

$$m_t = \Phi y_t + \beta_{11}\, m_{t-1} + \beta_{12}\, y_{t-1} + \varepsilon_{1t} \quad \text{3.3}$$

$$y_t = \gamma m_t + \beta_{21}\, m_{t-1} + \beta_{22}\, y_{t-1} + \varepsilon_{2t} \quad \text{3.4}$$

where the error terms, ε_{1t} and ε_{2t} are contemporaneously and serially uncorrelated. From these equations, m is predetermined for y if $\Phi=0$, while m is strictly exogenous for y if $\Phi=\beta_{12}=0$. From the reduced form model, y fails to Granger-cause m if $\pi_{12}=0$. Now, π_{12} is given by

$$\pi_{12} = (\Phi\beta_{22}+\beta_{12})/(1-\Phi\gamma)$$

It is clear that non-causality is neither necessary nor sufficient for predeterminedness: $\Phi=0$ neither implies nor is implied by $\pi_{12}=0$. Cooley and LeRoy (1985) argue that Granger and Sims tests are irrelevant to whether a causal interpretation of a conditional correlation is justified. Further, predeterminedness is also the exogeneity concept relevant for econometric estimation. Therefore, Granger causality test results can not be used to prove the direction of causation from one variable to another. It can be used to show that one variable can help forecast another variable [Hamilton (1994)].

3.3 Innovation Accounting Analysis

Innovation accounting analysis refers to two tools used to trace the impact of shocks (innovations) in the VAR system. These tools were introduced by Sims (1980) to measure the dynamic interaction among the variables. The first, the *forecast error variance decomposition* (FEVD), analyzes the errors the model would tend to make if it were used to forecast its variables. The FEVD shows how much of the average squared forecast error, which the model tends to make, is caused by innovations associated with each of the variables in the model. The FEVD of a variable thus can suggest that forces associated with one variable are major influences on the evolution of another variable.

A covariance stationary vector time series process has a vector moving average representation. That is, each variable can be expressed as a linear combination of its own current innovation (error) and lagged innovations of all the variables in the system. If there is no contemporaneous correlation among the innovations, it is possible to uniquely decompose the variance of each variable into components accounted for by each innovation. In general, however, the innovations are contemporaneously correlated and so a unique decomposition does not exist. This problem is usually "resolved" by applying a triangular orthogonalizing transformation to the vector of innovations in order to obtain a new vector of "orthogonalized innovations" which are contemporaneously uncorrelated. This transformation is not unique and by selecting one, the researcher arbitrarily imposes a particular causal ordering on the variables in the VAR model.

The other tool, *the impulse response function* (IRF), shows how one variable responds over time to a single innovation in itself or in another variable. Specifically, it traces the effect on current and future values of the endogenous variable of a one standard deviation shock to one of the innovations. Innovations or surprise movements are jointly summarized by the error terms of the VAR model. For derivation of the FEVD and IRF from a VAR model, see appendix C.

The ambiguity in interpreting impulse response functions arises from the fact that the errors are never totally uncorrelated. When the errors are correlated they have a common component which cannot be identified with any specific variable. A somewhat arbitrary method of dealing with this problem is to attribute all of the effect of any common component to the variable that comes first in the VAR system. In our example of Sims (1980) model described above, the common component of e_{rt} and e_{mt} is totally attributed to e_{rt} because e_{rt} precedes e_{mt}. Changing the order of equations can dramatically change the impulse responses and care should be given to interpreting the impulse response functions. For a full technical discussion of these issues, see Hamilton (1994), pp. 318-323.

3.4 VAR Specification Issues

The following issues are related to specifying VAR models. Alternative specifications differ with respect to ordering of variables, method of "trend" removal, lag length on the VAR equations, and level of temporal aggregation. These issues must necessarily be addressed beyond the choice of variables to be included.

3.4.1 Ordering of Variables

Ordering of the variables always matters when an unrestricted VAR is considered. As indicated previously, the conventional orthogonalization procedure requires imposing a particular causal ordering of the variables. This choice is arbitrary and, when there is contemporaneous correlation among the innovations, it can make a significant difference for the variance decomposition. Therefore, the empirical results may depend to a large extent on the ordering of the variables, and no econometric technique is available to determine the right ordering. This problem has been widely criticized as a deficiency of VAR methods. Noting the potential sensitivity of innovation accounting results to ordering, it is generally recognized that, for results to be considered conclusive, they must be robust to ordering.

3.4.2 Transforming Nonstationary Data

The validity of the VAR approach relies on the presumption that the economic variables under consideration are covariance stationary. Granger causality tests are not applicable if the data are nonstationary. Data are said to be stationary if neither the mean nor the autocovariances (including the variance) of the error terms depend on time. Using a VAR terminology, the effect of a shock to the error terms on the endogenous variables must eventually die out for the data to be stationary. Thus, it may be important to induce stationarity by appropriately transforming any nonstationary series, a process referred to as "trend removal." Differencing the data or including a time trend variable in the model are among the common practices of transforming nonstationary data. Alternative detrending transformations will yield variables with different time series properties and thus generate different variance decomposition results.

There are appropriate tests, such as the Dickey and Fuller test, that can be used to determine whether the data are nonstationary. In this study, data are used in a growth rate form. Usually, data expressed in this form are expected to be nonstationary. The Dickey and Fuller test will be applied to the growth rates data to test for nonstationarity.

3.4.3 Lag Length

The empirical evidence from a VAR model is very sensitive to the choice of lag length in the equations of the model. Alternative choices will give different innovations series and thus will likely make a difference in the variance decomposition results. The appropriate lag length could be tested using the likelihood ratio test, the Akaike Information Criterion or the Schwarz Criterion. In this study, the lag length will be specified based on these criteria and the results obtained in each case will be compared. Changing the lag length will also test the robustness of the empirical results.

3.4.4 Frequency of the Data

The frequency of the data or the level of temporal aggregation has two implications in the VAR model. The first is the short-run and long-run interaction between the variables. Temporally disaggregated series like monthly data or quarterly data capture the short-run relationship between the variables. If the purpose is to study long-run relationships, yearly data might be the right level of temporal aggregation to be used. The other implication is a statistical one. The fact that contemporaneous correlation among innovations is likely to increase as the data become more temporally aggregated suggests that results using semiannual or annual data are likely to be more sensitive to choice of ordering. Furthermore, using temporally disaggregated data increases the sample size. However, monthly data may be too frequent to reflect the "natural" interval in the relationship between money and output. On the other hand, data that have been aggregated by averaging over time are likely to be less noisy and thus may be better able to correctly find such relationships. Most of the empirical work done using VARs has employed either monthly or quarterly data. In this research, quarterly data will be used in the VAR analysis.

3.4.5 Cointegration and the Error Correction Model

Cointegration exits when a group of nonstationary variables has a linear combination of them that is stationary. Cointegration means that although many developments can cause permanent changes in the individual elements of the group, there is some long-run equilibrium relation tying the individual components together. If the group is cointegrated, then it is not correct to fit a VAR to the differenced data [Hamilton (1994)]. As argued by Engle and Granger (1987), the VAR estimated with cointegrated data (without including the cointegration term) will be misspecified. However, another representation of VAR, the Error Correction model (EC), can be used. It is a VAR model for data in difference form augmented by the error correction term. In an EC model the short-run dynamics of the variables in the group are influenced by the deviation from an equilibrium relationship. If we have an (n×1) vector X= (X1t, X2t,.....Xnt)′, it has an EC representation if it can be expressed in the form:

$$\Delta Xt = \pi 0 + \pi\ Xt\text{-}1 + \pi 1\ \Delta\ Xt\text{-}1 + \pi 2\ \Delta\ Xt\text{-}2 + \ldots\ldots\ldots\ldots + \pi p\ \Delta\ Xt\text{-}p + \varepsilon t$$

where $\pi 0$: an (n×1) vector of intercepts with elements $\pi i0$

πi: (n×1) coefficients matrices with elements $\pi ik(i)$

π: is a matrix with elements πij such that one or more of $\pi ij \neq 0$

εt: an (n×1) vector with elements εit

The π Xt-1 represents the error correction term, which captures the conitegrated long-run relationship between the variables in the model. As discussed above, this conintegration term is stationary. We can see this from the above model because it can be expressed as a linear function of stationary variables, that is

$$\pi X_{t-1} = \Delta Xt - \pi_0 - \pi_1 \Delta X_{t-1} - \pi_2 \Delta X_{t-2} - \ldots\ldots\ldots\ldots - \pi_p \Delta X_{t-p} - \varepsilon t$$

If all elements of π equal zero, the above model is a traditional VAR in first difference form. As in the traditional VAR analysis, the innovation accounting (Impulse Responses and Variance Decomposition) can be used from the EC model to obtain information concerning the interaction between the variables.

To sum up, VARs are relatively simple type models that have become popular among economist to gather evidence on the business cycle dynamics. All variables in a VAR can be treated endogenous in the system. Further, the user of the VAR method imposes few restrictions and generally can use ordinary least squares estimation procedure. Using the VAR method is, however, controversial. The main criticism of the VAR method is that the statistics from VARs are sensitive to alternative specifications.

The dynamic nature of VARs is of special importance for this dissertation. The VAR method allows all variables to be endogenous. This is valuable because competing macro theories have different exogenous shocks (shocks to productivity in the RBC model, to money in the new Keynesian model, etc.). Allowing all variables to affect, and to be affected, by other variables helps to examine all types of shocks in the economy. For the specific variables used in this dissertation, the VAR model will allow residential investment to be endogenous (affected by money and interest rates), but also to affect output. Output, in turn, will be allowed to be endogenous but also, as predicted by the Non-Market-Clearing model, to affect investment.

CHAPTER FOUR

EMPIRICAL RESULTS FOR THE FULL SAMPLE PERIOD

This chapter investigates the dynamic relationship between the variables using correlation analysis and VAR models for the full sample period 1959.3-1998.4. Before estimating final models, a few issues need to be addressed regarding the application of the VAR method. The first step is testing the stationarity of each series. If data series are nonstationary, cointegration tests will be applied to each system of variables to be used for estimation. If the data are not cointegrated, the growth rate form of the data will be used in the VAR estimation. If cointegration exists, the Error Correction model will be applied. Given the sensitivity of the VAR results to the lag length, for each model the lag length will be determined before final estimation according to three criteria. These are the Likelihood Ratio (LR), the Akaike Information Criterion (AIC), and the Schwarz Criterion (SC). Finally, the results should be robust to the ordering of the variables to be considered conclusive.

The following are the potential variables of interest for the study. All of them are in log linear form. Variables expressed in real form are the GDP, FI, RI and NRI. GDP is Gross Domestic Product, FI is Total Fixed Business Investment, RI is Residential Fixed Investment, NRI is Nonresidential (Business) Fixed Investment. Variables expressed in nominal form are M2, MB, TR, NBR, K, and Tbr. M2 is The Money Supply M2, MB is the Monetary Base, TR is Total Reserves, NBR is Nonborrowed Reserves, K is the Money Multiplier, and Tbr is the three-month Treasury Bill Rate. The

VAR analysis will start with the most aggregated form of the variables; then, the monetary variables will be disaggregated. Investment and its components will be introduced later in the analysis.

4.1 The VAR model

The VAR model estimated using all the variables takes the following form [similar to models used by Guirguis (1999)]:

$$NBR_t = k_1 + \sum_{i=1}^{n} a_{1i} NBR_{t-i} + \sum_{i=1}^{n} b_{1i} Tbr_{t-i} + \sum_{i=1}^{n} c_{1i} RI_{t-i} + \sum_{i=1}^{n} d_{1i} K_{t-i} + \sum_{i=1}^{n} g_{1i} Y_{t-i} + \sum_{i=1}^{n} f_{1i} NRI_{t-i} + h1CO + e_{1t}$$

$$Tbr_t = k_2 + \sum_{i=1}^{n} a_{2i} NBR_{t-i} + \sum_{i=1}^{n} b_{2i} Tbr_{t-i} + \sum_{i=1}^{n} c_{2i} RI_{t-i} + \sum_{i=1}^{n} d_{2i} K_{t-i} + \sum_{i=1}^{n} g_{2i} Y_{t-i} + \sum_{i=1}^{n} f_{2i} NRI_{t-i} + h2CO + e_{2t}$$

$$RI_t = k_3 + \sum_{i=1}^{n} a_{3i} NBR_{t-i} + \sum_{i=1}^{n} b_{3i} Tbr_{t-i} + \sum_{i=1}^{n} c_{3i} RI_{t-i} + \sum_{i=1}^{n} d_{3i} K_{t-i} + \sum_{i=1}^{n} g_{3i} Y_{t-i} + \sum_{i=1}^{n} f_{3i} NRI_{t-i} + h3CO + e_{3t}$$

$$K_t = k_4 + \sum_{i=1}^{n} a_{4i} NBR_{t-i} + \sum_{i=1}^{n} b_{4i} Tbr_{t-i} + \sum_{i=1}^{n} c_{4i} RI_{t-i} + \sum_{i=1}^{n} d_{4i} K_{t-i} + \sum_{i=1}^{n} g_{4i} Y_{t-i} + \sum_{i=1}^{n} f_{4i} NRI_{t-i} + h4CO + e_{4t}$$

$$Y_t = k5 + \sum_{i=1}^{n} a_{5i} NBR_{t-i} + \sum_{i=1}^{n} b_{5i} Tbr_{t-i} + \sum_{i=1}^{n} c_{5i} RI_{t-i} + \sum_{i=1}^{n} d_{5i} K_{t-i} + \sum_{i=1}^{n} g_{5i} Y_{t-i} + \sum_{i=1}^{n} f_{5i} NRI_{t-i} + h5CO + e_{5t}$$

$$NRI_t = k6 + \sum_{i=1}^{n} a_{6i} NBR_{t-i} + \sum_{i=1}^{n} b_{6i} Tbr_{t-i} + \sum_{i=1}^{n} c_{6i} RI_{t-i} + \sum_{i=1}^{n} d_{6r} K_{t-i} + \sum_{i=1}^{n} g_{6i} Y_{t-i} + \sum_{i=1}^{n} f_{6i} NRI_{t-i} + h6CO + e_{6t}$$

Where t is time; Y is real GDP, NBR, Tbr, RI, K, and NRI are as defined earlier; CO is a vector of the variables in level form and represents the cointegration term in each equation; the k, a, b, c, d, f, g, and the h terms are the unknown coefficients that determine how the variables interact; and the e's are the error terms. All the variables are expressed in difference form. The error terms in the VAR model capture the unexpected or surprise movements in each variable. The only restrictions imposed are the variables included in the model, the number of lags and the ordering of the variables. The unknown parameters can be estimated by applying ordinary least squares regression to each equation separately.

To identify the system, Choleski decomposition is used. This scheme gives exact identification to the VAR model. The constraint imposed according to Choleski decomposition is that variables ordered first in the system have contemporaneous effects on the variables that follow them in the order, while variables ordered last do not have contemporaneous effects on the variables that precede them in the order. In general, the identification of relationships between the variables in the VAR model is guided by a traditional Keynesian IS-LM view of the monetary transmission mechanism. The economic rationale for placing NBR first is that movements in NBR are assumed to be independent of economic activity and under the direct control of the Fed. This identification scheme is consistent with Guirguis (1999), Strongin (1992), Leeper (1992) and Christiano and Eichenbaum (1991).

The ordering of the rest of the variables is based on the following chain of causality. Exogenous changes in money initiated by the Fed affect interest rates. This assumption is consistent with Fed policy of targeting interest rates. Interest rates, in turn, are assumed to have a direct and a rapid impact on RI. As such, RI is ordered third. This assumption seems to be reasonable and consistent with findings of many studies that RI is more interest sensitive than NRI or GDP. Endogenous money response is identified by allowing movements in inside money (the multiplier) to follow innovations of interest rates and residential investment. However, inside money movements are ordered before GDP in the model. The assumption is consistent with the result from the correlation analysis in the next section that fluctuations in inside money precede GDP fluctuations. It is also consistent with the view that inside money changes precede output changes because inside money are more rapidly produced than final products. While RI is ordered before GDP, NRI is ordered last after GDP. This assumption is consistent with the stylized fact of business cycle that RI leads the cycle while NRI lags behinds it. It is also consistent with the findings of Green (1997) that RI Granger-cause GDP, but is not caused by GDP, while NRI does not Granger-cause GDP but is caused by GDP [see Garrison (1991) for similar findings]. Other orderings of the variables will be examined to test the results for robustness.

4.2 Correlation Analysis

The approach used here to study the correlation between the variables is based on separating the cyclical movements from trends in the variables. The assumption made is that economic variables evolve along underlying growth paths, which can be thought of as trends. Short term or cyclical fluctuations are deviations from trends. The correlation between deviations of one variable from its trend and deviations of another variable from its trend measures the degree of association between surprise or unexpected shocks between the two variables. There are different methods to estimate the trend of a variable. In the following analysis, data have been transformed according to the Hodrick and Prescott (HP) procedure, see Hodrick and Prescott (1980). Following this procedure, deviations of each series from its trend have been calculated. The trend component $\acute{Y}$ of a variable y is calculated by minimizing the following function with respect to $\acute{Y}$:

$$\Sigma_1^T (y_t - \acute{Y}_t)^2 + \gamma\ \Sigma_2^{T-1} [(y_{t+1} - \acute{Y}_t - (\acute{Y}_t - \acute{Y}_{t-1}]^2.$$

Where γ is a positive number chosen to produce a smooth trend. For quarterly data $\gamma = 1600$ is reasonable [see Kydland and Prescott (1990)].

Transformed series are nonstationary. The correlation between variables that have been transformed according to this procedure gives an estimate of the correlation between the variables during business cycles [see Kydland and Prescott (1990)].

For the monetary variables, Table 4.1 presents the cross correlation between money and its components, outside money, measured by the monetary base, and inside money, measured by the multiplier. We see that the monetary base has the lowest fluctuations, while the multiplier has the highest fluctuations. It is also clear from the table that deviations of money supply M2 around its trend are strongly associated with the fluctuations in the multiplier. These correlation coefficients are positive. The correlation with the monetary base, on the other hand, is smaller and negative for the

TABLE 4.1: CROSS CORRELATION OF THE MONETARY BASE AND THE MULTIPLIER WITH MONEY SUPPLY M2. QUARTERLY DATA, 1959.3-1998.4

Variable	Volatility *	M2(t-4)	M2(t-3)	M2(t-2)	M2(t-1)	M2t	M2(t+1)	M2(t+2)	M2(t+3)	M2(t+4)
Money M2	0.0144	0.23	0.42	0.63	0.85	1	0.85	0.63	0.42	0.23
Monetary base	0.0121	-0.41	-0.44	-0.36	-0.22	-0.04	-0.01	0.01	0.08	0.19
Multiplier	0.0192	0.44	0.60	0.70	0.76	0.77	0.64	0.44	0.23	0.03

** Standard deviation from the trend; $[\Sigma_1^T (y_t - \acute{Y}_t)^2]/n$, where y is the series, $\acute{Y}_t$ is the trend component, and N is the number of observations. HP filter was used to transform the original series to deviations from their trends.*
Source: Author's calculations.

current and lagged quarters. The reason for this pattern is that monetary base fluctuations cause fluctuations in the multiplier in the opposite direction. The correlation results are consistent with the fact that the largest part of the monetary aggregate M2 is inside money (deposits). Still, the negative impact of the monetary base on inside money needs more investigation. A possible explanation is that policy-induced increases in outside money during recessions do not necessarily induce banks to extend more credit. As a result, the reserve ratio or the currency ratio increases, resulting in a decrease in the multiplier. By the same token, the multiplier ratios respond negatively to decreases in the monetary base during expansions.

Table 4.2 summarizes the cross correlation among all the variables. Only the significant correlation coefficients are reported. In the lead and lag columns, the highest correlation between the variables in the lead and lag periods is reported. All the series have been filtered using the HP procedure. The figures in the lead/lag column indicate that the variable leads/lags the listed variables. For example, in the first row, M2 leads GDP with a correlation coefficient of 0.55, and lags GDP with a correlation coefficient of 0.21.

The cross correlation coefficients presented in Table 4.2 provide the following preliminary evidence on the pattern of interactions between the variables:

1- Monetary variables tend to lead the real variables.

2- Of the monetary aggregates, the nonborrowed reserve has the highest negative correlation with the interest rate. It is also the only monetary aggregate that leads the interest rate negatively.

TABLE 4.2: CROSS CORRELATION COEFFICIENTS BETWEEN THE MONETARY AND REAL VARIABLES (DEVIATION FROM TREND, 1959.3-1998.4)

Variables		Lead			Contemporaneous		Lag		
		Sign	Correlation	Quarter	Sign	Correlation	Sign	Correlation	Quarter
M2 with:	GDP	+	0.55	3	+	0.40	+	0.21	1
	FI	+	0.53	2	+	0.44	+	0.21	1
	RI	+	0.55	1	+	0.55	+	0.43	1
	NRI	+	0.50	4			-	0.37	4
	Tbr				-	0.20	-	0.40	2
Multiplier (K) with:	GNP	+	0.31	4	+	0.25	-	0.19	4
	FI	+	0.29	2			-	0.24	4
	RI	+	0.29	1	+	0.25			
	NRI	+	0.21	4			-	0.26	4
	Tbr				-	0.24	-	0.30	2
MB with:	GDP	+	0.19	1	+	0.17	+	0.18	1
	FI	+	0.22	1	+	0.24	+	0.22	1
	RI	+	0.17	2	+	0.25	+	0.30	2
	NRI	+	0.26	3					
	Tbr						-	0.35	4
TR with:	GDP								
	FI	+	0.24	1	+	0.25	+	0.23	1
	RI	+	0.36	1	+	0.34	+	0.28	1
	NRI	+	0.20						
	Tbr			3	-	0.20	-	0.41	3
NBR with:	GDP	+	0.17	4	-	0.19	-	0.28	1
	FI	+	0.21	4			-	0.22	2
	RI	+	0.30	2					
	NRI	-	0.35	1	-	0.34	-	0.30	1
	Tbr	-	0.41	1	-	0.54	-	0.44	2
FI with:	GDP	+	0.82	1	+	0.90	+	0.81	1
	RI	+	0.55	1	+	0.79	+	0.87	1
	NRI	+	0.83	2	+	0.72	+	0.48	1
	Tbr	+	0.36	4	+	0.21	-	0.56	4
RI with:	GDP	+	0.73	1	+	0.64	+	0.41	1
	NRI	+	0.71	1			-	0.55	4
	Tbr	+	0.28	4			-	0.72	4
NRI with:	GDP	+	0.51	1	+	0.74	+	0.82	1
	Tbr	+	0.52	1	+	0.53	+	0.44	1
GDP with	Tbr	+	0.44	2	+	0.31	-	0.51	4

Each series has been filtered according to HP procedure. Where GDP is the Gross Domestic Product, M2 is the Money Supply M2, multiplier is the money multiplier, MB is the Monetary Base, NBR is nonborrowed reserves, TR is total reserves, FI is total Business Fixed Investment, RI is the Residential Fixed Investment, NRI is the Nonresidential Business Fixed Investment, Tbr is the three-month Treasury Bill Rate.
Source: Author's calculations.

3- The monetary variables have greater and more immediate effects on residential investment (RI) than on the other output variables (GDP, FI, and NRI).

4- Total fixed investment has a strong contemporaneous correlation with GDP. The residential component of investment has a strong leading effect on GDP, while the nonresidential component is strongly led by GDP.

5- The most significant negative effect of the interest rate is on RI, then on FI and GDP. However, the correlation between the interest rate and NRI is positive. Also, NRI has a leading positive effect on the interest rate.

The above correlation patterns are consistent with behaviors of those variables during business cycles found by other studies. Kydland and Prescott (1990) show that the monetary base does not lead the cycle while the money supply aggregate, M2, leads the cycle by a couple of quarters. That points to a leading behavior of the M2 multiplier, inside money, in the cycle,[11] Table 4.3. As for the investment and output variables, it is well known that fixed investment spending is strongly procyclical; investment generally fluctuates more than GDP. The two components of fixed investment, RI and NRI, are both strongly procyclical but have different lead-lag relationships with output fluctuations [see Garrison (1991) for possible explanation of this phenomenon]. While total fixed investment moves coincidentally with GNP over the cycle, the residential component of

[11] Kydland and Prescott (1990 defined the trend based on the steady state growth theory and measured the cyclical fluctuations by the deviation of GNP growth from its trend.

TABLE 4.3 : CYCLICAL BEHAVIOR OF U.S. OUTPUT AND MONEY, DEVIATION FROM TREND, QUARTERLY 1954-1989*

		Cross correlation of Real GDP with										
Variable X	Volatility	X(t-5)	X(t-4)	X(t-3)	X(t-2)	X(t-1)	Xt	X(t+1)	X(t+2)	X(t+3)	X(t+4)	X(t+5)
GDP	1.71	-0.03	0.15	0.38	0.68	0.85	1	0.85	0.63	0.38	0.15	-0.03
Fixed Investment	5.38	0.09	0.25	0.44	0.64	0.83	0.9	0.81	0.6	0.35	0.08	-0.14
Nonresidential	5.18	-0.26	-0.13	0.05	0.31	0.57	0.8	0.88	0.83	0.68	0.46	0.23
Residential	10.89	0.42	0.56	0.66	0.73	0.73	0.6	0.37	0.1	-0.15	-0.34	0.45
Monetary base	0.88	-0.12	0.02	0.14	0.25	0.36	0.4	0.4	0.37	0.32	0.28	0.26
M1	1.68	0.01	0.12	0.23	0.33	0.35	0.3	0.22	0.15	0.09	0.07	0.07
M2	1.51	0.48	0.6	0.67	0.68	0.61	0.5	0.26	0.05	-0.15	-0.33	-0.46
M2-M1	1.91	0.53	0.63	0.67	0.65	0.56	0.4	0.2	-0	-0.21	-0.39	-0.53
Real Interest Rate**	2.39	-0.33	-0.28	-0.21	-0.1	0.01	0.11	0.17	0.19	0.21	0.21	0.19

**Data source: Kydland and Prescott (1990), tables 2 and 3.*
***Data for interest rate from Fiorito and Kollintzas (1994).*

investment leads the cycle and the nonresidential component lags the cycle. Interest rates lead the cycle negatively and move with the cycle and lag it positively. Fiorito and Kollintzas (1994) provide evidence for this pattern in the G7 countries (Figures 4.1- 4.3).

The above facts show evidence of the differential timing of the cyclical behavior of the disaggregated variables. They give a strong justification for using disaggregated, rather than aggregated, variables in studying the relationship between money and output. The following hypotheses regarding the interaction between the variables are formulated based on the preliminary evidence presented above:

- Since the expected negative effect of monetary changes on the interest rate (the liquidity effect) can be detected only from the correlation of nonborrowed reserves with

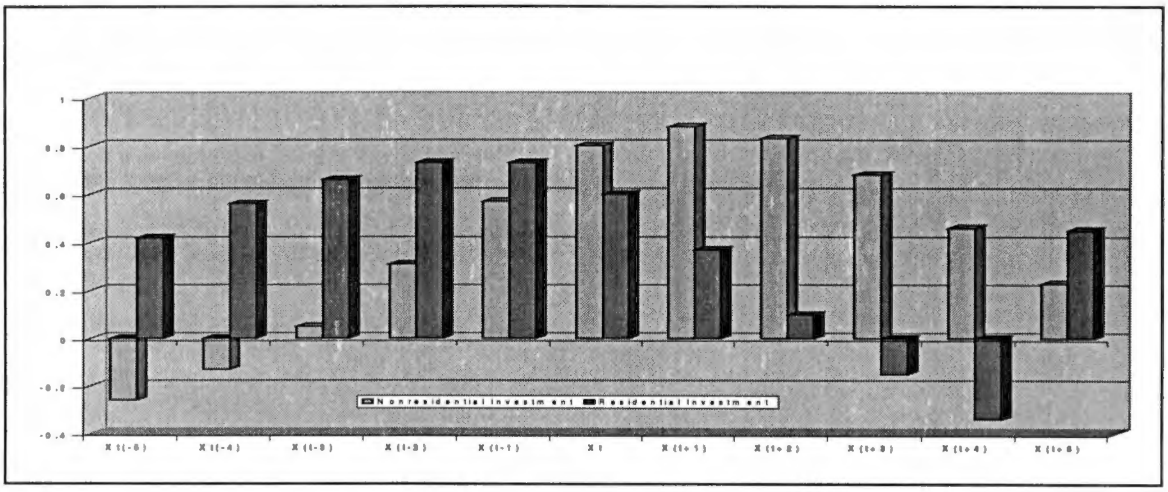

FIGURE 4.1: CYCLICAL BEHAVIOR OF RESIDENTIAL AND NONRESIDENTIAL INVESTMENT

The vertical axes measures the correlation of the variable x with output. The horizontal axes show the quarters, i.e. Xt-1 is the correlation between RI lagged one quarter with output at time t. Quarterly 1954-1989. Data source: Kydland and Prescott (1992),Table 3.

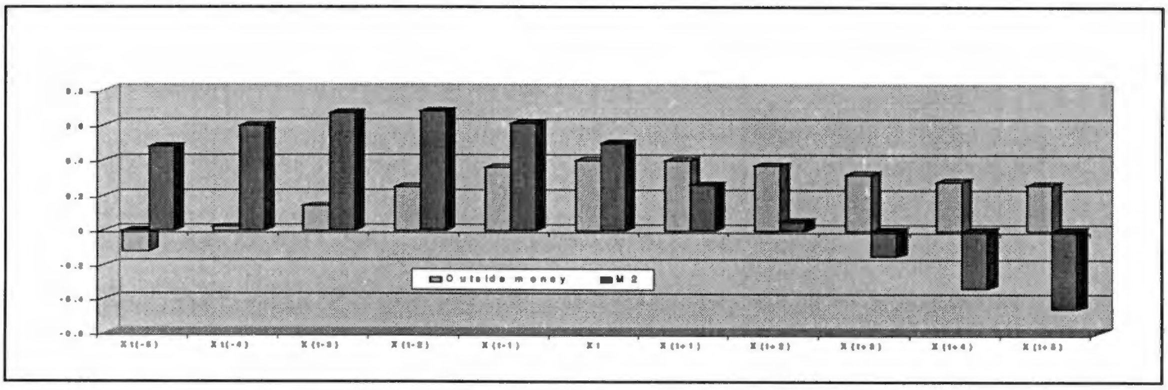

FIGURE 4.2: CYCLICAL BEHAVIOR OF INSIDE AND OUTSIDE MONEY

The vertical axes measures the correlation of the variable x with output. The horizontal axes show the quarters, i.e. Xt-1 is the correlation between RI lagged one quarter with output at time t. Quarterly 1954-1989. Outside money is measured by the monetary base. Data source: Kydland and Prescott (1992),Table 3.

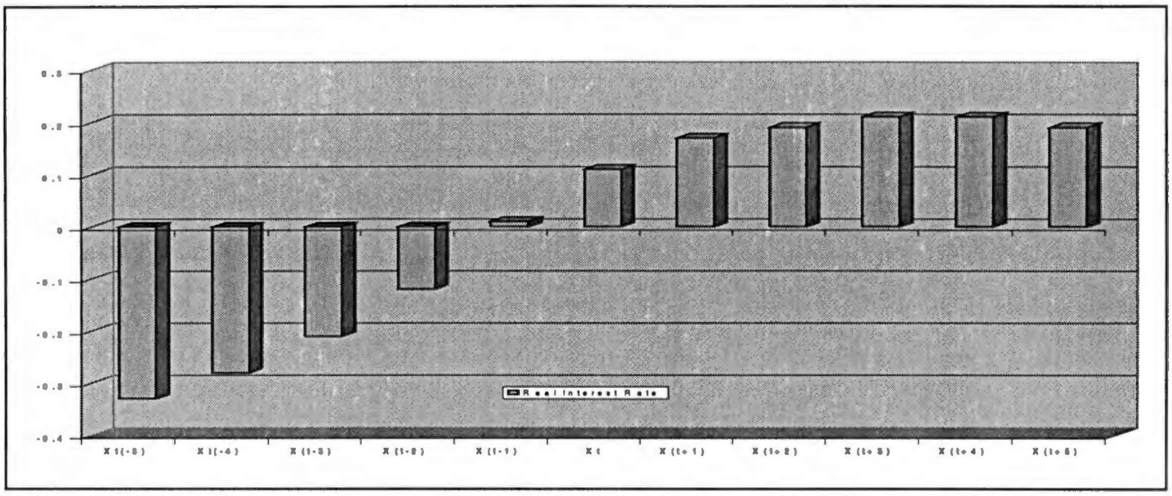

FIGURE 4.3: REAL INTEREST RATE CYCLICAL BEHAVIOR

The vertical axes measures the correlation of the variable x with output. The horizontal axes show the quarters, i.e. Xt-1 is the correlation between interest rate lagged one quarter with output at time t. Quarterly 1954-1989. Data source: Fiorito and Kollintzas (1994).

the interest rate (see Table 4.2), outside money measured by nonborrowed reserves seems to be the appropriate measure of money.

- Monetary and interest rate changes first trigger changes in residential investment, which in turn cause fluctuation in output. This hypothesis is consistent with the correlation analysis in Tables 4.2 and 4.3 and with the sensitivity of housing demand to changes in interest rate found by many studies.

- Output fluctuations in turn affect demand for nonresidential investment positively. This is compatible with a non-market-clearing (NMC) model where investment demand is a function of output (positively). Fluctuations in the demand for nonresidential investment and output create fluctuations in interest rates in the same direction. This is also compatible with a NMC model in which output is a positive determinant in both the demand for money function and the supply of financial assets function.

4.3 VAR Analysis Using Aggregate Data

The above mentioned hypotheses and the propositions of the different macroeconomic models will be tested using the results from the VAR models. The analysis starts with the aggregate variables: real GDP, the money supply (M2), and the interest rate (Tbr). These three variables are the main focus of most theoretical and empirical work on the money-output relationship. Starting with aggregated variables analysis also helps to show the benefits added from disaggregating the data in investigating the relationship between money and output. The data in level form are expected to be nonstationary as has been found by many studies. To test the series, the unit root test [see Dickey and Fuller (1981)] is applied to the data in level form. The Augmented Dickey-Fuller Test (ADF) is applied here by regressing the difference of a variable on its level lagged once, and on a given number of lagged difference terms.

Table 4.4 shows the t-statistic on the coefficient of the lagged test variable and critical values for the test of a zero coefficient. As can be seen from the statistics presented in the table, the unit root test shows that the hypothesis of unit root cannot be rejected at any level of significance for any of the series in level form. All the series appear to be nonstationary.[12] As such, the data need to be transformed to render them

[12] If a variable follows a unit root process, such that the first difference is stationary, the variable is said to be integrated of order one, I(1).

TABLE 4.4: UNIT ROOT TESTS

Variables in levels	ADF statistics	Variables in levels	ADF statistics
GDP	1.28	M2	1.8
LP	-1.53	MB	2.3
TR	-1.65	NBR	-1.13
FI	0.98	K	-2.19
RI	-1.46	CR	0.95
NRI	1.4	RR	-1.54
Tbr	-1.29	TSR	-1.66

- The critical values are –3.47, -2.88, and –2.57 at 1%, 5% and 10% respectively.

stationary prior to estimation. However, if the data series are cointegrated, the VAR estimation cannot be applied to the transformed data and the Error Correction model will be used. The Johansen Cointegration test [Johansen (1991)] is applied here to the group of the three variables, GDP, M2 and Tbr.

Table 4.5 shows the test results. The first line in the table tests the hypothesis of no cointegration; that is, the three variables have no equilibrium condition that keeps them in proportion to each other in the long run. The second line tests the hypothesis of one cointegrating vector against the alternative hypothesis that all series are stationary. This test indicates that one cointegrated equation exists in the system. The lag length in the cointegration test (5 quarters) is specified based on the three criteria mentioned earlier to determine the lag length. The hypothesis of no cointegration is rejected. Therefore,

TABLE 4.5: COINTEGRATION TEST, SERIES M2,GDP AND Tbr

Test assumption: Linear deterministic trend in the data Lags interval: 1 to 5				
Eigenvalue	Likelihood Ratio (LR)	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.135964	31.78246	29.68	35.65	None *
0.041786	9.569128	15.41	20.04	At most 1
0.020067	3.081187	3.76	6.65	At most 2

**(**) denotes rejection of the hypothesis at 5%(1%) significance level*

Log likelihood Ratio test indicates 1 cointegrating equation at 5% significance level

since we have nonstationary individual series and cointegration in the group of series, the Error Correction (EC) model is used here. To determine the best lag length, the three criteria mentioned earlier are applied to the results from running the EC model using different lags. The Log Likelihood Ratio (LR) is given by the following equation.

$$LR = (T\text{-}K)\,(\log|\Sigma(p_i)| - \log|\Sigma(p_j)|) \sim \chi^2(n^2(p_j - p_i))$$

Where Σ is the covariance matrix, T is the number of observations, K is the number of parameters in each equation, n is the number of equations, and p is the number of lags, given that $p_j > p_i$. The other two criteria, the AIC and the SC, try to minimize a function that depends on two elements: the determinant of the covariance matrix of residuals and a penalty for including a large number of parameters in the model. In other words, we have that Akaike (p)= T Log($|\Sigma$ (p) $|$ + 2pn, where Σ is the covariance matrix, p is the number of lags , n is the number of equations and T is the number of observations. Similarly, Schwarz (p) = T Log ($|\Sigma$ (p) $|$ + (pn^2) Log T. The best model is the one that minimizes these two functions.

Table 4.6 shows the LR calculated from the models with different lags, the critical values at 95% confidence interval, and the AIC and SC values for the same lags. The lags are examined up to eight quarters. The best model according to each criterion is underlined. Increasing the lags beyond five reduces the LR below the critical value. That is, there is no significant increase in the explanatory power by adding more lags than five quarters. This is confirmed by the SC statistics: the minimum value is reached at the 5^{th} lag. However, the AIC shows that six lags is the best lag length. Given the fact that SC penalizes more for the increase in the number of lags,[13] and that two criteria agree on a lag length of five quarters, the final estimation of this model will be carried out using five lags for each variable.

TABLE 4.6: LAG LENGTH STATISTICS

Increased lag from	LR	d.f	Critical value	AIC	SC
1 to 2	19.20	9	16.9	-20.342	-20.172
2 to 3	17.67	9	16.9	-20.433	-20.196
3 to 4	18.77	9	16.9	-20.530	-20.233
4 to 5	<u>31.11</u>	9	16.9	-20.720	<u>-20.362</u>
5 to 6	6.44	9	16.9	<u>-20.7289</u>	-20.309
6 to 7	3.59	9	16.9	-20.715	-20.233
7 to 8	10.03	9	16.9	-20.726	-20.182

Critical values are based on χ^2 distribution. LR is the Likelihood Ratio, AIC is the Akaike Information Criterion and SC is the Schwarz Criterion.

[13] It is well established in the literature that the Schwarz Criterion is consistent, that is, it will choose the correct order of the VAR when the sample size is large enough. However, if the sample size is small, the AIC performs better than the SC.

In analyzing the results from the EC model, the focus will be placed on the two tools mentioned earlier, the Forecast Error Variance Decomposition (FEVD) and the Impulse Response Function (IRF). Impulse Response Functions show how one variable responds over time to a single innovation in itself or in another variable. Innovations in the variables are represented by shocks to the error terms in the equations. See appendix A for more details on deriving the IRFs from a VAR model.

The IRFs (shown in Figure 4.4) provide details on the dynamic relationships among the variables. The signs of the relationships and the time factor are provided here. A shock to the interest rate has a negative impact on money up to 17 quarters ahead; after that the impact becomes positive. The negative impact on M2 is inconsistent with the view that a rise in the interest rate leads to an increase in deposits or in bank loans, which in turn results in an increase in money supply. The impact of the interest rate on GDP is positive for the first three quarters and negative afterwards. The positive effect of the interest rate on GDP is in contradiction with a theoretical relationship where interest rates have a negative impact on output.

The FEVDs for the three aggregate variables are presented in Tables 4.7, 4.8, and 4.9. The FEVDs are calculated from the EC model with five lags. What we are doing here is decomposing the forecast error of the endogenous variable Y over different time horizons into components attributable to unexpected innovations (or shocks) in variable X, where X can be any variable in the system. First, let us examine the variability of each variable explained by its own innovations. Regardless of the ordering, M2 accounts for most of its variation (above 92%). Tbr accounts for about two-thirds of its variation

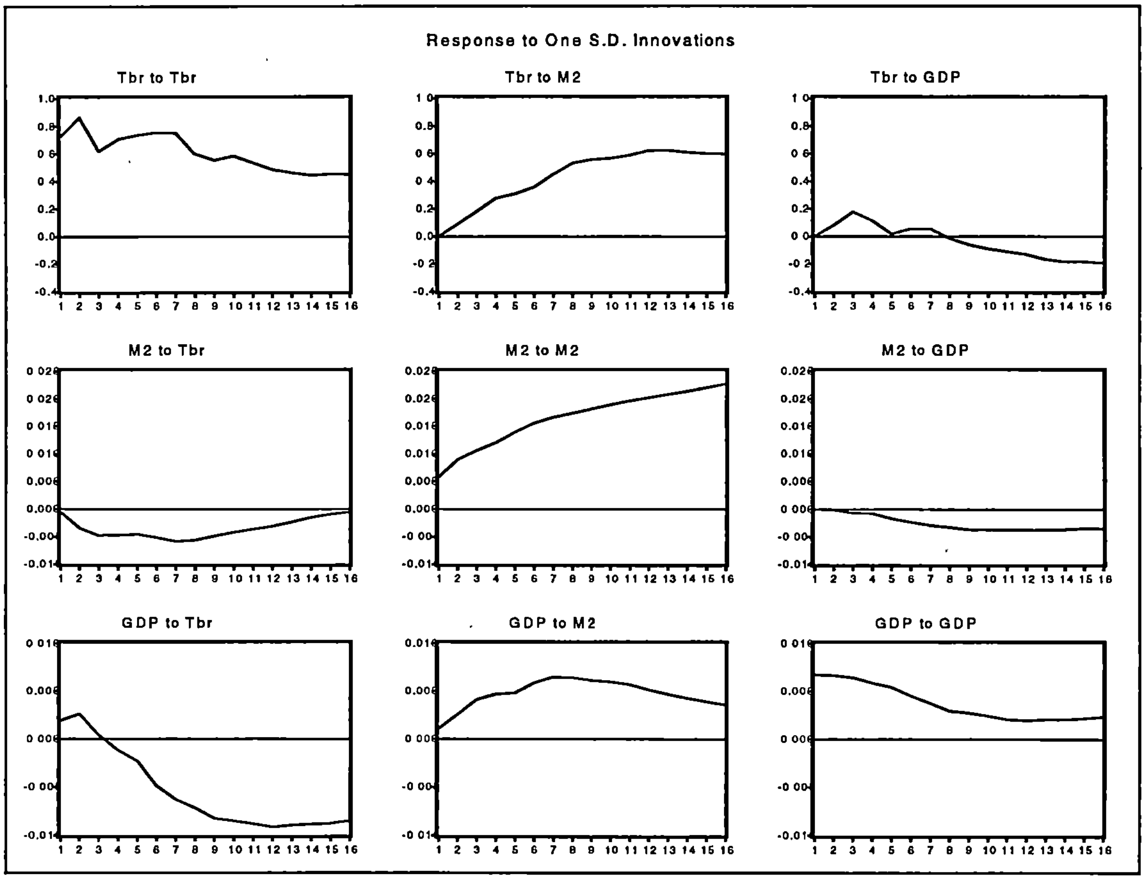

FIGURE 4.4: IMPULSE RESPONSES FROM THE EC MODEL (M2, Tbr, GDP)

The horizontal axes represent the quarters, the vertical axes measure the response of a particular variable to one standard deviation innovation in each one of the variables in the model. Tbr is the three-month Treasury Bill Rate, M2 is the Money Supply M2 and GDP is real Gross Domestic Product.

TABLE 4.7: VARIANCE DECOMPOSITION FROM EC MODEL, ORDERING: (M2, Tbr, GDP)

Variance Decomposition of M2:	Explained By:		
Period	M2	Tbr	GDP
1	100.00	0.00	0.00
5	92.84	6.52	0.64
10	93.23	4.37	2.40
16	95.18	2.17	2.64
Variance Decomposition of Tbr :	Explained By:		
Period	M2	Tbr	GDP
1	1.01	98.99	0.00
5	3.90	94.34	1.75
10	16.55	82.35	1.10
16	28.88	68.81	2.31
Variance Decomposition of GDP:	Explained By:		
Period	M2	Tbr	GDP
1	1.51	8.12	90.37
5	24.91	5.89	69.20
10	38.85	29.17	31.98
16	34.23	46.14	19.61

Tbr is the three-month Treasury Bill Rate, M2 is the Money Supply M2 and GDP is real Gross Domestic Product.

TABLE 4.8: VARIANCE DECOMPOSITION FROM EC MODEL, ORDERING: (Tbr,M2,GDP)

Variance Decomposition of Tbr :	Explained By:		
Period	Tbr	M2	GDP
1	100.00	0.00	0.00
5	91.06	7.18	1.75
10	76.05	22.85	1.10
16	61.34	36.35	2.31
Variance Decomposition of M2 :	Explained By:		
Period	Tbr	M2	GDP
1	1.01	98.99	0.00
5	12.11	87.25	0.64
10	9.13	88.47	2.40
16	4.80	92.55	2.64
Variance Decomposition of GDP:	Explained By:		
Period	Tbr	M2	GDP
1	7.35	2.27	90.37
5	6.15	24.65	69.20
10	34.87	33.15	31.98
16	53.01	27.38	19.61

Tbr is the three-month Treasury Bill Rate, M2 is the Money Supply M2 and GDP is real Gross Domestic Product.

TABLE 4.9: VARIANCE DECOMPOSITION FROM EC MODEL, ORDERING: (GDP, Tbr, M2)

Variance Decomposition of GDP :	Explained By:		
Period	GDP	Tbr	M2
1	100.00	0.00	0.00
5	76.42	9.27	14.31
10	31.02	43.94	25.04
16	17.26	61.28	21.47
Variance Decomposition of Tbr :	Explained By:		
Period	GDP	Tbr	M2
1	7.35	92.65	0.00
5	15.64	78.11	6.25
10	12.15	65.67	22.18
16	8.01	54.75	37.24
Variance Decomposition of M2:	Explained By:		
Period	GDP	Tbr	M2
1	1.51	1.93	96.56
5	0.21	12.64	87.15
10	0.78	8.61	90.60
16	0.47	4.47	95.06

Tbr is the three-month Treasury Bill Rate, M2 is the Money Supply M2 and GDP is real Gross Domestic Product.

in each ordering, while real GDP accounts for less than one-fifth of its own variation. This indicates that M2 is strongly exogenous in this model, while GDP is strongly endogenous. This result seems to be conclusive because it is robust to the ordering.

When we look at the effect of innovations in one variable on the others, Tbr explains most of the GDP variation, ranging from 46% to 61%. M2 innovations explain a high proportion of the variation in Tbr and GDP while Tbr and GDP have small contributions in accounting for M2 variation. Further, the effect of M2 on GDP is more immediate than on Tbr. While both M2 and Tbr affect GDP, the results indicate that M2 affects GDP at a shorter horizon than Tbr. Therefore, the above pattern of interaction between the variables suggests that the direction of influence runs from money to interest rates and from interest rates to real GDP. However, as we noticed in the impulse function analysis, the signs of the relationships are not consistent with prediction of macroeconomic theories.

4.4 Analysis Using Disaggregated Monetary Variables

In general, the previous analysis suggests that there are time lags in the dynamic relationships among the variables. These delays might be due to the fact that other important variables are absent in the analysis. Further, two of the widely accepted propositions in macroeconomics, the negative effect of money on interest rates and the negative effect of interest rates on output, are not supported by the analysis of the variables used here.

One hypothesis of this paper suggests that disaggregating money helps to shed light on the money-output relationship. A key issue in studying the dynamic relationship between money and output using VAR models is the empirical representation of a change in the stance of monetary policy. One explanation of the mixed findings of the interaction between money and output as well as the failure to find a statistically significant negative effect of money on the interest rate (the liquidity effect) is that shifts in monetary policy have typically been identified with movements in broad monetary aggregates [Chari, Christiano and Eichenbaum (1995)]. Measuring monetary policy changes by changes in broad aggregates has been criticized on the ground that, if the monetary authority follows a reaction function rule or if banks create money without policy stimulus, then the broad measures of money contain an endogenous part [Bernanke and Mihov (1998)]. In this case, the exogenous impulse of monetary policy cannot be identified if movements in inside money dominate movements of money. This might be responsible for the positive impact of money on interest rates in the previous aggregated model.

The following analysis is based on replacing the monetary aggregate M2 by its components. Inside money is measured by the multiplier. The outside money measures used here are the Monetary Base, Total Reserves, and Nonborrowed Reserves. The interest rate[14] and output variables are the same as in the model with aggregate data. The estimation results of the models with the monetary base and total reserves measures of outside money are generally the same. However, when nonborrowed reserves are used to measure outside money, the dynamic interactions from the VAR model produce the expected negative impact of the monetary policy changes on interest rates. Total reserves have a negative but insignificant impact on the interest rate. Further, only nonborrowed reserves produce the expected positive impact on GDP. Therefore, the focus will be placed here on nonborrowed reserves as a measure of exogenous monetary policy changes.

Figure 4.5 shows the impulse response functions calculated from the EC model [(Nonborrowed Reserves (NBR), the multiplier (K), the three-month Treasury Bill Rate (Tbr), and real GDP]. The lag length (five quarters) is chosen based on the same criteria used in the previous analysis. The cointegration test indicates that the series in this group are cointegrated with one possible cointegrated equation. Hence, the EC model is estimated including one cointegration equation. The ordering of the variables is specified

[14] The model will be extended in chapter five to include long term interest rates.

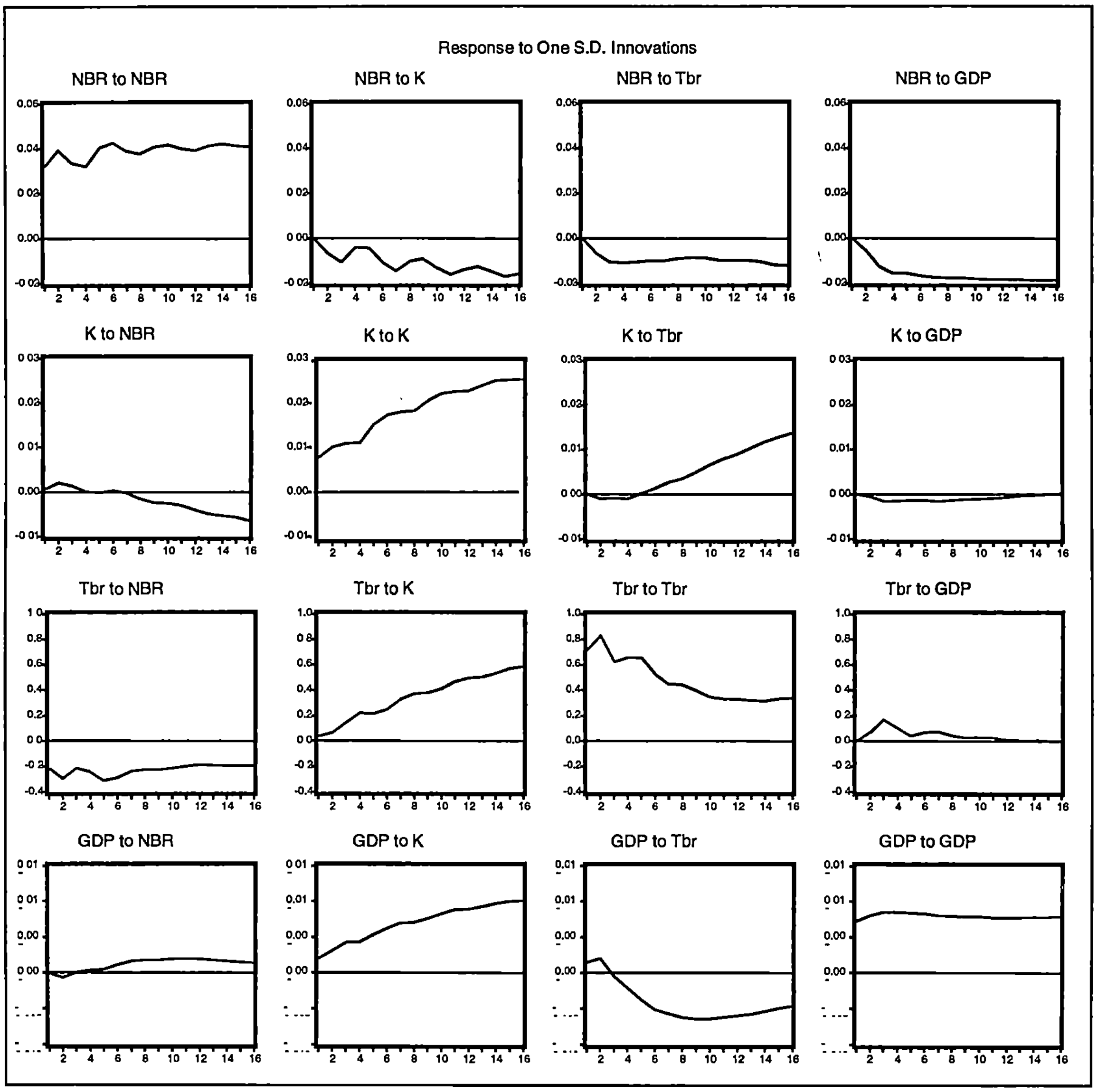

FIGURE 4.5: IMPULSE RESPONSES FROM THE EC MODEL (NBR, K, Tbr, GDP)

The horizontal axes represent the quarters, the vertical axes measure the response of a particular variable to one standard deviation innovation in each one of the variables in the model. NBR is nonborrowed reserves, K is the multiplier, Tbr is the three-month Treasury bill rate, and GDP is real Gross Domestic Product.

in line with the results from the model using aggregate data. That is, the monetary variables are ordered first, followed by the interest rate and GDP.

NBR responds negatively to all the variables except to itself. The highest response is the one to a shock in GDP. The negative responses to GDP and K could be interpreted as a " leaning against the wind" policy by the Federal Reserve. However, the negative response to interest rate is at odds with the expected positive response of the Fed to rises in interest rates (the Fed is expected to increase reserves in the face of a rise in interest rates).

As we will see in the Variance Decomposition analysis, the interest rate variation is explained by both nonborrowed reserves and inside money, with the latter explaining more of this variation. Here we can see that the two sources of money changes affect interest rates in opposite directions. The third row of impulse functions shows that Tbr decreases after a shock to NBR and increases after a shock to inside money. Also, a shock to NBR has a greater immediate effect on the interest rate than a shock to K. The longer the time lag the greater the effect of K on Tbr. Obviously, disaggregating money gives more insight into the effect of money on the interest rate. Unlike the model with aggregate data, the model here supports the liquidity effect proposition that monetary changes have a negative effect on interest rates.

Tbr responds positively to a shock in GDP, notably after three quarters, and then the response starts to die out. One possible explanation for this relationship is that increases in aggregate demand create an upward pressure on interest rates. This result is compatible with a non-market–clearing view that the demand for money and the supply of financial assets are positive functions of output. That is, an increase in GDP leads to an increase in the demand for money and the supply of financial assets, causing interest rates to rise.

The last row shows the responses of GDP to innovations in the variables. The highest response is the one to a shock in inside money. The effect of NBR on GDP is positive but small. The effect of the interest rate on GDP is the same as in the aggregate model. That is, the effect is positive up to three quarters ahead and negative after that. The lag of the response of aggregate output to interest rates explains the observed procyclical behavior of interest rates. A researcher who focuses on the relationship between contemporaneous innovations in interest rates and GDP during business cycles will find a positive relationship.

Table 4.10 summarizes the Variance Decomposition analysis. Most of the variation in NBR (two thirds) is accounted for by its own innovations. Other than NBR itself, the only variable that has a significant contribution is GDP, accounting for 13.21% of the NBR variation. The variance decomposition in inside money, K, shows that innovation in K accounts for 95% and 86% of the variation in itself at 10 and 16 quarter horizons, respectively. This behavior is similar to that of M2 found in the aggregate model. The result here is consistent with the fact that the largest part of M2 is inside money (deposits).

As for the interest rate variation, the contributions of the monetary variables, NBR and K, tell an interesting story. First, while the effect of NBR on Tbr is less than that of

TABLE 4.10 : VARIANCE DECOMPOSITION FROM EC MODEL (NB,K,Tbr, GDP)

Variance Decomposition of NBR:	Explained By:			
Period	NBR	K	Tbr	GDP
1	100.00	0.00	0.00	0.00
5	83.31	2.51	5.23	8.95
10	78.56	4.74	4.57	12.14
16	75.11	6.93	4.75	13.21
Variance Decomposition of K:	Explained By:			
Period	NBR	K	Tbr	GDP
1	0.52	99.48	0.00	0.00
5	0.78	97.66	0.45	1.11
10	0.77	95.34	3.27	0.62
16	2.44	86.10	11.21	0.26
Variance Decomposition of Tbr:	Explained By			
Period	NBR	K	Tbr	GDP
1	8.21	0.26	91.53	0.00
5	11.48	4.17	82.78	1.57
10	13.07	15.24	70.44	1.24
16	11.65	32.51	55.02	0.83
Variance Decomposition of GDP:	Explained By			
Period	NBR	K	Tbr	GDP
1	0.01	6.93	3.70	89.36
5	0.19	18.05	5.51	76.25
10	1.23	28.13	16.79	53.86
16	1.39	37.85	16.71	44.05

NBR is nonborrowed reserves, K is the money multiplier, Tbr is the three-month Treasury Bill Rate, and GDP is Gross Domestic Product.

K, the effect of NBR on Tbr is more immediate. After five quarters, NBR accounts for 11.5%, while K accounts for 4.2% of the Tbr variation. The contribution of NBR peaks at 10 quarters and then starts to decline, while the contribution of K continues to increase in the quarters ahead. The lag in the effect of inside money here is also similar to the lag in the effect of M2 on the interest rate found in the aggregate model. Since the largest part of money is inside money, which has a positive relationship with the interest rate, the early and negative effect of outside money, measured here by NBR, on the interest rate was unobserved in the model with aggregate data.

Another interesting outcome of disaggregating money is the decline of the contribution of the interest rate in explaining the variation in GDP. In VARs that include aggregate measure such as M1 and M2 and the interest rate [as in Sims (1980) and Litterman and Weiss (1985)], the interest rate typically explains a very high proportion of GDP variation. In the last part of Table 4.10, we can see that inside money is the main contributor to GDP fluctuations (37.8%), while the interest rate contribution is only 16.7 % (compared to 46% in the aggregate model). Furthermore, GDP responds significantly to innovations in money and the interest rate after four or five quarters. However, as we noticed from the IRFs, GDP responds positively to a shock in the interest rates up to three quarters after the shock.

The main conclusion here is that by using the aggregate money measure, M2, in the first model, we were not able to identify the exogenous impulse of monetary changes. The broad measures of money contain an endogenous part that hides the effect of the exogenous shocks of money. The fact that the NBR is the only monetary variable that has a negative impact on the interest rate justifies the use of NBR as the measure of the exogenous monetary policy[15]. Inside money, on the other hand, shows the expected positive pattern of relationships with the interest rate and output, which is consistent with the results obtained from using aggregate money, M2.

[15] The estimation results of the models using the monetary base and total reserves measures of outside money are generally the same as the results with using M2 measure. However, when NBR is used to measure outside money, the dynamic interactions from the VAR model produce the expected negative impact of the monetary policy changes on interest rates. Total reserves have a negative but insignificant impact on the interest rate. Further, among the reserve measures, only nonborrowed reserves produce the expected positive impact on GDP.

The implication is that endogenous variations in the money supply and the absence of a liquidity effect of aggregate money on the interest rate should not be interpreted as a failure of monetary policy to produce a real effect. The finding that monetary changes, as measured by changes in NBR, induce variation in the interest rate, which in turn affects output, is an indication of the impact of exogenous monetary changes on economic activity.

4.5 Analysis Including Investment Components

The previous analysis using disaggregated money variables allows us to distinguish between the impacts of outside and inside money on the interest rate. Specifically, the liquidity effect of money on the interest rate is detected by using NBR as a measure of outside money. However, some of the empirical results obtained from the previous models contradict predictions of economic theories. First, the finding that output responds positively to interest rates seems to be at odds with the prediction of some macroeconomic models. Other studies have reported this positive relationship between interest rates and aggregate measure of output. For example, Blanchard and Fisher (1989) present data that show positive correlation between real (and nominal) interest rates and GDP. They conclude that if money is the major source of fluctuations in GDP, then its contemporaneous effect on GDP cannot be explained through interest rates [see Fiorito and Kollintzas (1994) for similar evidence on the positive relationship between interest rates and GDP). However, the transmission mechanism with the interest rate channel suggests that an increase in interest rates affects output negatively by reducing consumption and/or investment. The other finding from the previous analysis is the negative impact of output on inside money. The RBC and the post Keynesian models predict a positive relationship between inside money and output. The two-way influence predicted by the monetarists also suggests a positive impact of output on inside money.

This research suggests that there are important relationships between money and output that are reflected in the behaviors of the components of these variables. Disaggregating money sheds light on part of these relationships. In this section, investment components will be included in the analysis to further investigate the channels through which money and interest rates interact with output. Aggregate investment is decomposed into residential fixed investment (RI) and nonresidential (Business) fixed investment (NRI) and both RI and NRI are included in the EC model. The cointegration test shows that this group of series is cointegrated and that two cointegration equations exist in the group. The lag length is five quarters as in the previous models.

The graphed impulse response functions from the EC models are presented in Figures 4.6 through 4.11 (Impulse response functions with other orderings are presented in appendix C. The results are generally similar across those orderings). As we can see, NBR responds negatively to innovations in all the other variables in the model. The greatest responses are to innovations in RI and Tbr. This negative response of outside money to innovations in the variables confirms the view of a reaction function on the part of the Fed and points to the exogenous movements of money represented by nonborrowed reserves. This negative response, however, is inconsistent with the accommodation view where the Fed would respond positively to the increase in demand

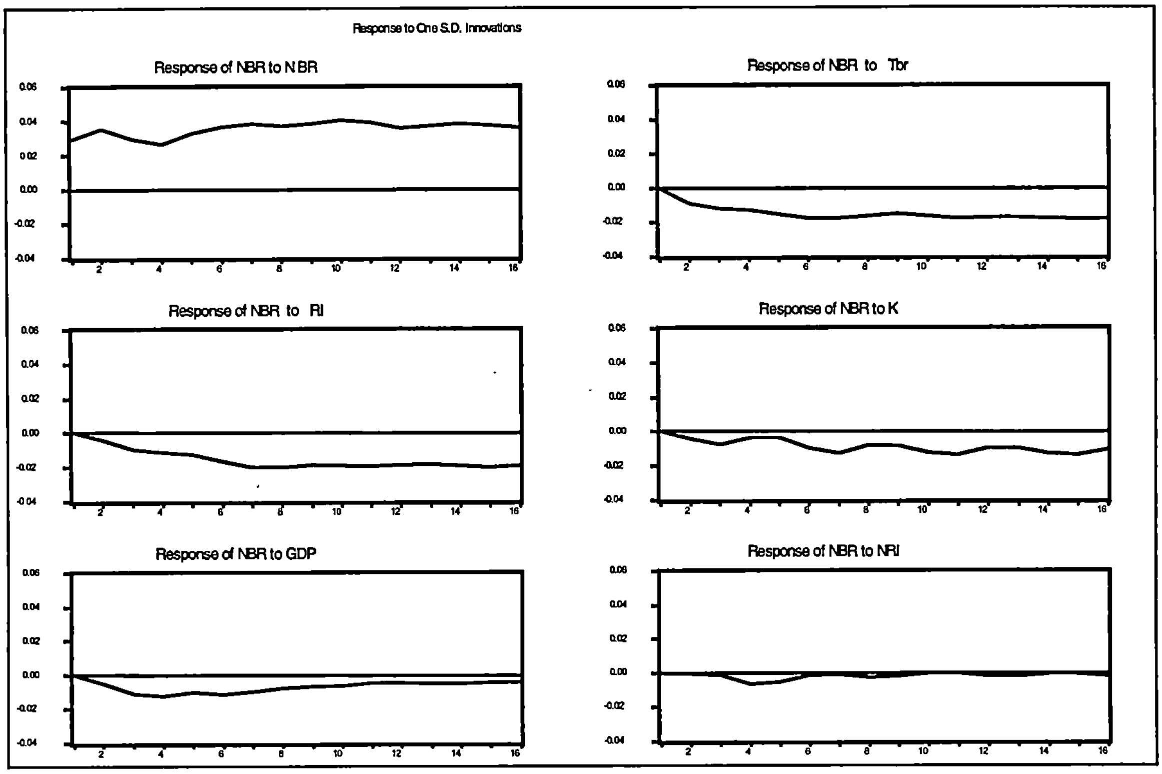

FIGURE 4.6: IMPULSE RESPONSES OF NBR FROM THE EC MODEL (NBR, Tbr, RI, K, GDP, NRI)

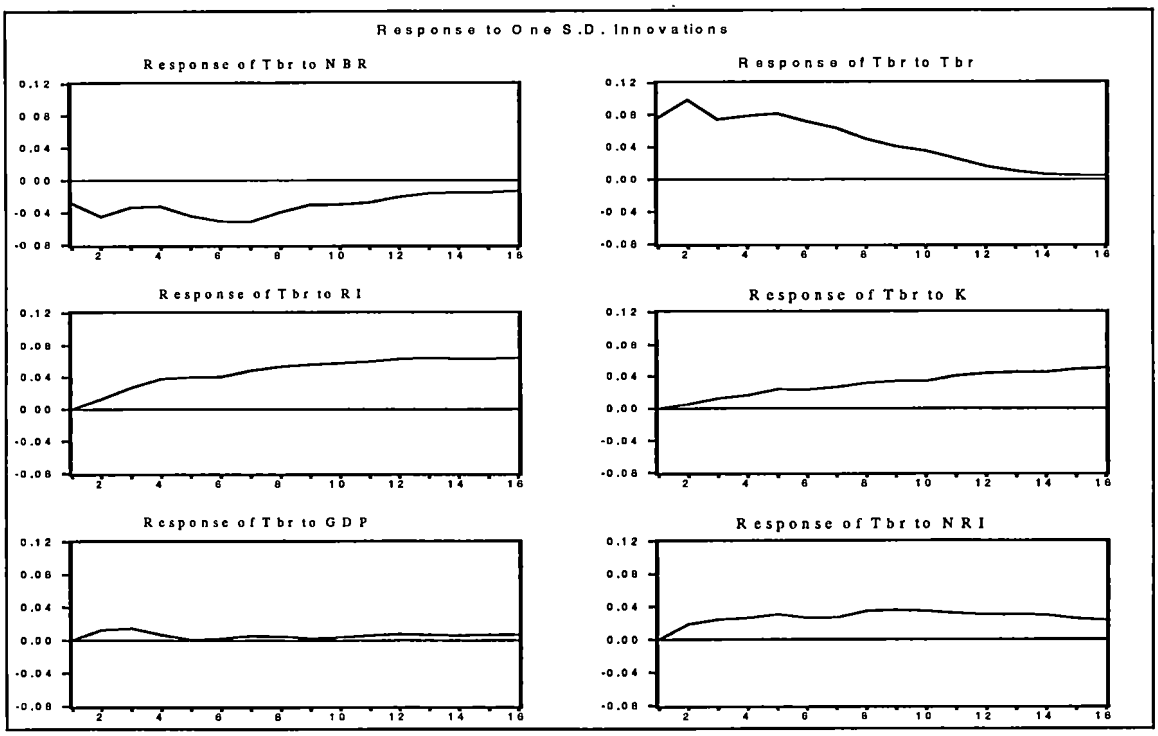

FIGURE 4.7: IMPULSE RESPONSES OF **Tbr** FROM THE EC MODEL (NBR, Tbr, RI, K, GDP, NRI)

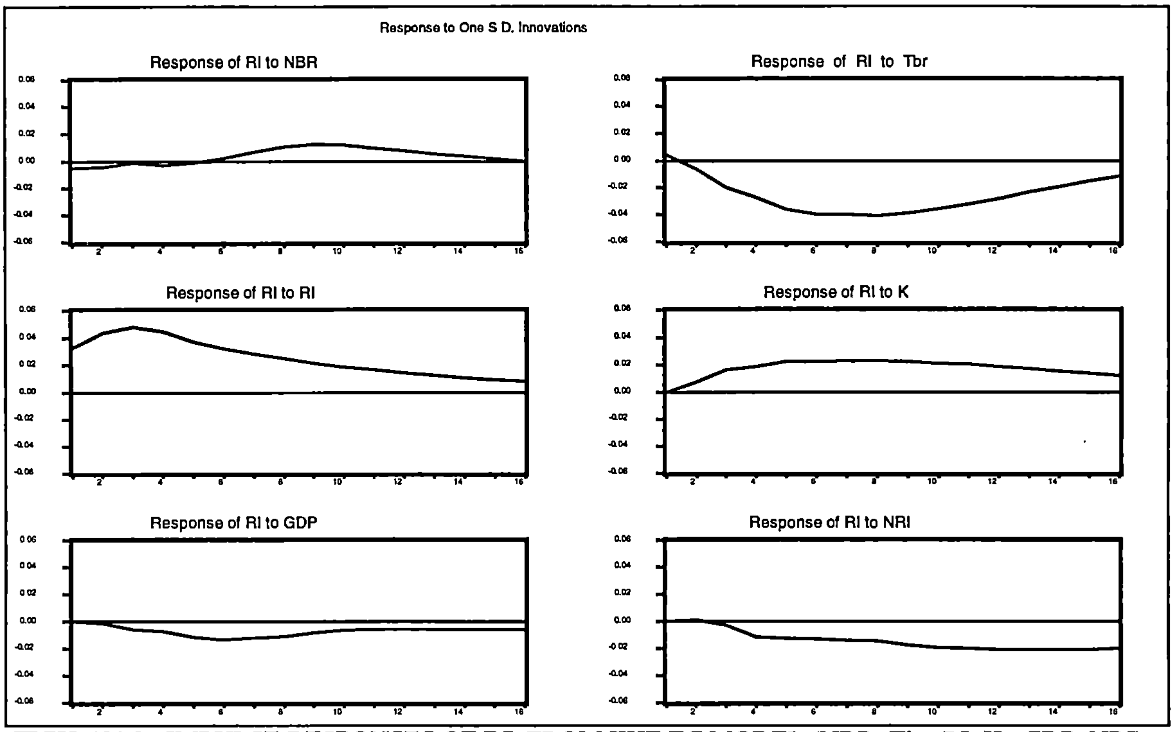

FIGURE4.8: IMPULSE RESPONSES OF **RI** FROM THE EC MODEL (NBR, Tbr, RI, K, GDP, NRI)

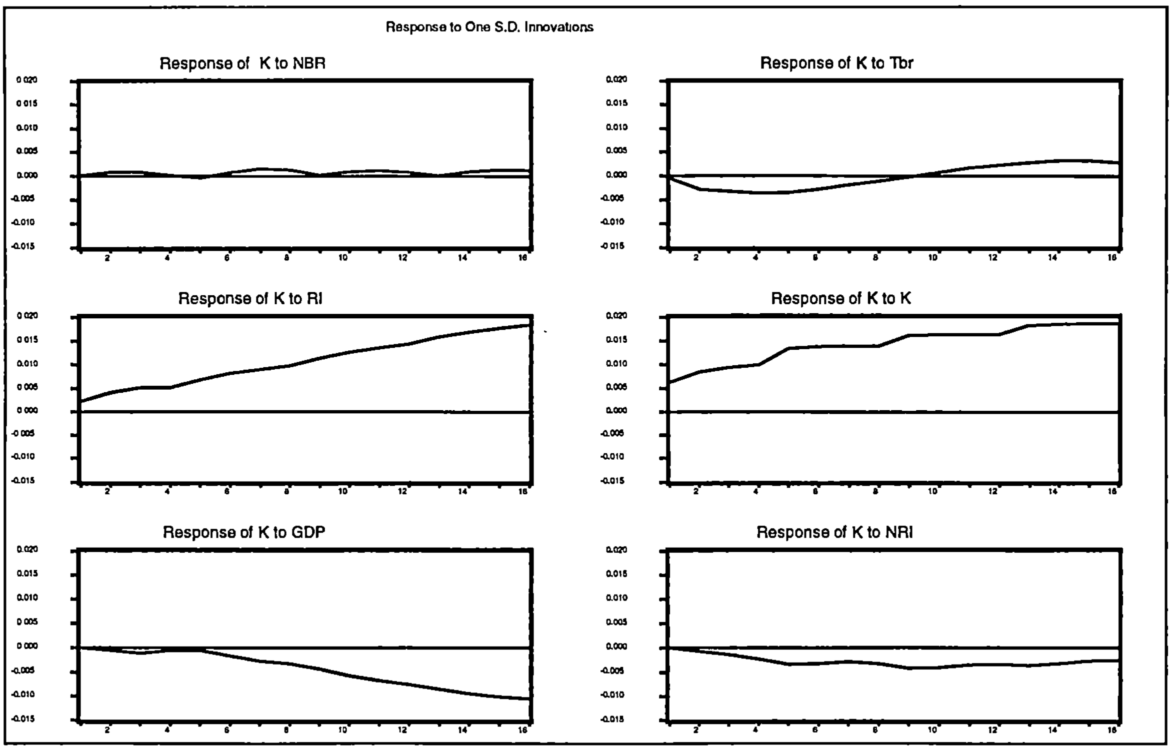

FIGURE 4.9: IMPULSE RESPONSES OF **K** FROM THE EC MODEL (NBR, Tbr, RI, K, GDP, NRI)

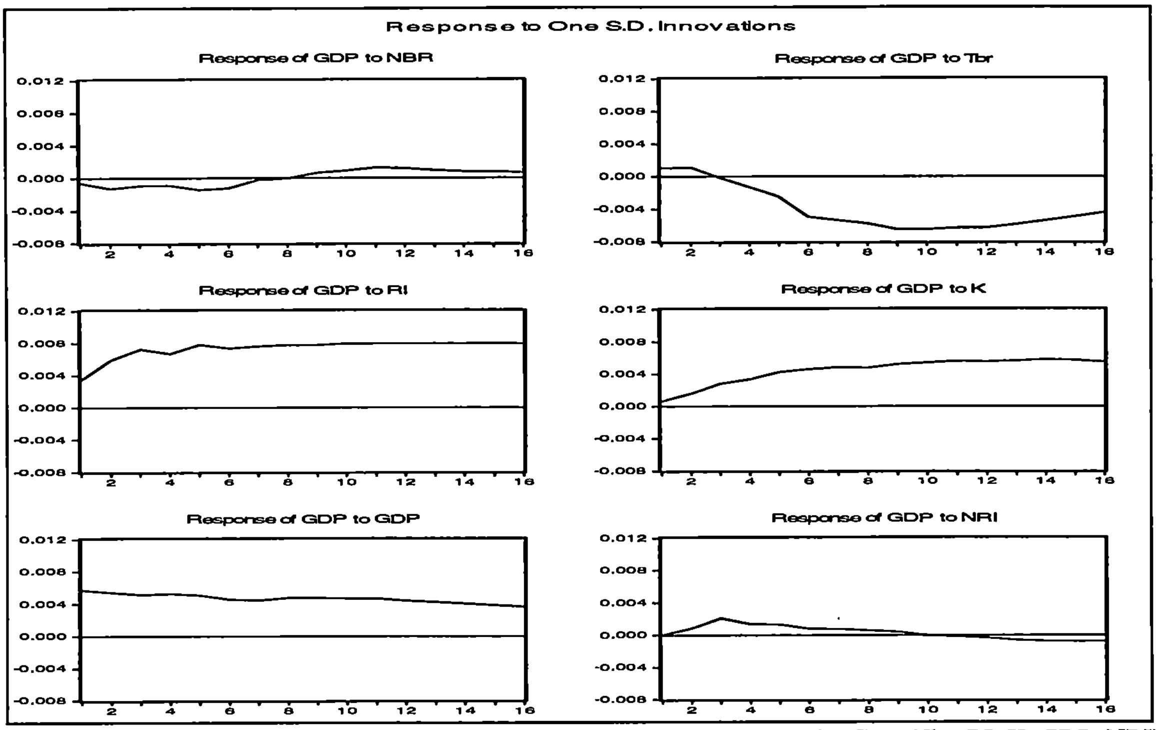

FIGURE 4.10: IMPULSE RESPONSES OF **GDP** FROM THE EC MODEL (NBR, Tbr, RI, K, GDP, NRI)

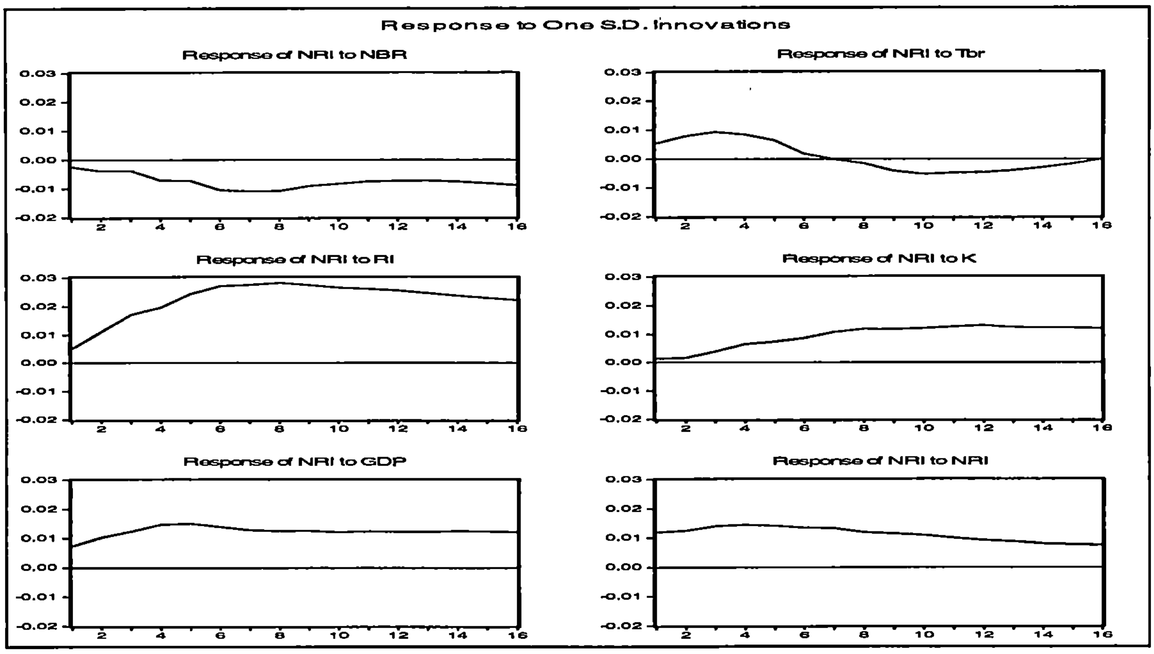

FIGURE 4.11: IMPULSE RESPONSES OF **NRI** FROM THE EC MODEL (NBR, Tbr, RI, K, GDP, NRI)

for money. As in the model with disaggregated money, the negative impact of money on the interest rate (the liquidity effect of money) is present in this model. One thing to notice here is the immediate effect of the innovation of outside money on Tbr, which responds after one quarter to an innovation in NBR.

Another interesting point is that innovations in the investment components, especially, in NRI, are followed by movements in Tbr in the same direction. The positive effect of GDP on Tbr in the previous models is explained as reflecting the upward or downward pressure on interest rates created by fluctuations in aggregate spending. This effect is clearer in this model when we look at the relationship between RI, NRI, and Tbr.

The responses of RI and NRI to innovations in the variables depicted in Figure 4.8 and 4.11, respectively, illustrate the differences in the interaction of these two components with the other macroeconomic variables. The opposite signs of the responses of RI and NRI to innovations in the interest rate and GDP are noteworthy. On one hand, RI responds negatively to Tbr, while NRI responds positively to Tbr during the first seven quarters in the forecast horizon. On the other hand, RI responds negatively to innovations in GDP while NRI responds positively to these innovations. We can see from Figure 4.7 that both components of investment have a positive effect on Tbr, which could be explained by the upward (downward) pressure on interest rates created by increases (decreases) in the demand for investment. Here, we see that Tbr is the most influential variable (negatively) on RI, which reflects the expected effect of changes in interest rates on investment. Therefore, the opposite effects of RI and Tbr on each other point to a two-way causality between them that is consistent with predictions of economic theories. The positive effect of the interest rate on NRI, on the other hand, is inconsistent with the transmission mechanism theory of interest rates. The only explanation for this pattern is the time differential in their behaviors during economic fluctuations; the interest rate is a lead variable, while NRI is a lag variable. For example, the interest rate may start to decline close to the end of a recession period while NRI is still declining. In this case a researcher would notice a positive correlation between these two variables.

The difference in the interactions of RI and NRI with GDP tells another interesting story. Figure 4.10 shows that RI affects GDP positively starting at the early quarters in forecast horizon, while Figure 4.8 shows that RI responds negatively to GDP innovations. NRI, on the other hand, has a much smaller positive impact on GDP that starts after a time lag and becomes negative after eleven quarters ahead. NRI responds positively to GDP innovations. Given these results, the relationships between these variables seem to reflect causation running from RI to both GDP and NRI, and from GDP to NRI. This conclusion is supported by the results from Figure 4.11, which show that RI is the most influential variable on NRI. The negative response of RI to both GDP and NRI (Figure 4.8), on the other hand, can be explained by the differential timing of the cyclical behavior of these three variables. That is, by the time GDP and NRI start to increase during economic expansions, RI will have already begun its decline back to its trend path.

Table 4.11 shows the Forecast Error Variance Decomposition (FEVD) from the EC model. As in the previous model, NBR accounts for two-thirds of its variation. RI

TABLE 4.11 : VARIANCE DECOMPOSITION FROM THE EC MODEL (NB, Tbr, RI, K, GDP, NRI)

Variance Decomposition of NBR			Explained By:			
Period	NBR	Tbr	RI	K	GDP	NRI
1	100.00	0.00	0.00	0.00	0.00	0.00
5	75.08	9.73	6.24	1.49	6.38	1.08
10	68.28	11.19	12.25	3.53	4.29	0.45
16	65.92	12.33	13.96	4.66	2.84	0.28
Variance Decomposition of Tbr			Explained by:			
Period	NBR	Tbr	RI	K	GDP	NRI
1	11.68	88.32	0.00	0.00	0.00	0.00
5	14.00	69.85	8.04	2.05	0.83	5.23
10	16.20	51.45	17.88	5.93	0.49	8.05
16	12.60	35.97	28.85	13.03	0.51	9.04
Variance Decomposition of RI			Explained by:			
Period	NBR	Tbr	RI	K	GDP	NRI
1	2.28	1.83	95.89	0.00	0.00	0.00
5	0.46	19.45	67.01	8.84	1.91	2.34
10	1.78	35.54	41.58	12.66	2.87	5.56
16	1.88	35.68	34.39	14.03	2.78	11.23
Variance Decomposition of K:			Explained by:			
Period	NBR	Tbr	RI	K	GDP	NRI
1	0.14	0.43	12.79	86.63	0.00	0.00
5	0.25	6.72	18.69	71.04	0.31	2.99
10	0.27	2.37	26.59	64.32	3.04	3.41
16	0.18	1.55	34.18	53.34	8.46	2.29
Variance Decomposition of GDP:			Explained by:			
Period	NBR	Tbr	RI	K	GDP	NRI
1	0.76	2.20	25.22	0.91	70.91	0.00
5	1.41	2.47	49.50	9.70	34.78	2.14
10	0.78	16.29	44.71	14.65	22.61	0.96
16	0.71	18.63	44.26	17.80	17.96	0.64
Variance Decomposition of NRI:			Explained by:			
Period	NBR	Tbr	RI	K	GDP	NRI
1	2.21	11.30	10.95	0.81	21.02	53.71
5	3.74	7.94	39.05	3.42	20.96	24.89
10	6.19	3.34	50.91	7.35	15.75	16.45
16	6.01	2.50	52.96	10.26	15.35	12.93

NBR is Nonborrowed reserves, Tbr is the three month Treasury Bill Rate, RI is Residential Fixed Investment, K is the money multiplier, GDP is real Gross Domestic Product, and NRI is Nonresidential (Business) Fixed Investment.

explains 14% of the NBR variation, while none of the other variables seem to have major contributions in explaining outside money variations. This points to an exogenous factor in money movements. The second part of the table presents the contributions of the variables in explaining the variation in Tbr, the two most important of which are RI and NBR. Variation at shorter horizons is explained by NBR, while variation at longer horizons is explained by RI. As for the other variables, the money multiplier, K, accounts for larger proportions of the Tbr variation at a long time horizon (13% at 16 quarters ahead), while GDP and NRI contribute little, both accounting for less than 10%. The FEVD of RI is presented in the third part of the table. Tbr contributes most in accounting for the RI variation, explaining 35%. The contribution of Tbr starts at a short time ahead (after two quarters) and continues to increase gradually up to 12 quarters ahead and then declines afterwards. The other variables, especially NBR, GDP, and NRI are insignificant in explaining the RI variation.

A noteworthy outcome of disaggregating investment can be seen from the contributions of the variables in explaining inside money. Aside from the contribution of innovations in K itself, the only variable that explains a significant part of the K variation is RI, accounting for 34%. We can see that the contribution of RI starts at the first quarter ahead in the forecast horizon. That is, RI has an immediate effect on inside money. The high contribution of RI in explaining K indicates that the feedback from real economic activity to inside money operates through RI. This channel of effect is not present in the model with aggregate data.

As for the GDP variation, RI accounts for the largest proportion, explaining 44% of this variation. Further, RI explains GDP starting at a short time horizon (40% after one quarter ahead). The contribution of Tbr in explaining the GDP variation comes second and starts after a time lag, accounting for 19% after 16 quarters. NRI, on the other hand, is not significant in explaining the GDP variation. Comparing the results here with the results from the models without investment components, we can see that inside money and the interest rate are no longer the main determinants of the GDP variation. Instead, RI is the main explanatory variable in explaining output variations.

The last part of Table 4.11 shows the variables accounting for the NRI variation. More than 50% of this variation is explained by RI innovations, while 15% are explained by GDP innovations. However, GDP contributes more than RI up two quarters ahead (21% and 22% compared to 10% and 20% for the two variables, respectively). This time differential in the interaction among RI, GDP, and NRI is consistent with the cyclical behavior of these variables found in this research as well as in many other empirical studies.

In general, the analysis including the two components of investment uncovers three facts about the interaction of these components with the other variables in the model. First, RI seems to play an important role in interacting with the other variables. As the FEVD analysis shows, RI contributions in explaining other variables are much higher than those of NRI. In fact, RI is the most important variable among all the variables in the model in terms of innovations accounting. It strongly determines variations in inside money, GDP, and NRI. Second, the determinants of the two fixed investment components are different. RI is strongly determined by the interest rate, while NRI is strongly determined by RI and GDP. Further, the interest rate does not seem to be an important factor in explaining the NRI variation. Finally, the two investment components have different time patterns in their interaction with the other variables in the model.

To sum up the above results, the strong impact of innovations in the interest rate on RI clearly reflects the transmission mechanism of interest rates predicted by macroeconomic theories. However, interest rates do not have a direct impact on NRI. RI and GDP, however, are the main determinants of NRI. As such, the interaction among the variables appears to follow this pattern: a decline in the interest rate predicts an increase in RI at the beginning of business cycles. The increase in RI leads an increase in GDP, which in turn affects NRI positively later in the cycle. The increase in demand for investment (aggregate demand in general) creates upward pressure on interest rates.

The outcome in terms of the time patterns and the correlation among variables would be a leading countercyclical behavior of interest rates, a coincidental and lagging procyclical behavior of interest rates, a leading procyclical and a lagging counter-cyclical behavior of RI, and a lagging procyclical behavior of NRI. This pattern of interaction is confirmed by the results from the EC model and the correlation analysis.

The inclusion of investment components identifies another important channel of influence between money and economic activity. The models using either aggregated data, or aggregate output with disaggregated money do not support the expected positive impact of output on money. We notice that GDP has a negative impact on M2 in the first model and a similar impact on inside money in the second model. In the model with disaggregated investment, the FEVD shows that variation in inside money is mostly accounted for by innovations in RI. The impulse response functions in Figure 9 indicate that the impact of RI on the multiplier, K, is positive. GDP or NRI do not have positive feedback on K. On the contrary, we can see that K responds negatively to innovations in GDP and NRI, especially after five quarters in the forecast horizon. These results are compatible with a scenario in which an increase in demand for RI leads to creation of inside money, so that RI is responsible for the observed comovement of inside money and output.

It is of interest to compare the results obtained here with the propositions of the two competing macroeconomic models, the Real Business Cycle and the Non-Market-Clearing models. In a RBC model, investment fluctuates because of fluctuations in the marginal productivity of capital. Interest rates affect investment negatively according to this model. However, the RBC model predicts interest rates and investment to move together because of productivity shocks.[16] Investment (NRI), in turn, is the impulse leading to fluctuations in output. Since all markets clear according to this model, investment does not depend on output. In a NMC model, investment depends on interest rates and output. As shown in the previous analysis, NRI variation is not explained by interest rates but by GDP. Therefore, the behavior of NRI is compatible with a NMC model. The behavior of RI is also compatible with a NMC view. The above analysis

[16] According to the RBC model, both interest rates and investment respond positively to shocks to capital productivity. The positive impact on investment of the increase in the marginal productivity of capital outweighs the negative impact of the increase in interest rates.

shows that RI responds negatively to interest rate innovations. This result, however, contradicts the prediction of the RBC model that interest rates and investment move in the same direction.

In addition, the negative effect of outside money on interest rate is at odds with the predictions of the RBC model that outside money affects only prices and that interest rate variations are caused by technology shocks. Also, the predictions of macroeconomic models regarding the positive impact of output on inside money are not supported by the results using aggregate measures of output such as GDP. The results show that GDP and inside money have a negative relationship. However, RI seems to be the component of output that has a positive impact on inside money.

In general, the findings here are more consistent with monetarist and Keynesian demand-driven models; the finding that interest rates are affected by innovations in money points to a role for monetary changes to affect real economic activity.

CHAPTER FIVE

SUB-SAMPLE ANALYSIS

The sample period studied in the last chapter spans different monetary policy regimes and periods of regulation, deregulation and financial innovations. The Fed changed its operating procedures between targeting free reserves, the federal funds rate, borrowed reserves, and nonborrowed reserves during the last four decades. In addition, in the early 1980s financial innovations proceeded at a rapid pace. This period witnessed the nationwide introduction of Negotiable Order of Withdrawal (NOW) accounts in 1981 and Super NOWs in 1983. The Money Market Deposit Accounts (MMDA) were also introduced in December of 1982. Deregulation also occurred around the same period. In 1980, interest rate ceilings on time and saving deposits at banks and thrift institutions were removed. Then, in 1983, regulation Q on NOW accounts was removed. On the other hand, during that same period, the mortgage market witnessed some regulatory changes and financial innovations such as the introduction of adjustable mortgage rates in 1981 and the growth of mortgage backed securities. These changes definitely increased competition among lenders.

Deregulation and financial innovations have altered the substitutability among financial assets by affecting the liquidity of some assets relative to that of others. They also affected the stability of the demand for money and other financial assets and the historical link between some monetary aggregates and GDP. Deregulation and financial innovations also affected the mortgage market and altered the effect of monetary policy on residential investment by altering the sensitivity of residential investment to interest rates [see Bennet and Peristiani (1998) Podenza (1990), and Kahn, (1989)]. Changes in policy regimes, on the other hand, affected the outcomes of monetary policy [see Taylor (1998) and Borado and Schwartz (1998].

In terms of the results obtained in the previous chapters, the before mentioned changes might have affected the liquidity effect of money (the negative impact of NBR on interest rates) and the pattern of interaction between the monetary variables (money and interest rates) and real economic variables (GDP, RI, and NRI). The purpose of this chapter is to investigate the sensitivity of the estimation results obtained for the full period to structural changes in the relationship between money and economic activity. To address this issue, the sample period is divided into two sample periods. The first one is the period 1959.3 -1979.3. This sample covers the period prior to financial innovations and financial deregulation. Also, it ends before the switch in the Fed's policy to target NBR in October of 1979. The second sample is 1983.3 -1998.4. This sample covers the period after deregulation and financial innovations that took place in the early eighties. It also represents a single regime period where the Fed was targeting the federal funds rate in its operational procedures. The period 1979.4-1983.2 is excluded to avoid the complications of adjustment that might have taken place as a result of financial innovations, deregulation and policy regime changes during that period.

5.1 Empirical Results from the Periods 1959.3 – 1979.4 and 1983.3 – 1998.4

Table (5.1) presents the Forecast Error Variance Decomposition (FEVD) of the variables from estimating the EC model over the two samples: 1959.3 – 1979.3 and

TABLE 5.1 : VARIANCE DECOMPOSITION FROM THE EC MODEL (NB, Tbr, RI, K, GDP, NRI), PERIODS 1959.3 – 1979.3 AND 1983.3 - 1998.4

PANEL A							PANEL B					
PERIOD 1983.3 – 1998.4							PERIOD 1959.3 – 1979.3					
Variance Decomposition of NBR Explained By:							Explained By:					
Period	NBR	Tbr	RI	K	GDP	NRI	NBR	Tbr	RI	K	GDP	NRI
1	100.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00
5	64.13	10.47	1.54	10.40	13.09	0.37	61.77	15.68	10.49	1.18	9.70	1.18
10	53.16	16.91	1.59	20.51	7.46	0.37	43.63	12.22	18.78	11.70	12.37	1.30
16	51.49	16.62	3.94	20.55	7.08	0.33	38.80	9.44	17.56	20.63	11.48	2.09
Variance Decomposition of Tbr Explained By:							Explained By:					
Period	NBR	Tbr	RI	K	GDP	NRI	NBR	Tbr	RI	K	GDP	NRI
1	22.44	77.56	0.00	0.00	0.00	0.00	4.04	95.96	0.00	0.00	0.00	0.00
5	18.28	62.38	0.72	10.24	1.83	6.54	7.68	70.84	12.78	0.81	5.61	2.28
10	28.20	50.01	1.08	10.80	2.47	7.43	12.98	49.87	21.41	3.52	9.55	2.66
16	**34.58**	44.04	1.50	9.16	3.22	7.50	**15.27**	41.81	21.45	**8.41**	10.97	2.09
Variance Decomposition of RI Explained By:							Variance Decomposition of RI Explained By:					
Period	NBR	Tbr	RI	K	GDP	NRI	NBR	Tbr	RI	K	GDP	NRI
1	2.24	2.33	95.42	0.00	0.00	0.00	0.59	5.21	94.20	0.00	0.00	0.00
5	2.46	10.80	77.69	7.13	0.89	1.04	8.00	25.53	61.08	1.33	1.41	2.65
10	2.73	23.51	62.98	4.91	2.30	3.56	4.37	42.22	36.46	1.29	9.88	5.79
16	6.30	**29.78**	52.06	3.56	2.99	5.31	3.87	**44.32**	30.30	1.88	14.27	5.36
Variance Decomposition of K Explained By:							Variance Decomposition of K Explained By:					
Period	NBR	Tbr	RI	K	GDP	NRI	NBR	Tbr	RI	K	GDP	NRI
1	4.17	4.17	44.06	47.59	0.00	0.00	3.08	3.03	5.22	88.66	0.00	0.00
5	0.96	4.80	50.97	39.49	1.22	2.56	5.05	42.92	3.05	44.41	0.10	4.47
10	2.97	3.01	40.69	51.40	1.17	0.75	2.55	45.70	9.15	33.93	1.70	6.97
16	6.34	**2.56**	**40.48**	49.58	0.78	0.26	**3.25**	**42.34**	14.89	29.49	2.57	7.46
Variance Decomposition of GDP Explained By:							Variance Decomposition of GDP Explained By:					
Period	NBR	Tbr	RI	K	GDP	NRI	NBR	Tbr	RI	K	GDP	NRI
1	1.52	4.32	43.63	0.00	50.52	0.00	2.40	1.78	8.06	2.08	85.68	0.00
5	5.54	1.38	64.36	15.90	12.63	0.18	27.30	3.06	19.39	5.33	43.40	1.53
10	7.89	3.07	67.00	16.32	5.30	0.43	24.46	20.83	10.83	11.02	31.98	0.88
16	6.65	**5.32**	**67.91**	15.92	3.44	0.75	21.63	**27.99**	**6.94**	12.75	30.11	0.58
Variance Decomposition of NRI Explained By:							Variance Decomposition of NRI Explained By:					
Period	NBR	Tbr	RI	K	GDP	NRI	NBR	Tbr	RI	K	GDP	NRI
1	4.22	4.73	4.78	6.26	5.76	74.25	0.29	2.88	9.35	2.26	35.40	49.82
5	31.38	1.32	12.53	32.03	13.77	8.98	19.91	0.87	31.69	0.68	30.91	15.94
10	35.47	2.29	13.47	35.23	7.81	5.72	25.48	4.18	34.41	4.27	23.68	7.99
16	**38.19**	3.83	8.85	34.21	7.93	7.00	24.39	9.26	33.14	7.15	20.41	5.65

NBR is Nonborrowed reserves, Tbr is the three month Treasury Bill Rate, RI is Residential Fixed Investment, K is the money multiplier, GDP is real Gross Domestic Product, and NRI is Nonresidential (Business) Fixed Investment.

1983.3 – 1998.4. Large structural breaks are detected for most of the variables between the two sample periods. Remarkable changes can be noticed in the timing and the magnitudes of the effects of the variables on each other. From Panel A and B, we can see a noticeable decline in the contribution of residential investment (RI) in accounting for outside money (NBR) fluctuations in the period after 1983. At the 16-quarter horizon, RI contribution declined from 17.65 to 3.92 percent. The other noticeable change is that the contributions of inside money (K) in explaining the NBR variation starts earlier in the forecast horizon in the later period as compared to the earlier period.

One of the notable changes that is of interest for this research is the change in the relationship between outside money and interest rates. The table shows that at a forecast horizon of 16 quarters, the contribution of NBR in explaining the variation in the interest rate (Tbr) increased significantly, from 15.27% in the earlier period (in Panel B) to 34.58% in the later period (Panel A). Also, the effect of NBR on Tbr in the later period starts after one quarter accounting for 22%, as compared to 4.04% in the earlier period. Figure 5.4, which depicts the impulse response functions, points to a small liquidity effect for the period before 1979. From the third row, we can see that the effect of an innovation in NBR has a negative but small impact on the interest rate for the first two quarters and a larger and positive impact after two quarters. Figure 5.1 on the other hand, shows a larger liquidity effect for the period after 1982. NBR impact starts earlier and reaches a peak after 8 quarters and starts to decline after that (see Figures 5.1 – 5.6).

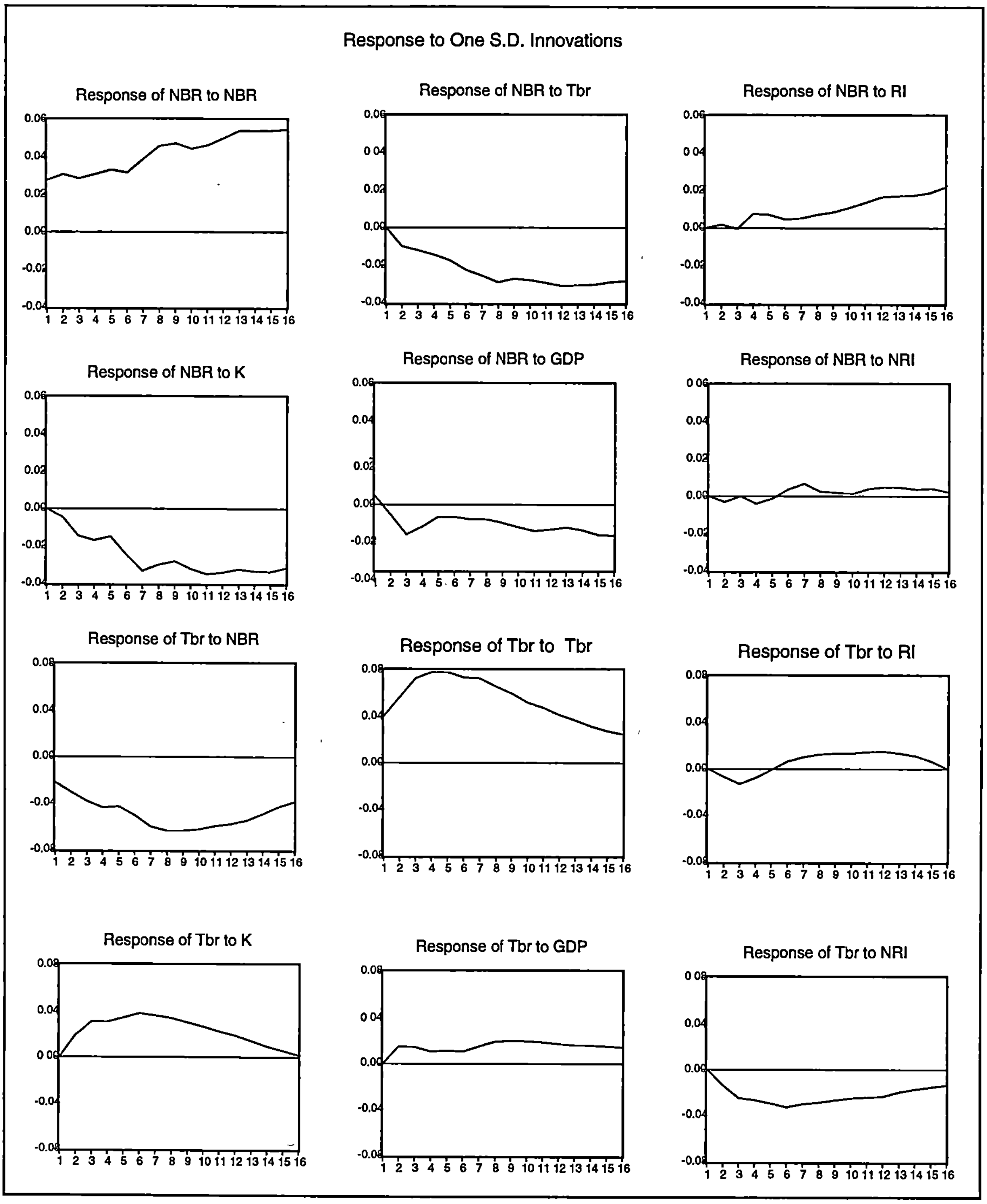

FIGURE 5.1: IMPULSE RESPONSE FUNCTIONS OF **NBR** AND **Tbr** FROM THE EC MODEL (NBR Tbr RI K GDP NRI) FOR THE PERIOD 1983:3-1998.4

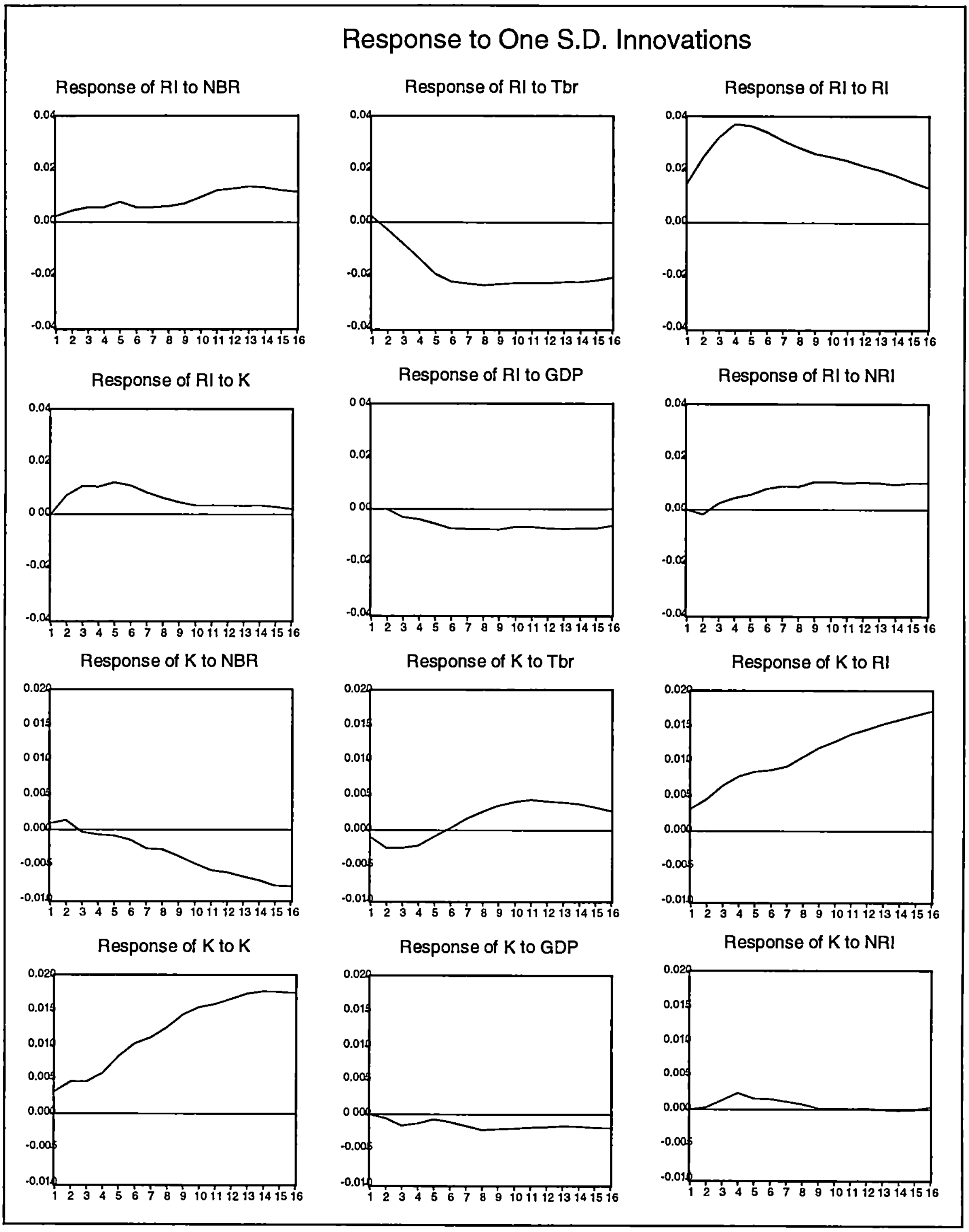

FIGURE 5.2: IMPULSE RESPONSE FUNCTIONS OF **RI** AND **K** FROM THE EC MODEL (NBR Tbr RI K GDP NRI) FOR THE PERIOD 1983.3-1998.4

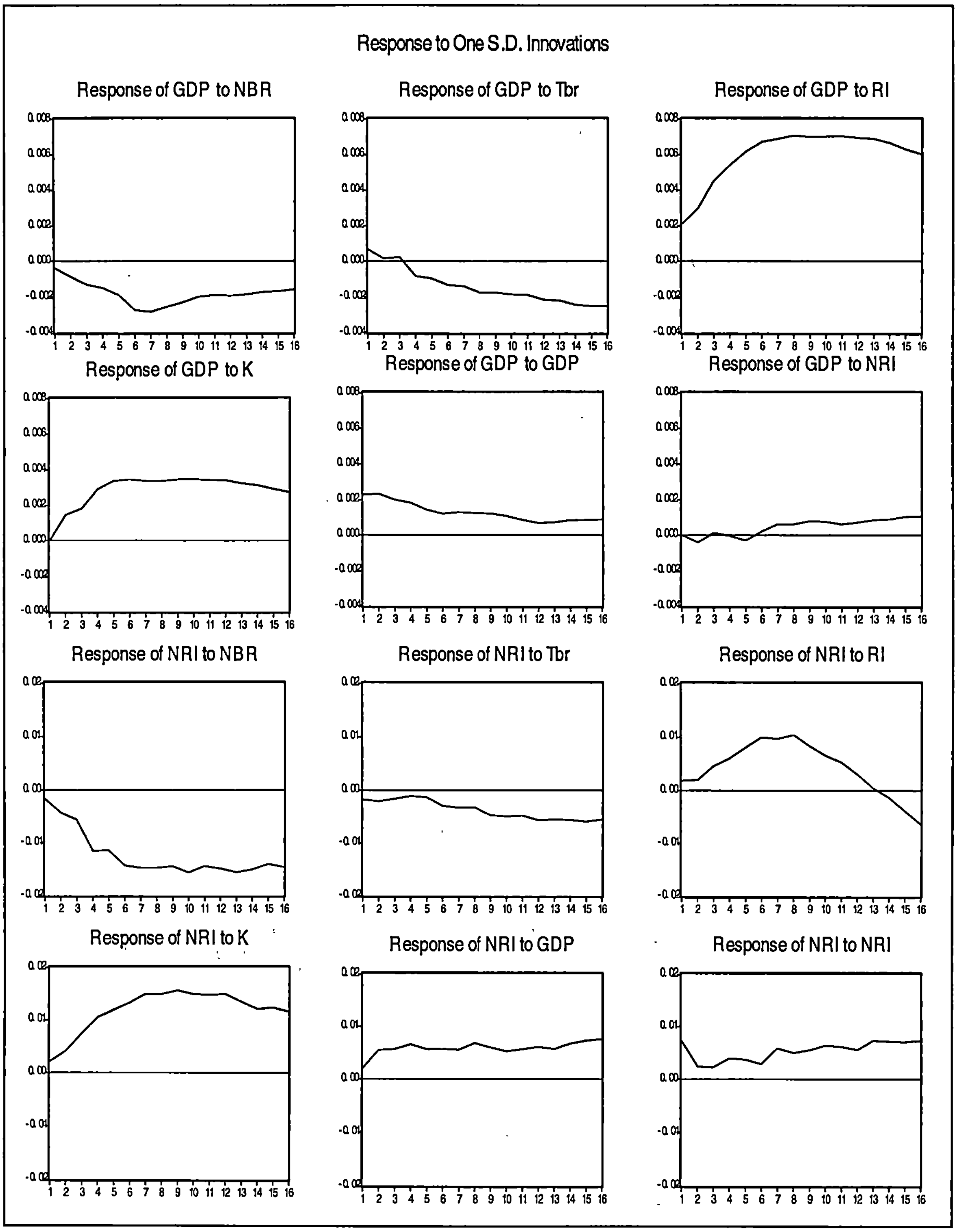

FIGURE 5.3: IMPULSE RESPONSE FUNCTIONS OF **GDP** AND **NRI** FROM THE EC MODEL (NBR Tbr RI K GDP NRI) FOR THE PERIOD 1983.3-1998.4

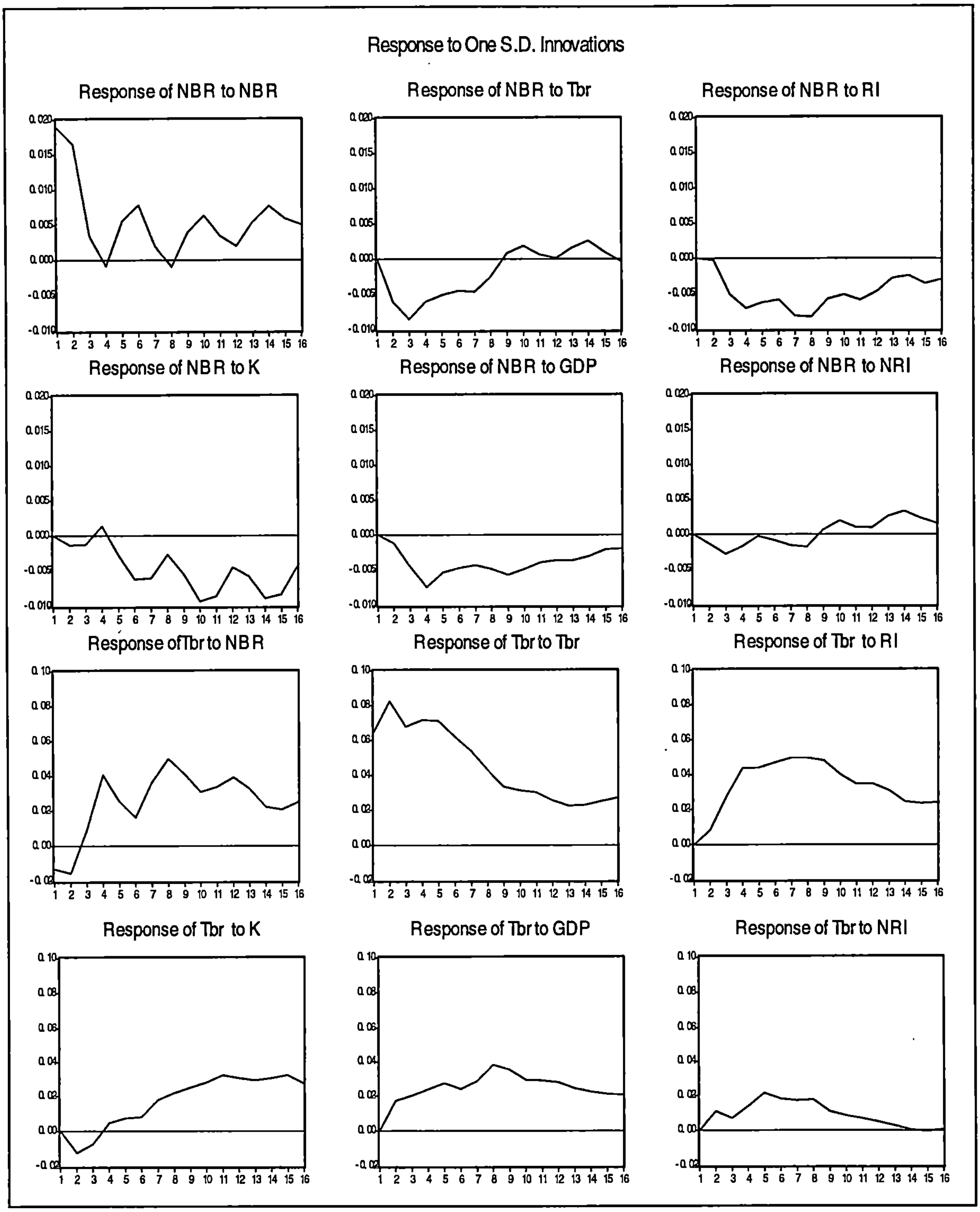

FIGURE 5.4: IMPULSE RESPONSE FUNCTIONS OF **NBR** AND **Tbr** FROM THE EC MODEL (NBR Tbr RI K GDP NRI) FOR THE PERIOD 1959.3-1979.43

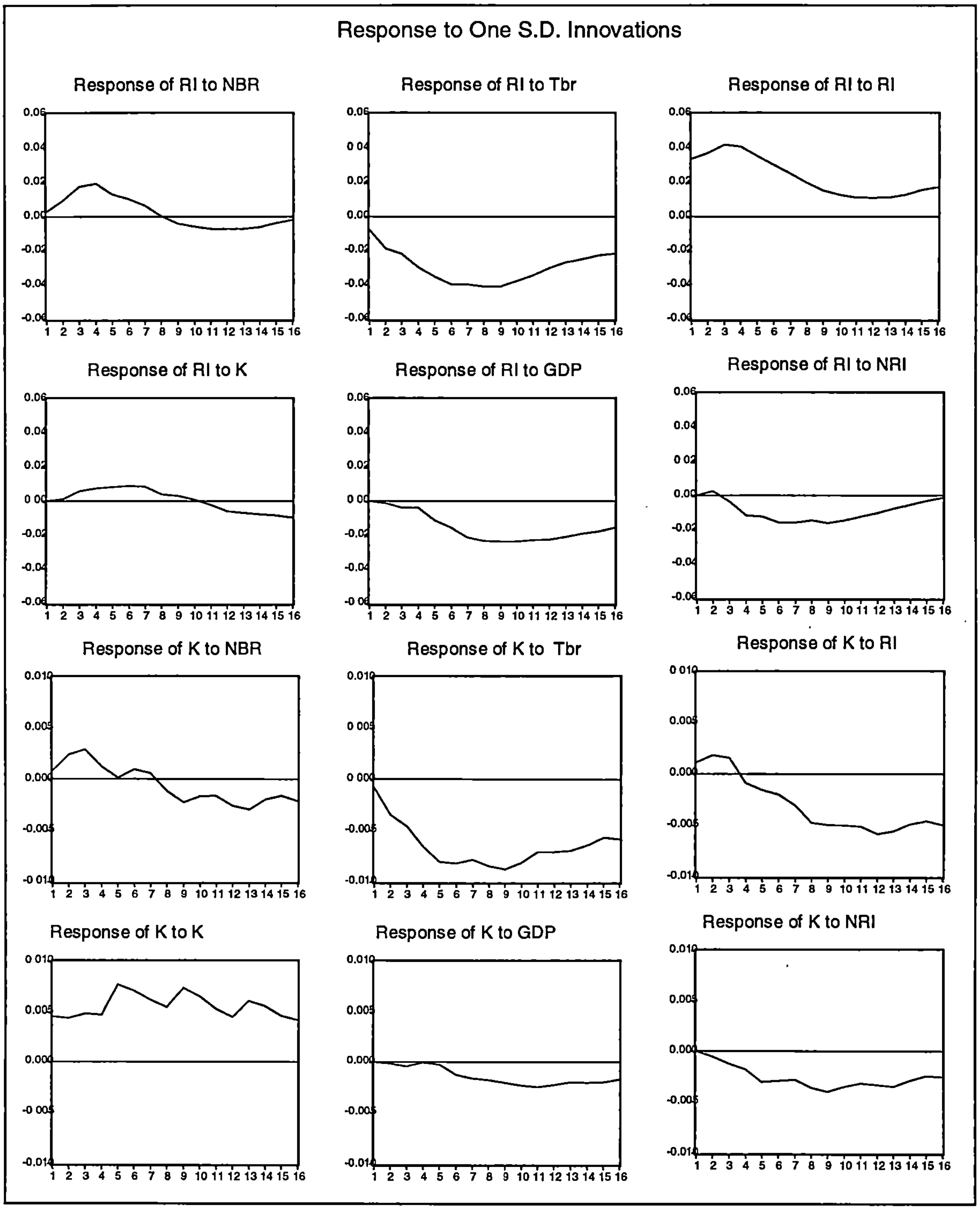

FIGURE 5.5: IMPULSE RESPONSE FUNCTIONS OF **RI** AND **K** FROM THE EC MODEL (NBR Tbr RI K GDP NRI) FOR THE PERIOD 1959.3-1979.43

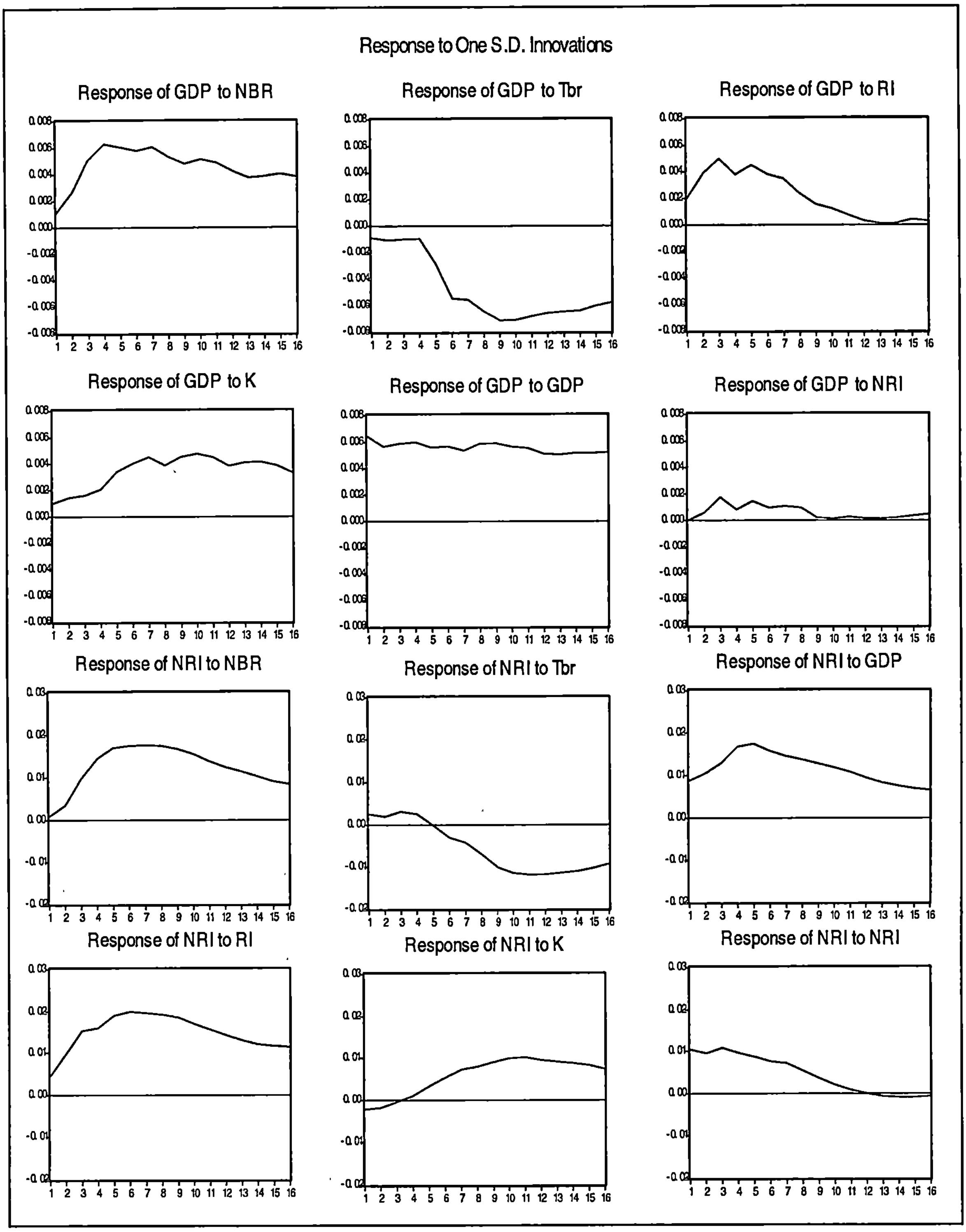

FIGURE 5.6: IMPULSE RESPONSE FUNCTIONS OF **GDP** AND **NRI** FROM THE EC MODEL (NBR Tbr RI K GDP NRI) FOR THE PERIOD 1959.3-1979.43

This change in the pattern of the relationship between outside money and interest rates (change in the liquidity effect) is consistent with the fact that interest rates are more responsive to monetary policy signals in the period after deregulation and financial innovations. On one hand, during this period, interest rates are more free to adjust after removing direct control over some interest rates. The rates are more reflective of supply and demand conditions in the market. On the other hand, the later period represents one policy regime. That is when the Federal Reserve was targeting the federal funds rate throughout the entire period. By means of open-market operations, the Fed changes the amount of NBR supplied to the banking system to attain the targeted federal funds rate. This policy creates a direct link between interest rates and nonborrowed reserve variations.

The evidence of the increasing liquidity effect of money is supported by the findings of Leeper and Gordon (1992) who find that the liquidity effect is sensitive to the sample period and that the later period (after 1982) shows a stronger negative impact of monetary changes on interest rates.[17] Strongin (1995) presents similar evidence.

Noteworthy changes also occur in the pattern of interaction among the interest rate, RI, inside money and GDP. On one hand, there is a decline in the contribution of the interest rate in accounting for the RI variation. From Table 5.1 we can notice a decline in this contribution from 44.32 % in the period before 1979 to 28.78% in the period after 1982. The decline in the sensitivity of RI to interest rates has been reported by other

[17] They estimate the response of the federal funds rate to innovations in the monetary base over the periods 1954 – 1972, 1973 – 1979, 1979 – 1982, and 1982 – 1992.

studies. The contributions of the other variables in accounting for the RI variation are about the same across the two periods. The decline in the Tbr contribution is matched by an increase in the contribution of RI itself in accounting for its own variation. However, as will be shown in the next section, using a different interest rate could alter this conclusion.

On the other hand, there seems to be a tradeoff between the contribution of the interest rate and the contribution of RI in explaining the other variables except NRI. The contribution of RI in explaining GDP variation increased remarkably from about 7% in the period prior to 1979 to about two thirds in the period after 1982. Coxwell (2000) finds a similar result. This increase was accompanied by a decline in Tbr contribution from 27.99% to 5.33% between the two periods. The RI contribution in accounting for inside money variation increased from 14.89% to 40.48%, while the Tbr contribution declined from 42.34% to 2.56% between the two periods. This change and the decline of the sensitivity of RI to Tbr point to a structural change in the transmission mechanism by which interest rates affect investment and output. The decline in the contribution of Tbr in explaining RI, given that fact that no other variables have replaced Tbr in explaining RI, points to the effect of other nonprice factors that became more important after deregulation. These factors include the increase in financial interemediation and competition in the mortgage market, the introduction of adjustable mortgage rates, and the growth of mortgages backed securities [see Bennet and Peristiani (1998), Podenza (1990].

5.2 Short-term vs. Long-term Interest Rates

I now alter the above analysis using the federal funds rate (FFR) to measure short-term interest rates and the Federal Housing Administration (FHA) rate to measure long-term interest rates. Tables 5.2 and 5.3 show the FEVD from estimating the VAR models using those two measures of the interest rate instead of Tbr. The impulse response functions (not shown) indicate that both measures of interest rates have a negative relationship with RI. As indicated by the FEVD tables, RI sensitivity to short term interest rates has declined, while RI sensitivity to long term interest rates has increased in the period after 1982 as compared to the period before 1979. Although the contribution of FFR in accounting for RI variation at a 16 quarter horizon are about the same in the two periods, the contribution at a shorter forecast horizon has, in fact, declined remarkably. At a five-quarter forecast horizon, for example, FFR contribution fell from 35.07 % in the earlier period to 12.47 % in the later period. FHA rate contribution, on the other hand, increased in the period after 1982 compared to the period before 1979. Unlike the FFR, at shorter horizons, the FHA rate contribution did not show a remarkable change between the two periods.

One possible explanation for the increase in the contribution of FHA rate in explaining RI variation is that FHA rates were more flexible in the period after deregulation as a result of removing ceilings on interest rates and increasing the competitiveness in the mortgage market. The outcome of deregulation on the mortgage market was a more flexible FHA rate. By the same token, the FFR was less volatile

TABLE 5.2: VARIANCE DECOMPOSITION OF **RI** FROM THE EC MODEL(NB, FF, RI, K,GDP, NRI)

PEREIOD 1983.3 – 1998.4							PEREIOD 1959.3 – 1979.3					
Variance Decomposition **of RI** Explained By:							Variance Decomposition of RI Explained By:					
Period	NBR	FFR	RI	K	GDP	NRI	NBR	FFR	RI	K	GDP	NRI
1	1.66	0.12	98.22	0.00	0.00	0.00	0.27	4.00	95.73	0.00	0.00	0.00
5	6.74	12.47	67.49	12.21	0.74	0.35	2.17	35.07	44.18	0.21	0.38	17.99
10	7.32	22.30	52.52	14.71	1.99	1.16	0.93	37.76	24.99	0.16	10.72	25.45
16	9.04	28.82	43.53	14.59	1.92	2.10	0.70	28.47	26.97	0.32	17.10	26.43

NBR is Nonborrowed Reserves, FFR is the Federal Funds rate, RI is Residential Fixed Investment, K is the money multiplier, GDP is real Gross Domestic Product, and NRI is Nonresidential (Business) Fixed Investment.

TABLE 5.3:VARIANCE DECOMPOSITION OF **RI** FROM THE EC MODEL(NB,FHA,RI,K,GDP, NRI)

PEREIOD 1983.3 – 1998.4							PEREIOD 1959.3 – 1979.3					
Variance Decomposition **of RI** Explained By:							Variance Decomposition of RI Explained By:					
Period	NBR	FHA	RI	K	GDP	NRI	NBR	FHA	RI	K	GDP	NRI
1	6.09	0.12	93.79	0.00	0.00	0.00	0.39	6.09	93.52	0.00	0.00	0.00
5	10.67	27.64	56.73	0.83	0.06	4.07	8.52	25.86	58.95	1.12	0.97	4.59
10	14.10	31.52	46.33	2.12	0.62	5.32	5.78	21.61	40.21	2.13	5.98	24.30
16	16.11	38.24	35.08	3.39	0.69	6.49	4.40	14.25	36.87	1.91	7.83	34.74

NBR is Nonborrowed Reserves, FHA is the Federal Housing Administration rate, RI is Residential Fixed Investment, K is the money multiplier, GDP is real Gross Domestic Product, and NRI is Nonresidential (Business) Fixed Investment.

during the period of FFR targeting after 1982. Consequently, innovations in FFR explained less of RI variation in the period after 1982 than in the period before 1979.[18]

5.3 Volatility of the Variables

To further investigate the effect of deregulation and financial innovations on the variables, the volatility of the variables is examined over the two sample periods. To measure the volatility, the Hodrick Prescott (HP)(1980) procedure is used here. First,

[18] Kahn (1989) supports this evidence. He finds that RI is less sensitive to the federal funds rate after deregulation than before deregulation.

data series are filtered according to the HP procedure to find trends in the series.[19] Then deviations from trends are calculated for each series. To measure the relative amplitude of fluctuations in each series the percentage standard deviation (of the deviations) is calculated for each series. Table 5.4 shows the results for the two sample periods. All the real variables have become less volatile in the period after deregulation and financial innovations.[20] The volatility measure used here has declined by around 48% percent for GDP, 45% for RI, and 34% for NRI. However, RI is still twice as volatile as NRI. The declines in volatility can be seen in Figure 5.7, which depicts the deviations from trend for the variables. Fluctuations after 1983 look smaller for GDP, RI and NRI [McConnell, Mosser and Quiros (1999) report a similar trend].

The NBR volatility after 1983 is twice as great as its volatility before 1979. The increase in NBR volatility after 1983 reflects the fact that the Fed's focus was on attaining more stability after 1983 using the federal funds rate as the instrument of its policy.[21] The Fed, via open market operations, makes whatever adjustments needed in NBR to attain the federal funds targets. This policy is also reflected in the decline in the

[19] The trend component $\acute{Y}$ of a variable y is calculated by minimizing the following equation with respect to $\acute{Y}$: $\Sigma_1^T\ (y_t - \acute{Y}_t)^2 + \gamma\ \Sigma_2^{T-1}\ [(y_{t+1} - \acute{Y}_t - (\acute{Y}_t - \acute{Y}_{t-1}]^2$. Where γ is a positive number chosen to produce a smooth trend. For quarterly data $\gamma = 1600$ is reasonable [see Kydland and Prescott (1990)].
[20] Tylor (1998) presents evidence of greater macroeconomic stability in the recent period (after mid-1980s). He attributes this increase in stability to strict "leaning against the wind" policies by the Federal Reserve in the recent period. Romer (1999) points to the same evidence.
[21] The focus of the Fed's policy in the 1970s and the early 1980s was on the stability of overall market conditions. That policy, especially during the period of targeting nonborrowed reserves, 1979-1982, created a large amount of interest rate volatility. The increase in interest rates volatility was one of the strongest factors in the rejection of continued nonborrowed reserves targeting. As argued by Strongin (1995), under an interest rate targeting regime, which started after 1982, the Fed is concerned with interest rate smoothing.

TABLE 5.4: VOLATILITY OF THE VARIABLES*

Period	NBR	TBR	FFR	FHA	K	RI	GDP	NRI
1959.3-1979.3	3.43	18.71	25.09	6.56	1.72	11.47	1.81	5.19
1983.3-1998.4	7.60	18.46	19.26	7.39	2.20	6.2	0.93	3.42

NBR is Nonborrowed Reserves, Tbr is the three month Treasury Bill Rate ,FFR is the Federal Funds rate, FHA is the Federal Housing Administration rate RI is Residential Fixed Investment, K is the money multiplier, GDP is real Gross Domestic Product, and NRI is Nonresidential (Business) Fixed Investment.

** Standard deviation from the trend; $[\Sigma_1^T\ (y_t - \hat{Y}_t)^2]/n$, where y is the series, $\hat{Y}_t$ is the trend component, and N is the number of observations. HP filter was used to transform the original series to deviations from their trends.*

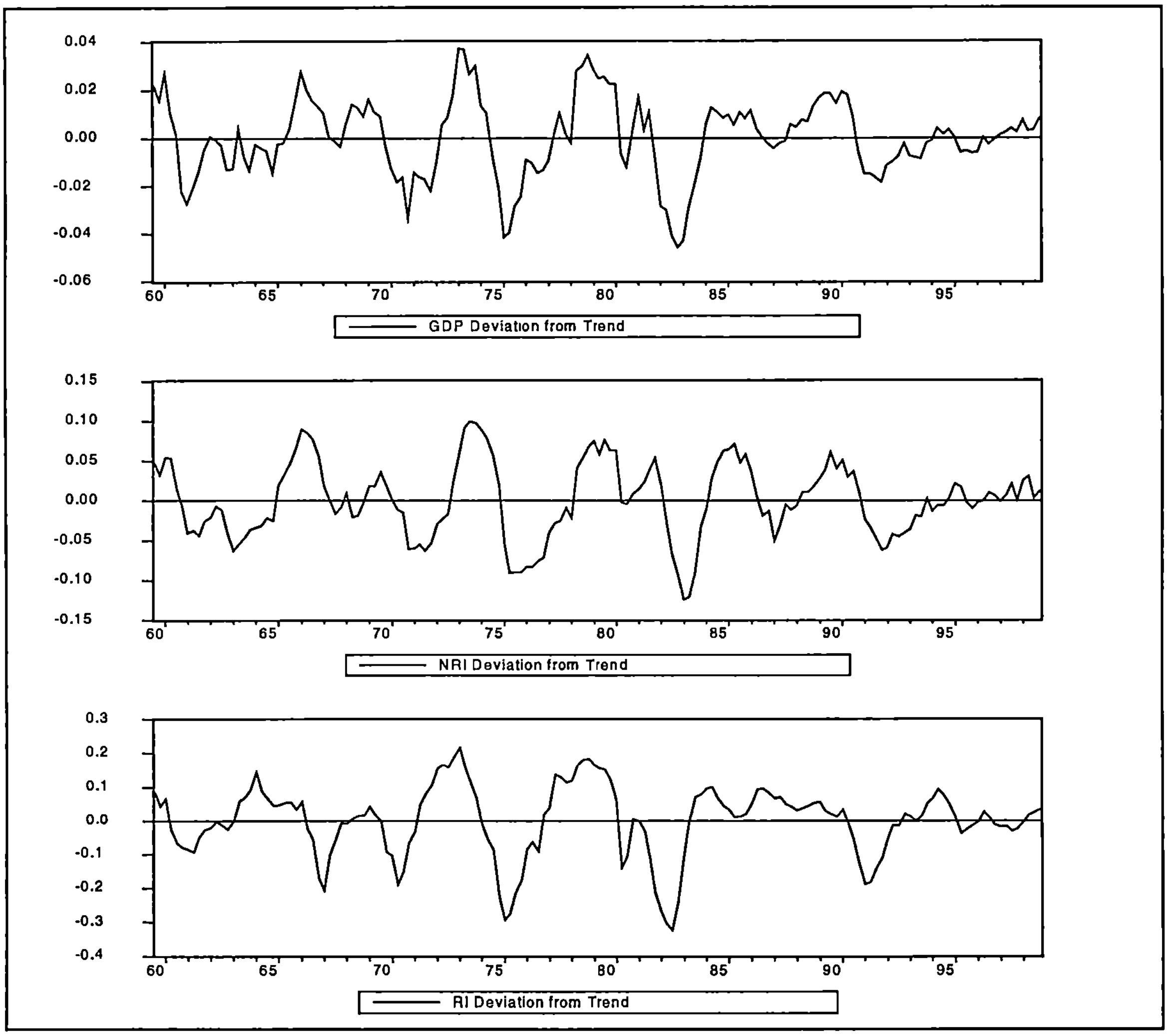

FIGURE 5.7: DEVIATION FROM TREND: GDP, NRI, AND RI

volatility of the federal funds rate (FFR) in the table. Inside money volatility increased in the later period. However, inside money volatility is less than outside money volatility in both periods. As for Tbr, it shows a slight decline in its volatility across the two periods. Its volatility is nearly the same as in the early period. The long-term interest rate (FHA) shows a higher volatility in the second period. This pattern reflects the effect of deregulation of deposit rates on the mortgage market that resulted in greater flexibility of the FHA rate.

Changes in the volatility of the variables are consistent with the results obtained from the VAR model regarding the increase in the liquidity effect of money and the change of the contribution of interest rates in explaining RI variation. The increase in NBR volatility explains the increase in the contribution of NBR innovations in accounting for the interest rate variation. The decline in the volatility of short-term interest rates and the increase in volatility of the long-term interest rate (FHA) are also consistent with the result obtained regarding the contribution of interest rates in accounting for RI variations.

The increase of RI contribution in explaining GDP variation can also be explained in terms of changes of the volatility of the variables. Although RI volatility has declined after 1982, the volatility of other components of GDP has also declined by larger magnitudes. As shown by McConnell et al. (1999), the declines in the volatility of consumption and inventory investment have the largest contributions to the stability of GDP after 1982. Consequently, RI became relatively more important in accounting for GDP variation.

The conclusion could be drawn here that there was a structural change in the relationship between the variables as a result of the changes in policy regimes, deregulation and financial innovations that took place in the early eighties. These changes also affected the volatility of the variables. The main outcomes were an increase in the liquidity effect of money and a decline in the sensitivity of RI to short-term interest rates in the period after 1983. However, RI seems to be more tied to long-term interest rates. Also, RI became more important in explaining other variables after deregulation and financial innovations.

As discussed in the full sample analysis, these results are in line with predictions of a non-market-clearing view. Important evidence to note here, which supports predictions of a non-market-clearing view, is the role of monetary policy in contributing to the overall economic stability after 1982. The success of the Fed in attaining more interest rates stability after 1982 was accompanied by less volatile real economic variables. In general, the results from dividing the full sample into the two sub-samples points to a stronger evidence of the impact of money on real economic activity after 1983.

CHAPTER SIX

BUSINESS CYCLES ANALYSIS

This chapter employs an historical approach to analyze the behavior of disaggregated variables during business cycles. This method of examining the behavior of variables during specific historical episodes (narrative approach) has a long tradition in economic literature. The work of Romer and Romer (1989) is the best known work employing this methodology. The advantage of the narrative approach is that it avoids problems of causality and identification in quantitative econometrics models. This method is used here to test the results obtained from the VAR and the correlation analysis regarding the patterns of interaction and the timing of cyclical movements in the variables. More specifically, the previous analysis shows that fluctuations in outside money produce a negative impact on interest rates and that those interest rate changes trigger fluctuations in residential investment, which in turn cause fluctuations in output and nonresidential investment. For these conclusions to be correct, movements in those variables during business cycles should reflect those patterns of interaction. This implies that movements in outside money, interest rates, and residential fixed investment begin earlier than movements in aggregate GDP, while movements in nonresidential fixed investment start later than GDP.

The following analysis employs the National Bureau of Economic Research business cycle dates. The behavior of the variables before and at the beginning of recessions and expansions will be examined to determine whether there are early causes or indicators of business cycles. The variables include (1) three outside money measures

(Nonborrowed Reserves NBR, Total Reserves TR, and Monetary Base MB), (2) the interest rate (three-month Treasury Bill rate, Tbr), (3) Residential Investment (RI), (4) Nonresidential Investment (NRI), and (5) GDP.

6.1 Recessions

Tables 6.1 through 6.6 present data on the variables during five recessions since 1960. The tables contain quarterly data and include data for one or two quarters prior to each recession. As a first observation, outside money as measured by NBR appears to perform well in predicting the interest rate, which in turn predicts RI correctly during most of the quarters of those particular recessions. Out of 34 quarters presented, NBR and Tbr moved in opposite directions in 25 quarters and Tbr and RI moved in opposite directions in 21 quarters. This observation is consistent with the liquidity effect of money and the transmission mechanism hypotheses as well as with the results obtained from the VAR and the correlation analysis in the previous chapter.

Outside money: In general, outside money as measured by NBR appears to be a leading procyclical variable. A fall in NBR has preceded all the recessions since 1960 except the short recession in 1980. However, later in those recessions NBR moved counter cyclically. Based on the quarter-to-quarter change, NBR rose in 24 quarters out of the 32 quarters presented in the tables. This fact points to a reaction role on the part of the Fed (leaning against the wind policy). That is, once a recession was underway, the Fed tried to stimulate the economy during those recessions. This behavior of NBR reflects what

TABLE 6.1: RECESSION 1960.2 (PEAK) – 1961.1 (TROUGH)

Date	Outside Money			ΔTbr	ΔRI	ΔNRI	ΔGDP
	ΔNBR	ΔTR	ΔMB				
1960.1	-0.20	-0.27	-0.77	-0.30	3.68	5.35	48.27
1960.2	0.20	-0.17	-0.07	-0.90	-10.84	1.99	-13.74
1960.3	0.40	0.27	0.47	-0.60	-3.67	-4.12	2.81
1960.4	0.50	0.30	0.57	-0.10	-0.16	-0.96	-29.72
1961.1	-0.10	-0.13	-0.77	0.10	0.45	-3.08	13.11

Figures are in billions of 1992 Dollars except for Tbr, which are percentage point changes.

TABLE 6.2: RECESSION 1969.4 (PEAK) – 1970.4 (TROUGH)

Date	Outside Money			ΔTbr	ΔRI	ΔNRI	ΔGDP
	ΔNBR	ΔTR	ΔMB				
1969.3	0.00	-0.07	0.93	**0.80**	-1.26	7.35	19.42
1969.4	0.50	0.57	1.67	0.40	-11.76	-2.21	-17.04
1970.1	0.40	0.13	-0.07	-0.20	0.31	-2.41	-6.12
1970.2	-0.20	-0.13	0.93	-0.50	-9.91	-1.66	5.12
1970.3	0.10	0.17	1.17	-0.40	7.35	1.49	31.34
1970.4	0.80	0.53	1.50	-0.90	15.42	-10.50	-33.59

Figures are in billions of 1992 Dollars except for Tbr, which are percentage point changes.

TABLE 6.3: RECESSION 1973.4 (PEAK) – 1975.3 (TROUGH)

Date	Outside money			ΔTbr	ΔRI	ΔNRI	ΔGDP
	ΔNBR	ΔTR	ΔMB				
1973.3	-0.20	0.43	1.67	**1.70**	-9.63	5.69	-11.92
1973.4	0.90	0.77	2.23	-0.80	-10.24	2.27	40.02
1974.1	0.60	0.23	0.70	0.10	-15.22	-0.26	-38.96
1974.2	-1.40	0.20	2.27	0.60	-8.39	-1.05	14.42
1974.3	-0.90	0.33	1.83	0.00	-6.07	-4.65	-42.59
1974.4	2.30	-0.43	1.70	-0.80	-23.23	-10.86	-25.85
1975.1	1.20	-0.20	0.10	-1.60	-9.53	-22.18	-53.20
1975.2	-0.10	-0.07	1.90	-0.40	3.10	-8.67	34.28
1975.3	0.00	0.23	2.13	0.90	10.27	3.07	71.81

Figures are in billions of 1992 Dollars except for Tbr, which are percentage changes.

TABLE 6.4: RECESSION 1980.1 (PEAK) – 1980.3 (TROUGH)

Date	Outside money			ΔTbr	ΔRI	ΔNRI	ΔGDP
	ΔNBR	ΔTR	ΔMB				
1979.3	0.60	0.63	3.77	0.30	-3.20	14.45	29.29
1979.4	0.30	1.30	4.07	2.10	-9.25	-0.10	11.30
1980.1	0.10	0.40	0.77	1.60	-16.08	5.62	22.73
1980.2	0.00	0.07	2.90	-3.80	-40.47	-25.49	-112.34
1980.3	1.00	-0.27	3.13	-0.40	3.16	3.73	-4.37

Figures are in billions of 1992 Dollars except for Tbr, which are percentage point changes

TABLE 6.5: RECESSION 1981.3 (PEAK) – 1982.4 (TROUGH)

Date	Outside money			ΔTbr	ΔRI	ΔNRI	ΔGDP
	ΔNBR	ΔTR	ΔMB				
1981.2	-0.70	-0.37	2.80	0.50	-7.23	8.20	-42.34
1981.3	0.40	0.20	2.30	0.20	-14.25	11.21	56.20
1981.4	1.10	0.37	2.47	-3.30	-16.88	10.66	-59.26
1982.1	-0.50	0.23	0.43	1.00	-8.56	-13.35	-77.87
1982.2	-0.30	-0.80	3.07	-0.40	-4.56	-18.38	18.99
1982.3	0.60	0.13	3.17	-3.10	-1.73	-15.47	-22.80
1982.4	1.40	1.20	4.30	-1.40	13.06	-8.67	6.18

Figures are in billions of 1992 Dollars except for Tbr, which are percentage point changes.

TABLE 6.6: RECESSION 1990.3 (PEAK) – 1991.1 (TROUGH)

Date	Outside money			ΔTbr	ΔRI	ΔNRI	ΔGDP
	ΔNBR	ΔTR	ΔMB				
1990.1	-0.90	0.27	3.23	**0.10**	3.42	6.55	59.08
1990.2	0.20	-0.23	7.10	-0.10	-11.56	-11.95	18.98
1990.3	0.40	0.03	7.13	-0.20	-12.91	4.73	-29.47
1990.4	1.30	0.80	7.57	-0.50	-14.59	-14.22	-63.14
1991.1	0.40	0.90	7.53	-1.00	-12.93	-18.83	-31.47

Figures are in billions of 1992 Dollars except for Tbr, which are percentage point changes the Fed was trying to do in those periods. Romer (1999), and Romer and Romer (1989), based on their reading of the Federal Open Market Committee, find that in nearly every postwar recession, the Federal Reserve eventually adopted active expansion in an attempt to end or ameliorate the recession. The declines in outside money prior to those recessions, given the fact that they led to rises in interest rates, indicate that monetary changes might have caused or participated in causing those recessions. This evidence is also supported by Romer (1999) who finds that there were monetary policy shocks in all but two (1953 and 1960) of the postwar downturns in the economy.[22]

Comparing the performance of the three measures of outside money, we can see that NBR performs better than total reserves (TR) and the monetary base (MB) in terms of predicting interest rate movements. NBR movements predicted interest rate movements correctly in 25 quarters, compared to 16 quarters in the case of both TR and MB. MB was rising during the recessions and declined in a few quarters. It did not decline before or at the beginning of the recession, except in the 1960-1961 recession. On the other hand, the precedence of declines in outside money to the recessions is clearer in the case of NBR than TR.

Interest rates: In contrast with the outside money behavior, the interest rate rose before or very early in the recessions, but fell during the later portion of recessions. Tbr rose before or at the beginning of all the recessions except the one in 1960-1961. Later on in

[22] This evidence is also supported by Christiano, Eichenbaum, and Evan (1997) who argue that monetary policy was tight before each recession and became easier around the time of the trough. Fackler and Mckillin (1998) support this evidence.

the recessions, Tbr was falling. Furthermore, movements in the interest rate were mostly associated with movements in the opposite direction in outside money (NBR). On the other hand, rises in the interest rate correctly predicted declines in RI in most of the quarters. See Garrison (1999) for similar results. This behavior of the interest rate provides evidence of the transmission mechanism by which interest rates affect investment and output negatively. It also points to the dynamic nature of the relationship between interest rates, investment, and output. That is, interest rates affect investment and output after a time lag.[23] However, analyzing the behavior of interest rates (which appear to be procyclical) only over the entire cycle does not provide this evidence. Such analysis has led RBC economists to conclude that interest rate movements are procyclical and therefore do not provide an explanation of fluctuations in investment during business cycles.

Residential Investment: RI declined in most of the quarters of the recessions and in most cases the declines were associated with increases in the interest rate. An interesting aspect of RI behavior is that it started to increase before the end of five out of the six recessions studied here. NRI, on the other hand, continued to decline until the end of most of the recessions and indeed well into the ensuing expansions. Another noteworthy point is the magnitude of RI fluctuations. Although RI constitutes a small portion of total fixed investment, it fluctuated in larger magnitudes than NRI in many of the quarters

[23] Fiorito and Kollintzas (1994) present data showing that interest rates lead business cycles countercyclically.

(especially during earlier quarters of the recessions). This might be due to the fact that RI is more sensitive to interest rates than is NRI [see Garrison (1991)]. These observations are consistent with the findings from the VAR and the correlation analysis in the previous chapter.

Nonresidential Investment: Unlike RI, NRI fluctuations are not closely associated with fluctuations in the interest rate. Only in 13 of the 32 quarters presented did NRI respond negatively to Tbr, compared to 21 quarters of negative response in the case of RI. On the other hand, NRI does not appear to be a leading indicator of recessions. It did not start to fall before any of the recessions, and in all of the recessions it started to decline one to three quarters later than RI.

6.2 Expansions

Tables 6.7 through 6.11 contain data for the variables during expansions after 1960. Since expansion periods are long annual data are presented in the tables. Similar to their behavior in recessions, outside money as measured by NBR, and the interest rate (Tbr) moved in opposite directions during most of the years presented. While this negative relationship did not prevail in every single year, all the expansions presented in the tables started by a rise in nonborrowed reserves and a fall in Tbr. At the same time the interest rate performed well in predicting residential investment (RI) in most of the expansions years. A clear pattern in the relationship between Tbr and RI is that large increases in RI followed a sharp decline in Tbr at the beginning of every expansion.

TABLE 6.7: EXPANSION 1961.1 (TROUGH) – 1969.4 (PEAK)

Date	Outside money			ΔTbr	ΔRI	ΔNRI	ΔGDP
	ΔNBR	ΔTR	ΔMB				
1960	0.90	0.13	0.20	**-1.90**	-10.98	2.26	7.62
1961	0.30	0.30	0.73	0.20	**11.42**	6.12	142.44
1962	0.00	0.10	1.07	0.30	6.12	9.48	95.66
1963	-0.20	0.13	1.93	0.70	22.31	15.27	127.95
1964	0.40	0.43	2.30	0.20	-4.20	20.01	135.13
1965	0.10	0.27	2.30	0.50	-1.04	40.38	230.73
1966	-0.10	0.10	2.10	1.00	-28.08	15.89	131.88
1967	1.30	1.00	2.93	-0.40	24.74	-2.24	75.62
1968	0.10	0.60	3.63	0.80	9.38	14.17	153.24
1969	-0.20	0.53	3.27	1.80	-9.12	15.62	61.39

Figures are in billions of 1992 Dollars except for Tbr, which are percentage point changes.

TABLE 6.8: EXPANSION 1970.4 (TROUGH) – 1973.4 (PEAK)

Date	Outside money			ΔTbr	ΔRI	ΔNRI	ΔGDP
	ΔNBR	ΔTR	ΔMB				
1970	1.10	0.70	3.53	**-2.00**	13.18	-13.08	-3.25
1971	0.30	0.63	3.20	-0.40	**35.13**	7.07	134.44
1972	0.90	1.47	5.40	0.70	26.43	35.95	256.65
1973	-0.10	1.67	6.27	2.60	-24.29	36.83	156.67

Figures are in billions of 1992 Dollars except for Tbr, which are percentage point changes.

TABLE 6.9: EXPANSION 1975.3 (TROUGH) – 1980.1(PEAK)

Date	Outside money			ΔTbr	ΔRI	ΔNRI	ΔGDP
	ΔNBR	ΔTR	ΔMB				
1975	1.50	0.27	6.23	**-1.80**	**10.74**	-24.58	98.35
1976	0.60	0.83	7.63	**-0.90**	**42.39**	22.52	173.91
1977	-0.10	1.20	8.80	1.40	**26.55**	45.53	201.95
1978	0.90	1.47	10.27	2.50	15.49	59.35	275.31
1979	-0.20	1.43	10.63	3.20	-22.59	23.76	52.58
1980	1.40	0.83	11.00	1.80	-35.15	-5.97	-4.37

Figures are in billions of 1992 Dollars except for Tbr, which are percentage point changes.

TABLE 6.10 : EXPANSION 1982.4 (TROUGH) – 1990.3 (PEAK)

Date	Outside money			ΔTbr	ΔRI	ΔNRI	ΔGDP
	ΔNBR	ΔTR	ΔMB				
1982	1.20	0.77	10.97	**-3.90**	-1.79	-55.87	-75.50
1983	1.80	2.23	15.80	0.90	**68.45**	44.47	320.97
1984	-2.60	1.13	11.33	0.00	9.21	68.85	264.45
1985	7.60	4.33	15.90	-1.60	9.60	14.07	189.89
1986	7.30	6.43	18.90	-1.80	26.12	-29.52	133.20
1987	1.90	1.93	17.50	0.50	-6.50	8.58	223.80
1988	-0.40	1.40	17.17	1.80	-1.02	20.95	202.26
1989	1.70	0.20	10.30	0.00	-17.77	15.90	140.68
1990	1.00	0.87	25.03	-0.70	-35.64	-14.89	-14.55

Figures are in billions of 1992 Dollars except for Tbr, which are percentage point changes.

TABLE 6.11: EXPANSION 1991.1 (TROUGH) –

Date	Outside money			ΔTbr	ΔRI	ΔNRI	ΔGDP
	ΔNBR	ΔTR	ΔMB				
1991	3.80	3.50	23.97	**-2.50**	2.12	-34.38	26.29
1992	9.10	8.53	32.77	-1.40	**34.24**	29.55	221.87
1993	6.60	6.60	36.57	0.00	18.44	56.48	149.74
1994	-0.90	-0.40	32.33	2.20	10.84	47.33	211.75
1995	-3.00	-2.20	17.03	0.00	-3.81	49.38	137.19
1996	-6.60	-4.73	15.83	-0.30	14.14	84.77	267.32
1997	-3.70	-2.80	26.93	0.10	11.63	79.19	271.51
1998	-2.10	-1.53	33.63	-0.20	36.30	105.63	305.36

Figures are in billions of 1992 Dollars except for Tbr, which are percentage point changes

Outside money: All the expansions have witnessed rises in the three measures of outside money. TR and MB rose in every year of the expansions, except the period after 1994 where TR was declining. NBR was also rising, especially in the early years of these expansions. NBR outperformed TR and MB in predicting interest rate movements. Most of the NBR rises were accompanied by declines in Tbr (24 out of 37 years presented), whereas TR and MB rises were accompanied by declines in Tbr in just 13 years. NBR, however, moved against the cycle in several years. The only persistent movement against the cycle was the one in the latest expansion. After witnessing unprecedented yearly increases during the first three years of the expansion, NBR and TR have been declining since 1995 against the still rising economic activity. This latest behavior of NBR needs more investigation. The declines of NBR are puzzling especially, since interest rates have been falling and investment and GDP have been rising in larger amounts since 1995. A possible explanation for this behavior of NBR could be that inflation expectations have been declining, so that nominal interest rates fall even if outside money declines [Garrison (1999)]. Actual data on inflation show that inflation rates and inflation expectations were declining since 1990.

Another possible explanation for NBR movements against the cycle is that the Fed was trying to prevent inflation from rising in the face of the booming economic activity in the second half of the 90s, i.e., countercyclical policy. Figure 6.1 shows that the Fed policy aimed at keeping inflation rates low. It shows that the Fed increased the targeted Federal Funds rate after 1994 to attain a lower inflation rate. This indicates a tightening policy by the Fed. In fact, recent trends show that interest rates started to rise

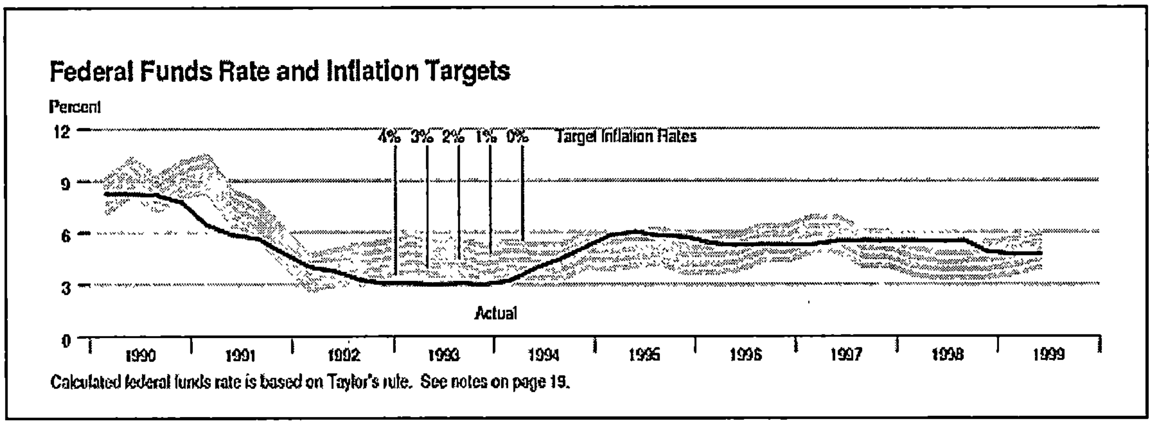

FIGURE 6.1: FEDERAL FUNDS RATES AND INFLATION TARGETS 1990-1999

Source: Monetary Trends, November 1999, Federal Reserve Bank of St. Louis web site: http://www.stls.frb.org/images/publications/mt/page9.gif

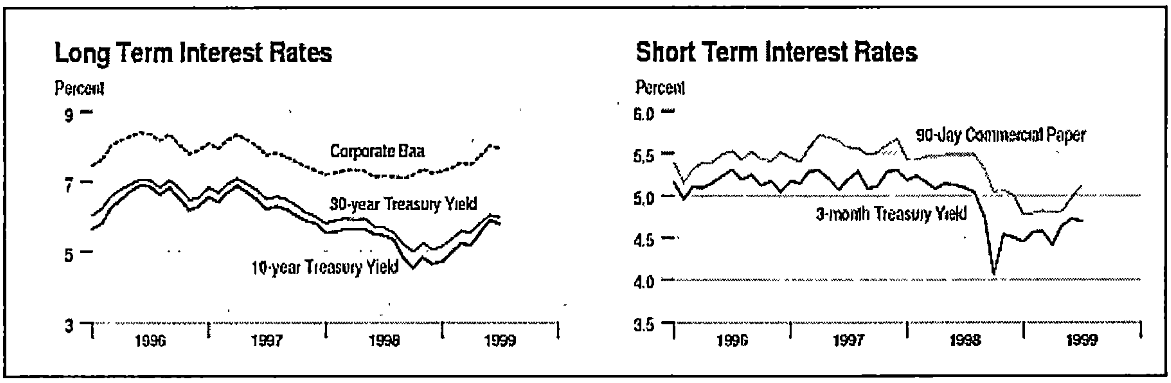

FIGURE 6.2: INTEREST RATES 1996-1999

Source: Monetary Trends, Federal Reserve Bank of St. Louis. http://www.stls.frb.org/images/publications/mt/page9.gif again in 1999 (Figure 6.2). Therefore, the decline of NBR is an indication that it is the correct stance of monetary policy. The other measures of money, on the other hand, did not reflect this behavior of the Fed.

Interest rates: The interest rate is procyclical in most of the expansions years. However, every single expansion has started with a relatively sharp decline in the interest rate (Tbr). In the majority of the time the early declines in the interest rate were accompanied by increases in NBR. At the same time these declines in the interest rates were followed by increases in investment and output. Later in the expansions the interest rate tended to rise, possibly as a result of the upward pressure created by increases in aggregate demand. This pattern confirms the results obtained in the VAR analysis and is consistent with a non-market–clearing explanation of business cycles.

Residential Investment: If we look at RI during the expansions studied here, we can notice two main patterns of RI behavior in the annual data. The first is that RI increased in large magnitudes (after declines in the interest rate) at the beginning of every cycle. For example, RI rose by $35 billion in 1971 following a fall of 2.0 points in Tbr in 1970, by $58.5 billion in 1983 after a fall of 3.9 points in Tbr in 1982, and by $34.2 billion in 1992 after a fall of 2.5 points in Tbr in 1991. One thing to mention here is that the lag might be shorter than a year as we noticed in the analysis using quarterly data for recessions.

The second pattern is that RI tends to increase at the beginning of the expansions and starts to decline before the end of the expansions. For example, RI started to decline three years before the end of the expansion of 1982-1990, and two years before the end of the expansion of 1975-1980. This pattern is complementary to the behavior of RI in recessions, where RI starts to decline early in the recessions and begins to increase again before the end of the recessions. This timing factor of RI movements during expansions was also found in the correlation and the VAR analysis in the previous chapter.

Nonresidential Investment: NRI movements during expansions are strongly procyclical. In comparison with RI, NRI appears to be less sensitive to the interest rate. It is more associated with GDP movements than is RI. In the expansions studied, NRI and Tbr correlated negatively only in nine years while RI and Tbr correlated negatively in 20 years. In contrast, NRI is associated positively with GDP movement in 33 years compared to 24 years for RI. This behavior tends to confirm the results from the correlation and the VAR analysis.

The above analysis of the behavior of the variables during recessions and expansions is consistent with the results obtained from the VAR and correlation analysis. In particular, the negative relationships between outside money and interest rates and between interest rates and residential investment are found during the business cycles studied. Among the measures of outside money used, NBR appears to be the most appropriate measure of the stance of monetary policy. NBR fell at the beginning of the recessions and increased at the beginning of the expansions studied. In addition, the behavior of NBR reflected, to a large extent, "leaning against the wind" policy by the Fed; in most of the cycles studied, it declined against rising economic activity as expansions matured and increased against slowing economic activity.

Interest rates and residential investment appear to be leading variables in recessions and expansions, and residential investment tends to fluctuate strongly following changes in interest rates. Also, residential investment movements are more associated with interest rate movements than are nonresidential investment movements.

CHAPTER SEVEN

CONCLUSIONS

It is well documented, theoretically and empirically, that outside and inside components of money have different determinants, and their effects on other variables are different. As the evidence presented in this research shows, aggregate money, as measured by M2, has a positive relationship with interest rates. But broad measures of money contain an endogenous component that hides the effect of the exogenous shocks of money. It is monetary change that results from an exogenous policy shock that is expected to have a negative effect on interest rates. When money is decomposed into inside and outside money, the liquidity effect (the *negative* relationship with interest rates) can be observed from the relationship of outside money with interest rates.

The fact that the nonborrowed reserve component is the only monetary variable that has a negative relation with interest rates justifies the use of NBR as the measure of the exogenous monetary policy. Inside money, on the other hand, reveals the expected positive pattern of relationships with the interest rate and output, which is consistent with the results obtained from using aggregate money M2. The finding that monetary changes induce variation in the interest rate, which in turn affect output, is an indication of the impact of exogenous monetary changes on economic activity.

As for aggregate investment, the difference in behavior of the two components, residential and nonresidential fixed investment, is a stylized fact of business cycles. The residential component leads the cycle while the nonresidential lags the cycle. Further, it is well known that residential fixed investment is more sensitive to the interest rate than is nonresidential investment. The evidence from this research underscores the importance of disaggregating fixed investment into residential and nonresidential fixed investment in studying the relationship between money and output using the VAR method. The relationships of investment with other macroeconomic variables expected in a non-market-clearing model are not necessarily reflected in the relationships of aggregate investment with those variables. The evidence shows clearly that the two components have different, and most of the time opposing, relationships with other variables. The quantitative importance of the determinants of fixed investment differs markedly as between RI and NRI. RI is strongly determined by the interest rate, while NRI is strongly determined by RI and GDP. Further, the interest rate does not seem to be an important factor in explaining NRI variation.

The results also provide strong evidence on the importance of the behavior of RI in business cycles. RI is the major variable in terms of interacting with the interest rate, inside money, NRI and GDP. Particularly, the feedback from economic activity to inside money is reflected only in the effect of RI on inside money. Also, RI is the major determinant of GDP and NRI. However, most empirical studies have ignored RI as a variable that plays a major role explaining the relationship between money and economic activity.

A structural change in the relationships between the variables occurred in the early 1980s as a result of the changes in policy regimes, deregulation and financial innovations that took place at that time. These changes also affected the volatility of the variables.

The main outcomes were an increase in the liquidity effect of money and a decline in the sensitivity of RI to short-term interest rates in the period after 1983. RI now seems to be more tied to long-term interest rates. Also, RI became more important in explaining other variables after deregulation and financial innovations.

The analysis of the behavior of the variables during individual recessions and expansions is consistent with the results obtained from the VAR and correlation analysis. In particular, the negative relationships between outside money and interest rates and between interest rates and residential investment are found during the business cycles studied. NBR fell at the beginning of the recessions and increased at the beginning of the expansions studied. In addition, the behavior of NBR reflected, to a large extent, "leaning against the wind" policy by the Fed; in most of the cycles studied, it declined against rising economic activity and increased against slowing economic activity.

Interest rates and residential investment appear to be leading variables in recessions and expansions and residential investment tends to fluctuate strongly following changes in interest rates. Also, RI movements are more associated with interest rate movements than are NRI movements.

Comparing the results obtained here with the propositions of the macroeconomic models, the main implications of these results are the following. First, the negative effect of outside money on interest rates is at odds with the predictions of the Real Business Cycle (RBC) model that outside money affects only prices, and that interest rate variations are caused by technology shocks. The RBC model predicts a positive relationship between money (inside money) and interest rates. A productivity shock increases the rate of return on deposits (inside money), causing interest rates and inside to move in the same direction. The evidence presented in this dissertation supports this positive relationship.

The second implication regards the interpretation of the observed behavior of interest rates during business cycles. In particular, the RBC model predicts that the interest rate is procyclical. According to the RBC theory, a positive intermediate productivity shock to marginal productivity of capital (both residential and nonresidential business capital) causes an increase in investment demand. The excess demand drives interest rates up. The final impact is an increase in investment because the positive effect of the increase in the productivity of capital outweighs the negative effect of the rise in interest rates. As such, in the RBC model, interest rates play no causal role in explaining why business cycle movements get started. It appears that the RBC theorists have been driven to this theory by their reading of the empirical evidence that the interest rate is positively correlated with *aggregate* output. The finding in this dissertation that interest rates are negatively correlated with residential investment contradicts the prediction of the RBC model regarding the positive relationship between interest rates and investment. This finding implies a central causal role for interest rates.

On other hand, the evidence presented here is more compatible with a non-market-clearing (NMC) view. First, a NMC model is compatible with a central role for interest rates in explaining why movements in real variables occur. Second, in a NMC model both interest rates and output determine investment. Interest rates affect investment negatively, while output affects investment positively. The evidence from disaggregating investment supports this prediction. The negative impact of interest rates on investment is reflected in the relationship between interest rates and the residential component, while the positive impact of output on investment is reflected in positive impact of GDP on the nonresidential component. However, output is a choice variable in market-clearing models, so according to the RBC theory, investment predicts output. Clearly, RBC economists do not refer to RI when they discuss the effect of investment on output. If they are referring to NRI, the results here show that NRI does not predict but is predicted by GDP.

In addition, the predictions of macroeconomic models regarding the positive impact of aggregate output on money are not supported by the results in this research. Specifically, the prediction of the RBC model that there is a positive correlation between output and inside money is not found here. The results show that the response of inside money to GDP is negative. However, RI seems to be the component of output that has a positive impact on inside money.

Finally, the prediction of the post Keynesian model that the channel of influence runs from output to inside money and to outside money is clearly not supported by the results of this research. The pattern of interaction is more likely to be the other way around. That is, outside money predicts interest rates, interest rates predict RI, RI predicts both inside money and output, and output predicts NRI.

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APPENDIXES

APPENDIX A

DERIVATION OF THE VAR REDUCED FORM, IMPULSE RESPONSE FUNCTIONS AND THE FEVD

Consider the following two-variable (y and M) structural VAR model with a lag length of unity:

$$\begin{bmatrix} \delta_{11} \delta_{12} \\ \delta_{21} \delta_{22} \end{bmatrix} \begin{bmatrix} M_t \\ Y_t \end{bmatrix} = \begin{bmatrix} a_1 \\ a_2 \end{bmatrix} + \begin{bmatrix} a_{11} a_{12} \\ a_{21} a_{22} \end{bmatrix} \begin{bmatrix} M_{t-1} \\ y_{t-1} \end{bmatrix} + \begin{bmatrix} U_{mt} \\ U_{Yt} \end{bmatrix} \text{........} \quad 1$$

It is assumed (1) M_t and Y_t are stationary (2) U_{mt} and U_{Yt} are white noise disturbances with standard deviations of σm, σy, respectively (3) U_{mt} and U_{Yt} are uncorrelated white-noise disturbances.

Premultiply by

$$\begin{bmatrix} \delta_{11} \delta_{12} \\ \delta_{21} \delta_{22} \end{bmatrix}^{-1}$$

The reduced form of the VAR model will be given by the following model:

$$\begin{bmatrix} M_t \\ Y_t \end{bmatrix} = \begin{bmatrix} b_1 \\ b_2 \end{bmatrix} + \begin{bmatrix} b_{11} b_{12} \\ b_{21} b_{22} \end{bmatrix} \begin{bmatrix} M_{t-1} \\ Y_{t-1} \end{bmatrix} + \begin{bmatrix} e_{mt} \\ e_{Yt} \end{bmatrix} \text{..........} \quad 2$$

Where:

$$\begin{bmatrix} b_1 \\ b_2 \end{bmatrix} = \begin{bmatrix} \delta_{11} \delta_{12} \\ \delta_{21} \delta_{22} \end{bmatrix}^{-1} \begin{bmatrix} a_1 \\ a_2 \end{bmatrix}$$

$$\begin{bmatrix} b_{11} b_{12} \\ b_{21} b_{22} \end{bmatrix} = \begin{bmatrix} \delta_{11} \delta_{12} \\ \delta_{21} \delta_{22} \end{bmatrix}^{-1} \begin{bmatrix} a_{11} a_{12} \\ a_{21} a_{22} \end{bmatrix}$$

$$\begin{bmatrix} e_{mt} \\ e_{Yt} \end{bmatrix} = \begin{bmatrix} \delta_{11} \delta_{12} \\ \delta_{21} \delta_{22} \end{bmatrix}^{-1} \begin{bmatrix} U_{mt} \\ U_{Yt} \end{bmatrix}$$

This vector autoreggression can be written as a vector moving average:

$$\begin{bmatrix} M_t \\ Y_t \end{bmatrix} = \begin{bmatrix} \overline{M} \\ \overline{Y} \end{bmatrix} + \sum_{i=0}^{i=\infty} \begin{bmatrix} b_{11} b_{12} \\ b_{21} b_{22} \end{bmatrix}^i \begin{bmatrix} e_{mt-i} \\ e_{yt-i} \end{bmatrix} \text{..........} \quad 3$$

Equation 3 express M_t and Y_t in terms of the reduced form errors, e_{mt} and e_{yt}. The moving average representation in terms of the structural disturbances is given by the following equation:

$$\begin{bmatrix} M_t \\ Y_t \end{bmatrix} = \begin{bmatrix} \overline{M} \\ \overline{Y} \end{bmatrix} + \sum_{i=0}^{i=\infty} \begin{bmatrix} \phi_{11(i)} \phi_{12(i)} \\ \phi_{21(i)} \phi_{22(i)} \end{bmatrix} \begin{bmatrix} U_{mt-i} \\ U_{yt-i} \end{bmatrix} \text{.......} \quad 4$$

Where:

$$\phi_i = \left[A_1^{\,i} / (1 - a_{12} a_{21}) \right] \begin{bmatrix} 1 & \ldots\ldots & -a_{12} \\ -a_{21} & & 1 \end{bmatrix}$$

The moving average representation is used to examine the interaction between M_t and Y_t.

The coefficients of ϕi can be used to generate the effects of U_{mt} and U_{yt} shocks on the entire time path of M_t and Y_t.

Impulse response functions of money:

$\phi_{11h} = \partial M_{t+h} / \partial U_{mt}$
$\phi_{12h} = \partial M_{t+h} / \partial U_{yt}$

Impulse response functions of output:

$\phi_{21h} = \partial Y_{t+h} / \partial U_{mt}$
$\phi_{22h} = \partial Y_{t+h} / \partial U_{yt}$

The forecast Error variance Decomposition from for M and Y are given by the following formulas:

FEVD of M explained by innovations in M $= \sigma_m^2 [\Sigma_0^{n-1} \phi_{11(i)}] / \sigma_m(n)^2$

FEVD of M explained by innovations in y $= \sigma_y^2 [\Sigma_0^{n-1} \phi_{21(i)}] / \sigma_m(n)^2$

FEVD of Y explained by innovations in M $= \sigma_m^2 [\Sigma_0^{n-1} \phi_{12(i)}] / \sigma_y(n)^2$

FEVD of Y explained by innovations in Y $= \sigma_y^2 [\Sigma_0^{n-1} \phi_{22(i)}] / \sigma_y(n)^2$

APENDIX B

DEVIATION OF THE VARIABLES FROM TREND

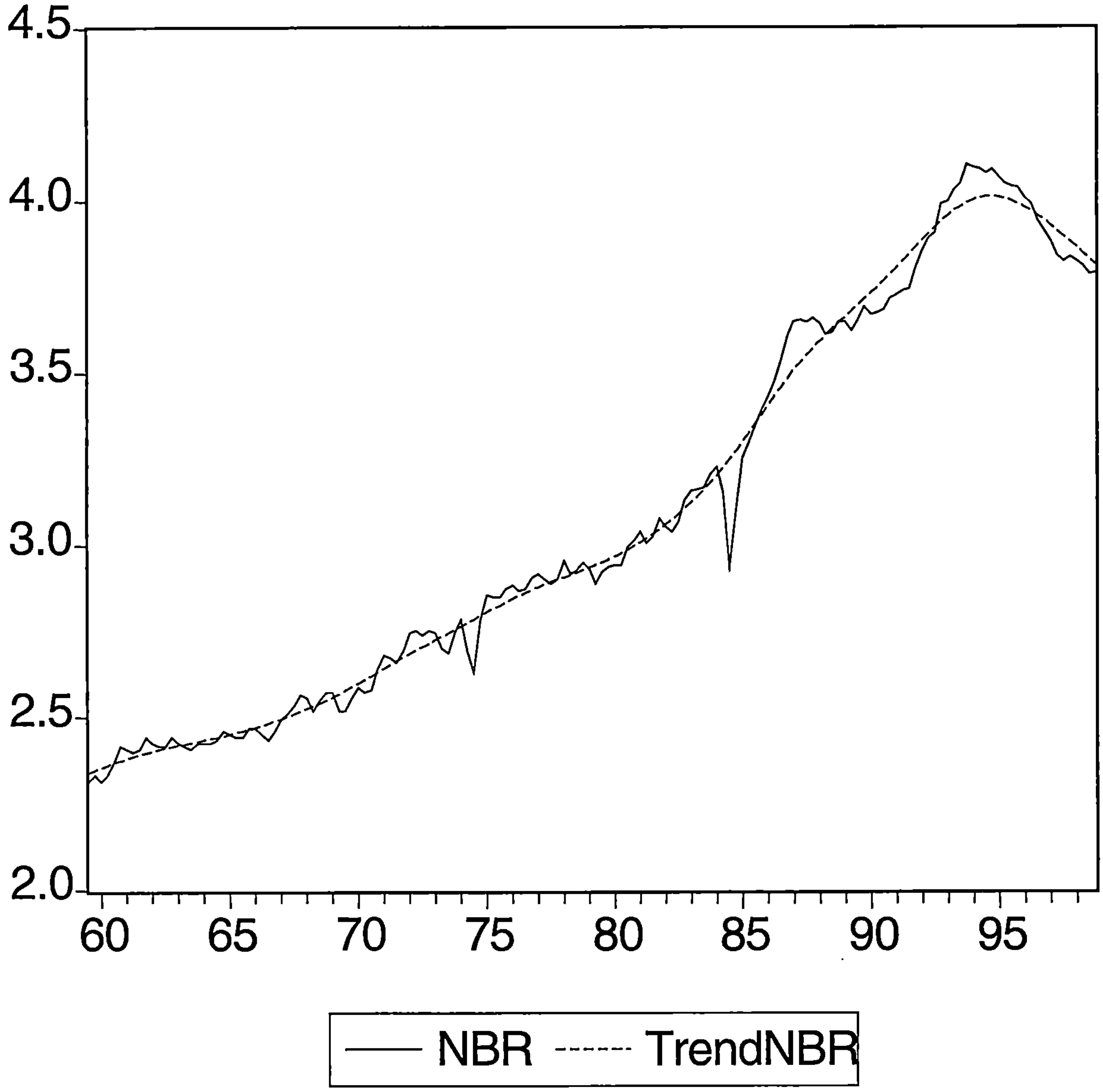

FIGURE B.1 : DEVIATION OF NBR FROM TREND, 1959.3 – 1998.4
DATA IN LOG FORM

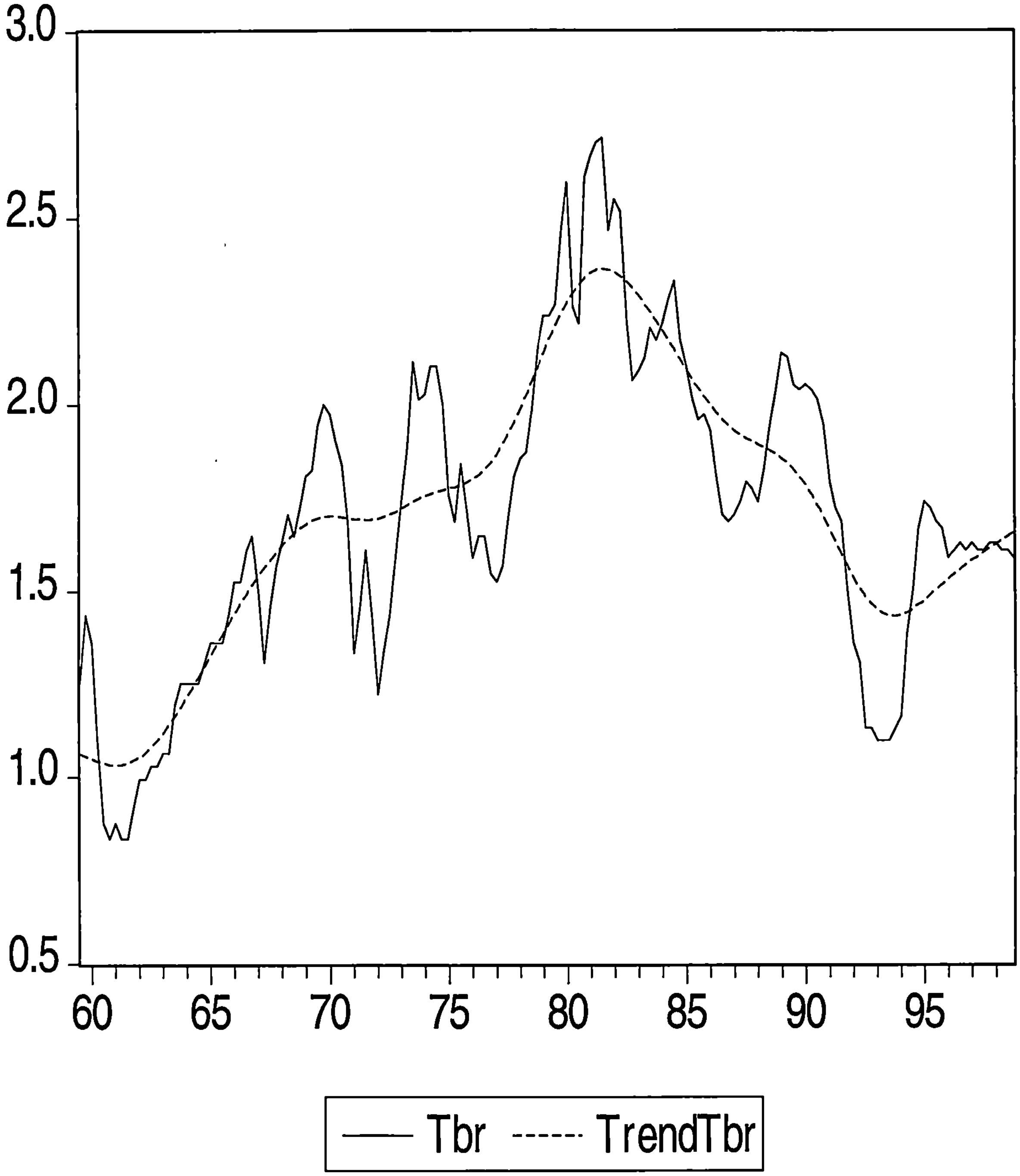

FIGURE B.2 : DEVIATION OF Tbr FROM TREND, 1959.3 – 1998.4
DATA IN LOG FORM

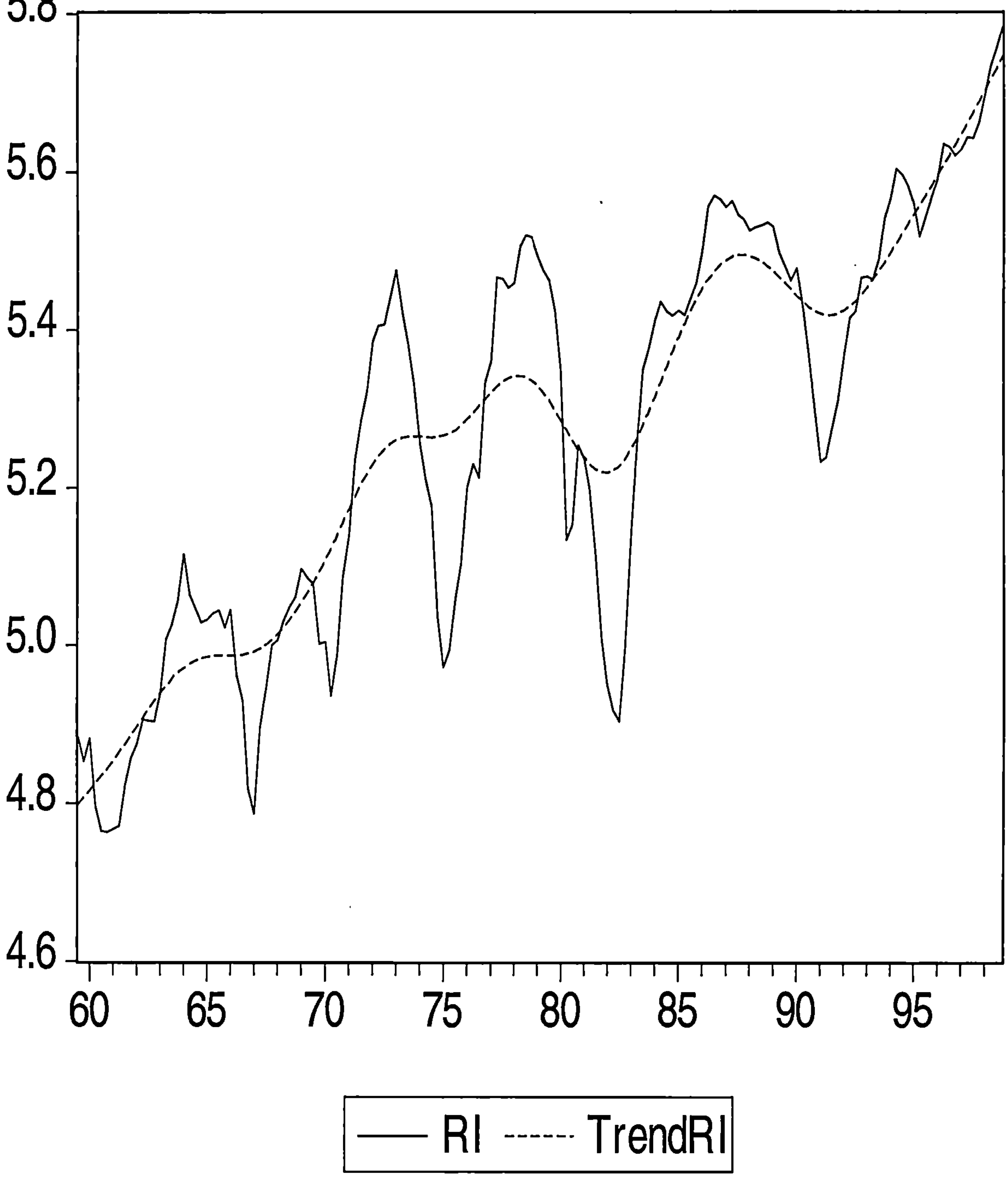

FIGURE B.3 : DEVIATION OF RI FROM TREND, 1959.3 – 1998.4
DATA IN LOG FORM

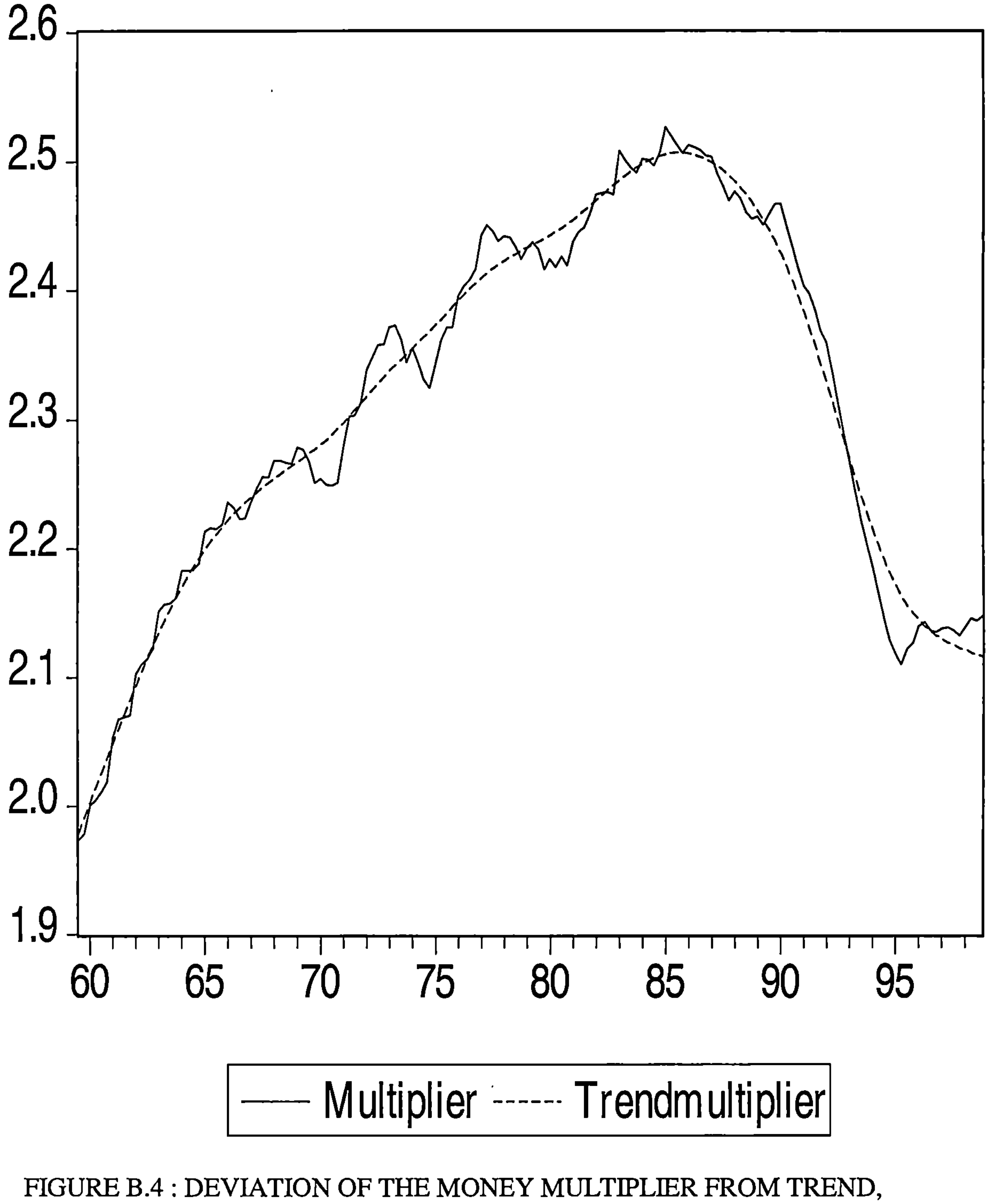

FIGURE B.4 : DEVIATION OF THE MONEY MULTIPLIER FROM TREND, 1959.3 – 1998.4. DATA IN LOG FORM

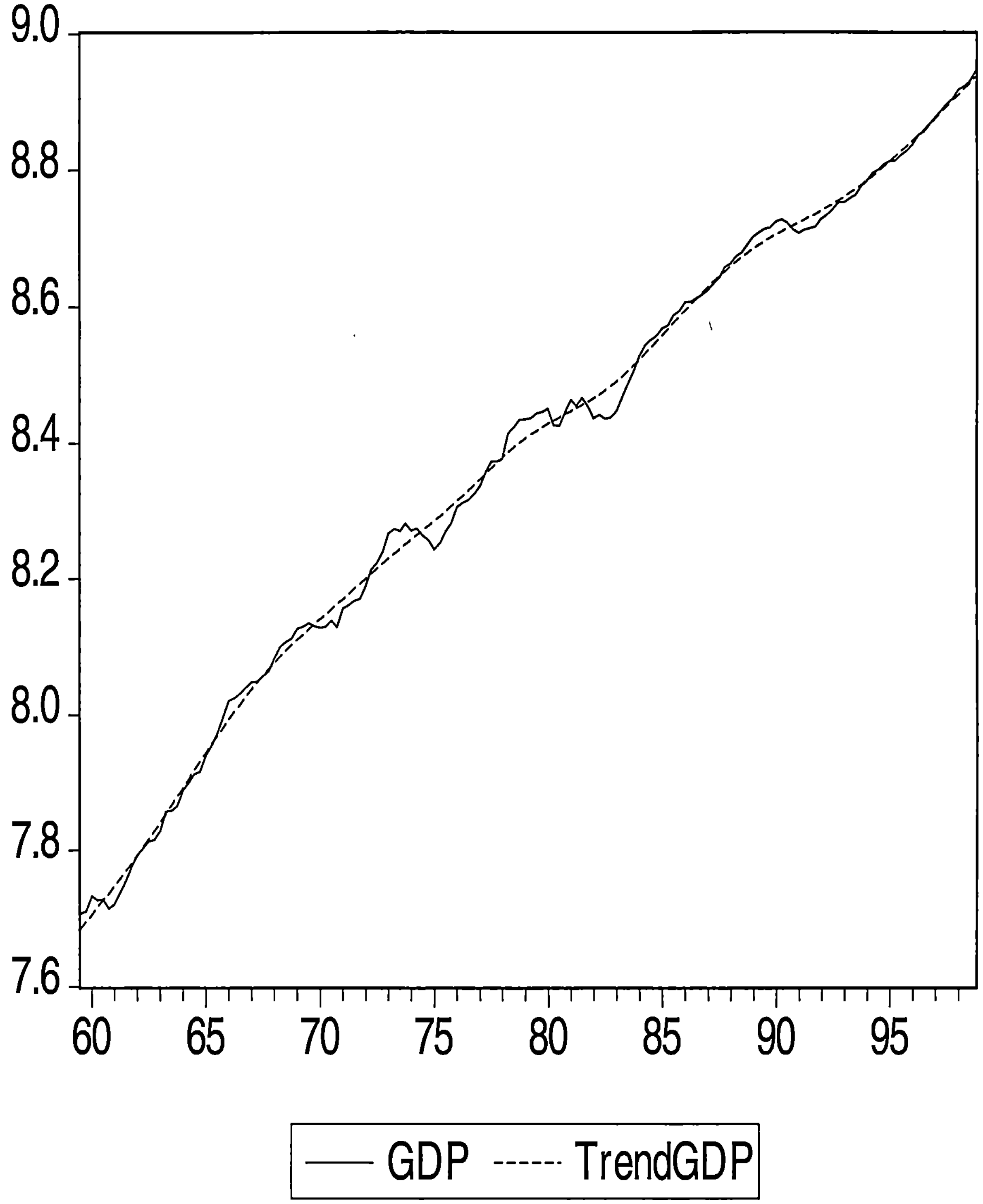

FIGURE B.5 : DEVIATION OF GDP FROM TREND, 1959.3 – 1998.4
DATA IN LOG FORM

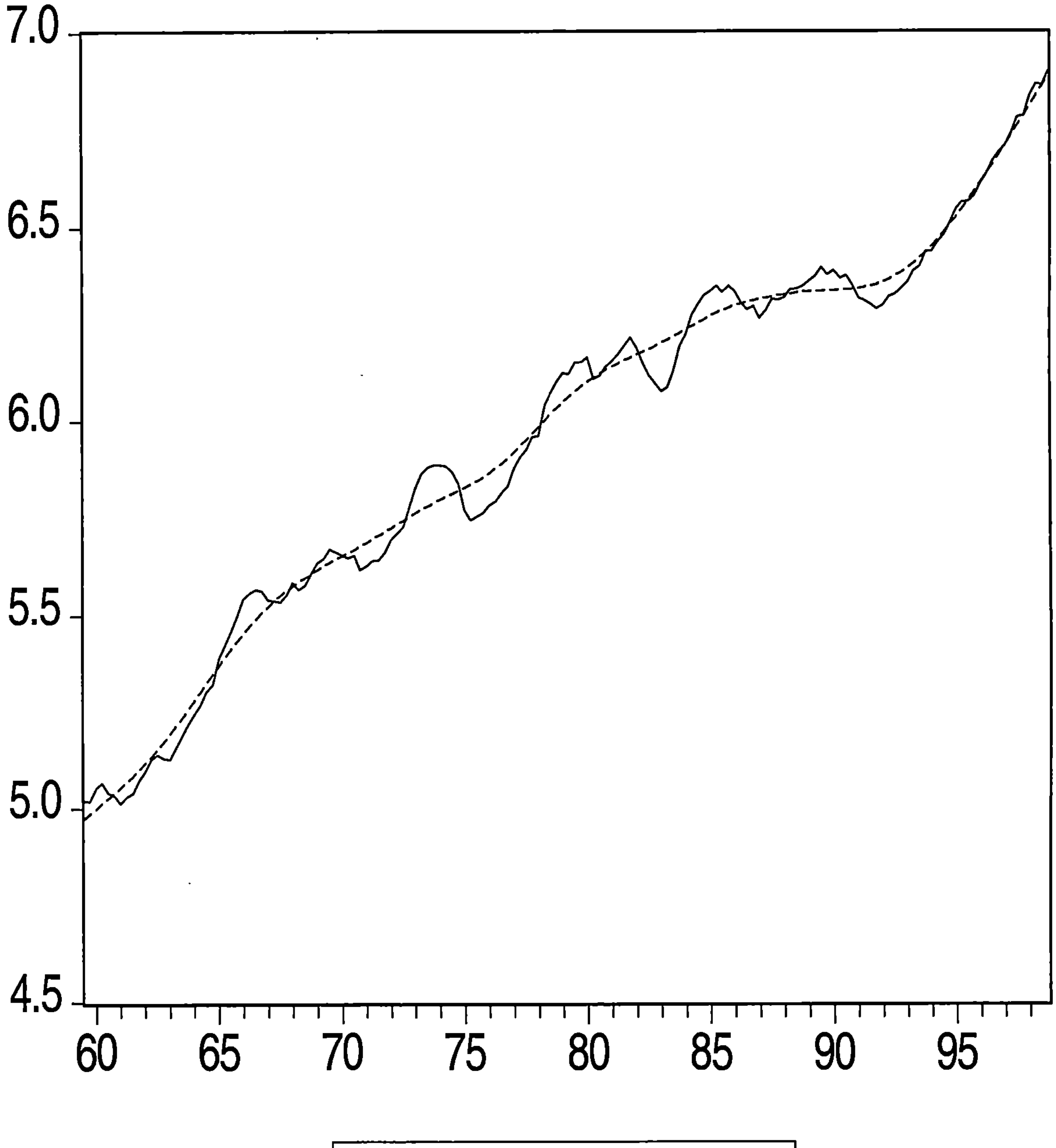

FIGURE B.6 : DEVIATION OF NRI FROM TREND, 1959.3 – 1998.4
DATA IN LOG FORM

APPENDIX C

OTHER VARIABLE ORDERINGS

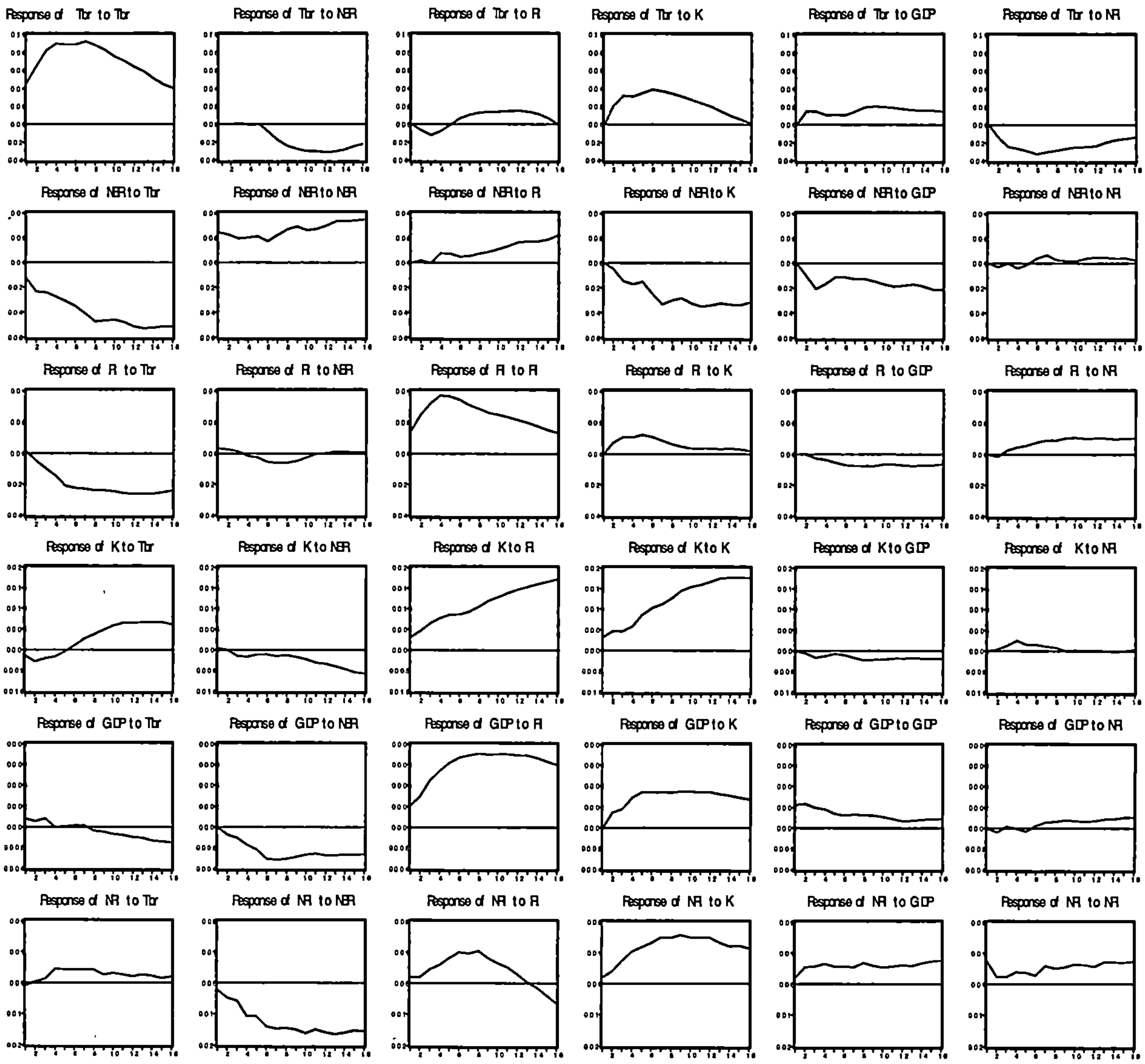

Figure C.1: Response to One S.D. Innovations: Ordering: (Tbr NBR RI K GDP NRI)

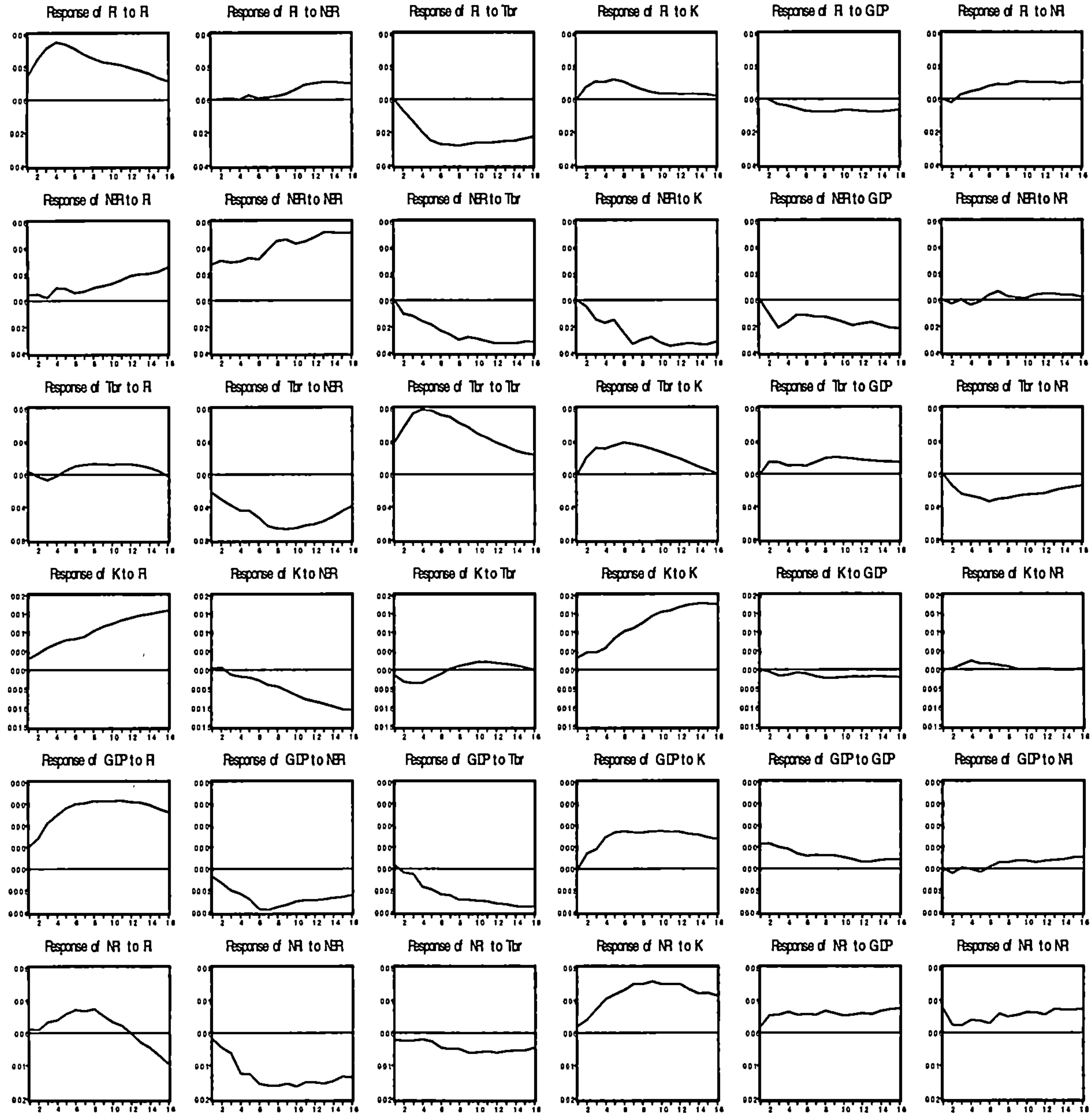

Figure C.2: Response to One S.D. Innovations Ordering: (RI NBR Tbr K GDP NRI)

APPENDIX D

DATA

obs	M2	MONE-TARY BASE	TOT-AL RESE RVES	NBR	M2 MUL TIPLI ER	T.BILL RATE	FF RATE	FHA RATE	RI	NRI	GDP
1959:03	296.12	41.03	12.07	10.10	7.19	3.50	3.97	6.00	131.99	151.58	2221.40
1959:04	297.14	41.27	12.23	10.30	7.23	4.20	3.99	6.00	128.14	151.39	2230.95
1960:01	298.66	40.50	11.97	10.10	7.39	3.90	3.93	6.23	131.82	156.74	2279.22
1960:02	301.11	40.43	11.80	10.30	7.42	3.00	3.70	6.20	120.98	158.73	2265.48
1960:03	306.48	40.90	12.07	10.70	7.47	2.40	2.94	6.14	117.31	154.61	2268.29
1960:04	310.92	41.47	12.37	11.20	7.53	2.30	2.30	6.06	117.15	153.65	2238.57
1961:01	316.29	40.70	12.23	11.10	7.79	2.40	2.00	5.90	117.60	150.57	2251.68
1961:02	322.14	40.60	12.07	11.00	7.91	2.30	1.73	5.90	118.03	153.22	2292.02
1961:03	327.57	41.23	12.23	11.10	7.92	2.30	1.68	5.68	124.41	154.55	2332.61
1961:04	333.33	42.20	12.67	11.50	7.93	2.50	2.40	5.70	128.58	159.77	2381.01
1962:01	340.24	41.67	12.43	11.30	8.19	2.70	2.46	5.67	130.89	163.32	2422.59
1962:02	347.41	41.97	12.37	11.20	8.25	2.70	2.61	5.61	134.99	168.61	2448.01
1962:03	352.84	42.47	12.40	11.20	8.28	2.80	2.85	5.57	134.87	170.78	2471.86
1962:04	359.90	43.27	12.77	11.50	8.35	2.80	2.92	5.54	134.70	169.25	2476.67
1963:01	367.91	42.93	12.60	11.30	8.60	2.90	2.97	5.49	139.56	168.70	2508.71
1963:02	375.91	43.37	12.53	11.20	8.64	2.90	2.96	5.45	149.61	173.67	2583.05
1963:03	383.57	44.20	12.60	11.10	8.65	3.30	3.33	5.45	152.37	178.78	2586.26
1963:04	391.03	45.20	12.90	11.30	8.68	3.50	3.45	5.45	157.01	184.52	2604.62
1964:01	397.53	44.93	12.80	11.30	8.87	3.50	3.46	5.45	166.65	189.36	2666.69
1964:02	404.34	45.43	12.70	11.30	8.87	3.50	3.49	5.45	158.24	194.08	2697.54
1964:03	413.47	46.43	12.93	11.40	8.87	3.50	3.46	5.46	155.65	200.62	2729.63
1964:04	421.96	47.50	13.33	11.70	8.92	3.70	3.58	5.45	152.81	204.53	2739.75
1965:01	430.38	47.20	13.23	11.60	9.14	3.90	3.97	5.45	153.36	218.70	2808.88
1965:02	437.56	47.57	13.23	11.50	9.17	3.90	4.08	5.45	154.56	226.61	2846.34
1965:03	446.04	48.53	13.33	11.50	9.16	3.90	4.07	5.44	155.16	235.01	2898.80
1965:04	455.81	49.80	13.60	11.80	9.19	4.20	4.17	5.49	151.78	244.91	2970.48
1966:01	464.59	49.77	13.63	11.80	9.35	4.60	4.56	5.67	155.20	255.55	3042.36
1966:02	470.17	50.30	13.63	11.60	9.32	4.60	4.91	6.11	142.76	259.31	3055.53
1966:03	472.94	51.07	13.60	11.40	9.24	5.00	5.41	6.51	138.18	261.98	3076.51
1966:04	477.73	51.90	13.70	11.70	9.24	5.20	5.56	6.69	123.70	260.80	3102.36
1967:01	485.46	51.93	13.90	12.10	9.36	4.50	4.82	6.62	119.95	254.96	3127.15
1967:02	497.09	52.43	13.93	12.30	9.45	3.70	3.99	6.36	133.56	254.38	3129.53
1967:03	510.59	53.40	14.17	12.60	9.54	4.30	3.89	6.55	140.27	253.36	3154.19
1967:04	521.37	54.83	14.70	13.00	9.54	4.80	4.17	6.68	148.43	258.56	3177.98
1968:01	530.21	54.90	14.83	12.90	9.66	5.10	4.79	6.80	149.34	266.42	3236.18
1968:02	539.08	55.67	14.73	12.40	9.67	5.50	5.98	6.90	153.12	261.59	3292.07
1968:03	549.52	56.90	14.90	12.80	9.65	5.20	5.94	7.43	155.87	264.93	3316.11
1968:04	562.30	58.47	15.30	13.10	9.64	5.60	5.92	7.31	157.81	272.73	3331.22

1969:01	571.84	58.57	15.47	13.10	9.76	6.10	6.57	7.66	163.48	280.44	3381.87
1969:02	576.90	59.13	15.33	12.40	9.75	6.20	8.33	8.06	161.71	283.21	3390.23
1969:03	580.53	60.07	15.27	12.40	9.66	7.00	8.98	8.36	160.45	290.56	3409.65
1969:04	585.57	61.73	15.83	12.90	9.50	7.40	8.94	8.45	148.69	288.35	3392.61
1970:01	587.74	61.67	15.97	13.30	9.53	7.20	8.57	8.84	149.00	285.94	3386.49
1970:02	591.66	62.60	15.83	13.10	9.49	6.70	7.88	9.14	139.10	284.28	3391.61
1970:03	605.05	63.77	16.00	13.20	9.48	6.30	6.70	9.11	146.44	285.77	3422.95
1970:04	621.36	65.27	16.53	14.00	9.50	5.40	5.57	8.96	161.87	275.27	3389.36
1971:01	641.29	65.63	16.90	14.60	9.77	3.80	3.86	8.04	170.55	277.86	3481.40
1971:02	666.04	66.87	16.87	14.50	10.00	4.30	4.56	7.48	187.77	281.79	3500.95
1971:03	685.87	68.47	17.17	14.30	10.01	5.00	5.47	7.93	196.99	282.34	3523.80
1971:04	704.41	69.53	17.30	14.80	10.11	4.20	4.75	7.74	204.63	287.69	3533.79
1972:01	725.64	69.97	17.80	15.60	10.37	3.40	3.54	7.51	218.28	297.57	3604.73
1972:02	743.81	71.37	18.03	15.70	10.46	3.80	4.30	7.49	222.57	302.48	3687.91
1972:03	768.84	72.70	18.20	15.50	10.57	4.20	4.74	7.54	223.09	307.29	3726.18
1972:04	794.38	74.93	18.77	15.70	10.57	4.90	5.14	7.57	231.06	323.64	3790.44
1973:01	813.25	75.83	19.53	15.60	10.72	5.70	6.54	7.58	238.82	338.98	3892.22
1973:02	826.58	77.30	19.23	14.90	10.73	6.60	7.82	7.80	226.65	352.51	3919.01
1973:03	838.21	78.97	19.67	14.70	10.61	8.30	10.56	8.52	217.02	358.20	3907.09
1973:04	849.00	81.20	20.43	15.60	10.43	7.50	10.00	8.87	206.78	360.47	3947.11
1974:01	864.69	81.90	20.67	16.20	10.55	7.60	9.32	8.66	191.56	360.21	3908.15
1974:02	875.11	84.17	20.87	14.80	10.43	8.20	11.25	9.36	183.17	359.16	3922.57
1974:03	884.63	86.00	21.20	13.90	10.29	8.20	12.09	10.18	177.09	354.51	3879.98
1974:04	898.39	87.70	20.77	16.20	10.22	7.40	9.35	9.92	153.86	343.65	3854.13
1975:01	915.37	87.80	20.57	17.40	10.41	5.80	6.30	9.11	144.33	321.47	3800.93
1975:02	948.90	89.70	20.50	17.30	10.61	5.40	5.42	8.85	147.43	312.80	3835.21
1975:03	983.56	91.83	20.73	17.30	10.71	6.30	6.16	9.17	157.70	315.87	3907.02
1975:04	1007.72	93.93	21.03	17.70	10.72	5.60	5.41	9.56	164.60	319.07	3952.48
1976:01	1039.42	94.47	21.20	17.90	10.98	4.90	4.83	9.14	181.42	324.88	4044.59
1976:02	1070.44	97.00	21.10	17.60	11.06	5.20	5.20	8.96	186.65	328.44	4072.19
1976:03	1099.03	98.97	21.27	17.70	11.11	5.20	5.28	8.99	183.62	335.36	4088.49
1976:04	1139.32	101.57	21.87	18.30	11.21	4.70	4.87	8.61	206.99	341.59	4126.39
1977:01	1177.89	102.13	22.13	18.50	11.50	4.60	4.66	8.43	212.81	357.64	4176.28
1977:02	1208.99	104.43	22.03	18.20	11.60	4.80	5.16	8.64	236.58	367.84	4260.08
1977:03	1237.35	107.30	22.60	18.00	11.54	5.50	5.82	8.77	236.37	374.64	4329.46
1977:04	1263.63	110.37	23.07	18.20	11.45	6.10	6.51	8.79	233.53	387.12	4328.34
1978:01	1286.70	111.60	23.73	19.20	11.50	6.40	6.76	9.11	235.06	389.07	4345.51
1978:02	1309.78	114.20	23.60	18.50	11.48	6.50	7.28	9.51	246.23	421.01	4510.74
1978:03	1335.25	117.23	24.23	18.70	11.40	7.30	8.10	9.84	249.68	433.83	4552.14
1978:04	1361.06	120.63	24.53	19.10	11.29	8.60	9.58	9.94	249.02	446.47	4603.65
1979:01	1380.14	120.90	24.40	18.80	11.39	9.40	10.07	10.24	243.17	456.76	4605.65
1979:02	1411.72	123.43	24.03	18.00	11.44	9.40	10.18	10.38	238.88	455.88	4615.64
1979:03	1446.36	127.20	24.67	18.60	11.38	9.70	10.95	10.51	235.67	470.33	4644.93
1979:04	1468.73	131.27	25.97	18.90	11.20	11.80	13.58	11.72	226.43	470.23	4656.23
1980:01	1493.66	132.03	26.37	19.00	11.29	13.40	15.05	12.48	210.34	475.85	4678.96
1980:02	1514.75	134.93	26.43	19.00	11.22	9.60	12.69	13.36	169.87	450.36	4566.62
1980:03	1561.69	138.07	26.17	20.00	11.31	9.20	9.84	12.59	173.03	454.09	4562.25
1980:04	1595.88	142.27	26.80	20.30	11.24	13.60	15.85	14.37	191.28	464.26	4651.86

1981:01	1622.05	141.47	26.47	20.90	11.45	14.40	16.57	14.37	188.00	471.30	4739.16
1981:02	1665.23	144.27	26.10	20.20	11.53	14.90	17.78	15.66	180.78	479.50	4696.82
1981:03	1695.70	146.57	26.30	20.60	11.58	15.10	17.58	17.01	166.52	490.71	4753.02
1981:04	1739.61	149.03	26.67	21.70	11.70	11.80	13.59	17.32	149.64	501.37	4693.76
1982:01	1778.61	149.47	26.90	21.20	11.87	12.80	14.23	16.97	141.08	488.02	4615.89
1982:02	1816.22	152.53	26.10	20.90	11.89	12.40	14.51	16.30	136.52	469.64	4634.88
1982:03	1850.66	155.70	26.23	21.50	11.90	9.30	11.01	15.88	134.79	454.17	4612.08
1982:04	1892.91	160.00	27.43	22.90	11.87	7.90	9.29	13.28	147.85	445.50	4618.26
1983:01	1995.47	162.17	28.60	23.50	12.28	8.10	8.65	12.77	170.75	435.86	4662.98
1983:02	2047.16	167.63	29.07	23.60	12.19	8.40	8.80	12.53	192.91	440.63	4763.57
1983:03	2079.87	171.47	29.37	23.70	12.13	9.10	9.46	13.66	210.54	459.21	4849.00
1983:04	2116.19	175.80	29.67	24.70	12.08	8.80	9.43	13.34	216.30	489.97	4939.23
1984:01	2161.68	176.83	30.17	25.20	12.21	9.20	9.69	13.18	224.00	505.51	5053.56
1984:02	2208.75	180.83	29.90	23.40	12.20	9.80	10.56	14.16	229.57	530.81	5132.87
1984:03	2239.01	184.33	30.23	18.90	12.14	10.30	11.39	14.57	226.63	546.32	5170.34
1984:04	2287.55	187.13	30.80	22.10	12.26	8.80	9.27	13.44	225.52	558.82	5203.68
1985:01	2355.30	188.07	31.83	25.90	12.51	8.20	8.48	13.09	226.94	564.64	5257.26
1985:02	2398.21	192.80	32.20	27.00	12.42	7.50	7.92	12.89	225.73	572.72	5283.74
1985:03	2450.49	198.43	33.80	28.40	12.34	7.10	7.90	12.00	230.23	563.54	5359.61
1985:04	2484.77	203.03	35.13	29.70	12.26	7.20	8.10	11.73	235.12	572.89	5393.57
1986:01	2520.66	204.17	36.07	30.90	12.34	6.90	7.83	10.69	245.11	563.79	5460.83
1986:02	2588.31	209.87	37.07	32.40	12.32	6.10	6.92	9.88	259.16	548.04	5466.95
1986:03	2654.89	215.87	39.40	34.30	12.29	5.50	6.21	9.93	262.55	538.71	5496.30
1986:04	2711.97	221.93	41.57	37.00	12.24	5.40	6.27	9.65	261.24	543.37	5526.77
1987:01	2753.73	225.07	43.30	38.50	12.23	5.50	6.22	8.94	258.76	526.25	5561.80
1987:02	2777.85	230.23	43.43	38.70	12.06	5.70	6.65	9.86	260.81	537.55	5618.00
1987:03	2796.79	234.10	43.33	38.40	11.94	6.00	6.84	10.42	256.18	553.77	5667.39
1987:04	2826.29	239.43	43.50	38.60	11.82	5.90	6.92	10.96	254.74	551.95	5750.57
1988:01	2876.01	241.60	43.87	38.30	11.90	5.70	6.66	10.22	251.32	556.08	5785.29
1988:02	2932.05	247.57	43.93	37.07	11.84	6.20	7.16	10.53	252.23	567.06	5844.05
1988:03	2961.38	252.73	44.77	37.27	11.71	7.00	7.98	10.68	252.90	567.98	5878.71
1988:04	2985.88	256.60	44.90	38.17	11.65	7.70	8.47	10.48	253.72	572.90	5952.83
1989:01	3002.11	257.20	44.70	38.55	11.67	8.50	9.44	10.79	252.59	579.46	6010.96
1989:02	3023.09	260.50	43.77	37.48	11.60	8.40	9.73	10.86	244.33	586.62	6055.61
1989:03	3082.35	263.30	44.10	38.83	11.69	7.80	9.08	9.88	240.11	600.47	6087.96
1989:04	3141.40	266.90	45.10	39.88	11.78	7.70	8.61	9.79	235.95	588.80	6093.51
1990:01	3184.23	270.13	45.37	39.37	11.79	7.80	8.25	9.98	239.37	595.35	6152.59
1990:02	3215.92	277.23	45.13	39.49	11.59	7.70	8.24	10.43	227.81	583.40	6171.57
1990:03	3249.04	284.37	45.17	40.09	11.41	7.50	8.16	10.19	214.90	588.13	6142.10
1990:04	3270.46	291.93	45.97	40.85	11.22	7.00	7.74	10.09	200.31	573.91	6078.96
1991:01	3310.14	299.47	46.87	41.71	11.06	6.00	6.43	9.60	187.38	555.08	6047.49
1991:02	3353.01	304.53	47.07	42.05	11.00	5.60	5.86	9.61	188.32	550.92	6074.66
1991:03	3696.77	309.17	47.67	42.65	10.86	5.40	5.64	9.48	195.62	545.28	6090.14
1991:04	3373.03	315.90	49.47	44.51	10.69	4.50	4.82	8.82	202.43	539.53	6105.25
1992:01	3402.26	321.17	51.80	47.28	10.59	3.90	4.02	8.52	213.92	544.36	6175.69
1992:02	3406.40	328.90	53.50	49.06	10.36	3.70	3.77	8.77	224.91	557.48	6214.22
1992:03	3411.65	336.93	54.17	50.27	10.11	3.10	3.26	8.25	226.74	560.56	6260.74
1992:04	3434.57	348.67	58.00	53.50	9.87	3.10	3.04	8.30	236.67	569.08	6327.12

1993:01	3425.89	354.53	58.97	54.77	9.65	3.00	3.04	7.90	237.02	577.76	6327.93
1993:02	3442.50	364.80	60.43	56.24	9.44	3.00	3.00	7.57	236.08	595.08	6359.90
1993:03	3460.68	374.60	61.77	57.93	9.22	3.00	3.06	7.35	242.20	602.25	6393.50
1993:04	3480.64	385.23	64.60	59.98	9.05	3.10	2.99	7.21	255.10	625.56	6476.86
1994:01	3493.70	392.03	64.77	60.50	8.90	3.20	3.21	7.39	261.28	626.19	6524.51
1994:02	3501.78	401.73	64.40	59.96	8.72	4.00	3.94	8.61	271.51	641.21	6600.31
1994:03	3502.88	409.67	63.90	59.56	8.54	4.50	4.49	8.78	269.40	653.15	6629.47
1994:04	3502.04	417.57	64.20	59.11	8.40	5.30	5.17	9.29	265.94	672.89	6688.61
1995:01	3506.71	421.47	63.47	58.68	8.31	5.70	5.81	9.23	259.87	698.40	6717.46
1995:02	3540.45	429.43	62.23	57.51	8.25	5.60	6.02	8.40	249.53	710.17	6724.20
1995:03	3603.85	431.33	62.23	57.27	8.35	5.40	5.80	8.04	255.61	711.71	6779.53
1995:04	3638.50	434.60	62.00	56.26	8.38	5.30	5.72	7.72	262.13	722.27	6825.80
1996:01	3683.98	433.70	61.40	55.24	8.49	4.90	5.36	7.40	268.04	744.78	6882.00
1996:02	3728.96	437.70	59.80	54.25	8.52	5.00	5.24	8.39	280.23	764.40	6983.91
1996:03	3765.00	444.40	59.00	51.94	8.47	5.10	5.31	8.56	279.04	790.14	7020.00
1996:04	3804.47	450.43	57.27	49.77	8.46	5.00	5.28	8.23	276.27	807.04	7093.12
1997:01	3849.85	454.40	56.50	48.67	8.48	5.10	5.28	8.07	278.37	820.86	7166.68
1997:02	3895.39	459.27	53.40	46.67	8.49	5.00	5.52	8.39	282.54	848.18	7236.50
1997:03	3956.93	466.90	54.00	46.14	8.47	5.00	5.53	7.88	282.26	882.18	7311.24
1997:04	4023.01	477.37	54.47	46.17	8.43	5.10	5.51	7.52	287.90	886.23	7364.63
1998:01	4099.04	483.23	54.33	45.99	8.49	5.10	5.52	7.10	298.49	931.86	7464.67
1998:02	4175.39	488.97	52.93	45.52	8.55	5.00	5.50	7.18	309.13	960.38	7498.64
1998:03	4246.61	497.93	52.93	44.55	8.53	5.00	5.53	7.05	316.48	958.66	7566.45
1998:04	4363.52	511.00	52.93	44.48	8.56	4.90	4.86	6.87	324.20	991.86	7669.99

RI, NRI, and GDP are in billions of 1992 dollars, SAAR. M2, Monetary Base, Total Reserves, and Nonborrowed Reserves are in billions of dollars. T.B. rate, FF rate, and FHA rate are in percent.

Source: Federal Reserves Bank of St. Louis web page, http://www.stls.frb.org/

VITA

Gazi Hamdallah Shbikat was born on July 24, 1966 in Amman, Jordan. He received a Bachelor of Arts in Economics in 1988 from the Yarmouk University. Gazi also received a Master of Arts in Economics from the University of Jordan in 1994 while working at the Central Bank of Jordan as an economic researcher. He joined the Doctoral program in Economics at the University of Tennessee, Knoxville in 1996. Throughout his time in the Ph.D. program, he worked as a teaching graduate assistant and as a research graduate assistant at the Oak Ridge National Laboratory. He also was a visiting instructor at Radford University.

His current position is an instructor at Radford University. Gazi currently lives in Knoxville with his wife, Jennifer. In their spare time, Gazi and Jennifer love to sky dive. He also enjoys scuba diving and white water rafting.