INTEREST RATE ADJUSTMENT AND THE U.S. ECONOMY:

A VECTOR AUTOREGRESSION ANALYSIS OF

THE ECONOMIC EFFECTS OF FEDERAL

FUNDS RATE POLICY

By

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CHAPTER I

THE PROBLEM

The study of the effects of monetary policy on both real and nominal economic variables has been a critical component of the macroeconomic agenda for decades. Much of this research has been framed in terms of "monetary transmission mechanisms," emphasizing the linkage between money supply fluctuations and various measures of economic activity. The implication in most of these studies has been that monetary policy actions, first and foremost, involve innovations to the money supply or money growth. Subsequently, much of the empirical research on monetary policy effectiveness has examined the statistical relationship between various measures of money or reserve aggregates and measures of economic activity.

The persistent emphasis of the research agenda on monetary adjustment is puzzling, since most contemporary references to monetary policy activity stress the role of interest rate adjustment in achieving economic objectives. A quick review of popular publications such as The Wall Street Journal, Barrons, and Business Week attests to this fact. For example, a recent Wall Street Journal headline proclaims, "Inflation Data Indicate No Fed Rate Rise." The article went on to say that "Inflation remained in check last month despite signs of resurgent consumer spending, indicating that the Federal Reserve policy makers will likely leave *interest rates* alone yet again when they meet next week. After lifting *its key short-term rate* (the fed funds rate) a quarter point to

5.5% in March, the central bank stayed on the sidelines in subsequent meetings in May and July" (emphasis added).[1]

Federal Reserve (Fed) policy-makers themselves often refer to raising ("tightening") or lowering ("loosening") interest rates as a means of responding to changing economic conditions. The Fed has recently become much more explicit in this regard. In October 1997, they announced that the Federal Open Market Committee (FOMC) directive will now specify an explicit target for the fed funds rate and expressed a "bias to possible future action in terms of (the fed funds) rate" (Thornton, 1997, p. 1). As Thornton observes:

> For some time, the Fed has *implemented monetary policy by making discrete and frequently small adjustments to its federal funds target.* Since this is widely known, some analysts see the change in the wording of the directive as merely the latest move by the FOMC to be more open and explicit about *how it conducts monetary policy.* (p. 1, emphasis added)

Thus, as Sims concludes, "economists closely connected with policy tend to view the monetary authority as capable of controlling nominal short-term interest rates and thereby influencing the level of economic activity." (1992, p. 975)

This apparent contradiction between the emphasis placed on interest rate adjustment in contemporary policy discourse and on monetary adjustment in theoretical and empirical research serves as the basis for this study. This study assumes that the Federal Reserve adjusts the fed funds rate to achieve its real income, employment, and inflation policy objectives. It then examines the nature of these relationships via alternative transmission mechanisms. A vector autoregressive (VAR) model is employed

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[1] The Wall Street Journal, August 14, 1997, p. A2.

to generate impulse response functions and variance decompositions which, along with Granger-causality tests, help clarify the extent of various postulated interest rate transmission relationships, as well as the extent to which the Federal Reserve's interest rate adjustments influence its stated objectives. The VAR procedure is particularly well suited to the task of examining the nature of the postulated interest rate transmission mechanisms, since these mechanisms represent a vector of intermediate variables linking interest rate adjustment to changes in real income, employment, and the price level.

The primary role of this study is to help clarify the effectiveness of monetary policy via interest rate adjustments. The results of the VAR analysis provide insight into whether policy discourse and, more importantly policy actions, are justified in placing significant emphasis on interest rate changes as a means of achieving income, employment, and inflation objectives. If these adjustments do not exert a measurable influence in the intended direction on the targeted variables, the validity of this approach becomes questionable.

Overview of the Dissertation

This discussion has highlighted the apparent discontinuity between the emphasis placed on interest rates in contemporary monetary policy discourse and the lack thereof in much of the relevant theoretical and empirical literature. Chapter 2 reviews various monetary transmission mechanisms and consolidates them into a comprehensive transmission mechanism, linking policy adjustment of interest rates to a series of intermediate and longer-term effects. It also critically considers the alternative approaches to modeling and testing these relationships by reviewing the monetary transmission literature. Chapter 3 outlines the research methodology and discusses data considerations and statistical techniques. Chapter 4 reports the results of the study. Chapter 5 discusses these results within the context of the Federal Reserve's reaction function and the alternative policy transmission mechanisms. It also examines the sensitivity of the results to alternative model specifications. Finally, chapter 6 summarizes the results of the study, discusses the implications and limitations of the findings, and provides suggestions for future research.

CHAPTER II

REVIEW OF LITERATURE

This chapter presents a theoretical basis for the examination of fed funds policy influences using a vector autoregressive model. The first section reviews variants of the monetary transmission mechanism, providing a comprehensive view of the process by which monetary policy influences the economy. These transmission mechanisms serve as the foundation for the development of the model used to explore policy influences. A recent study of the transmission components of the Federal Reserve's own economic model (Mauskopf, 1990) provides an interesting perspective on their relative contributions toward desired policy outcomes. The second section of the chapter reviews the development of alternative modeling strategies designed to capture the interaction of variables in complex systems. Relevant applications of each strategy are reviewed and the relative merits of each are considered, establishing an appropriate framework for model selection in the following chapter.

Monetary Transmission Mechanisms

The overwhelming majority of theoretical and empirical research linking monetary policy to macroeconomic activity has emphasized the central bank's influence over monetary aggregates as a means of influencing the economy. This body of research is often referred to as the "money view" of monetary transmission. More recently, there has been considerable attention paid to the influence of monetary policy on bank lending policies–the "credit view" of monetary transmission. Each of these monetary transmission mechanisms seems to obscure the effects of interest rate adjustment on economic activity. Since contemporary policy discourse emphasizes interest rate effects, a study isolating their influence is warranted.

While there is a strong consensus among macroeconomists that monetary policy influences economic activity, at least in the short run, there is considerably less agreement on the means by which this influence is achieved. This sentiment is echoed by Sims, who concludes that:

> Though many macroeconomists would profess little uncertainty about it, the profession as a whole has no clear answer to the question of the size and nature of the effects of monetary policy upon aggregate economic activity. (1992, p. 975)

Similarly, Bernanke finds that:

> Federal Reserve actions seem to have important effects on the macroeconomy, but precisely why is one of the most poorly understood and contentious issues in economics. (1986, p. 324)

Mishkin (1995) recently summarized the popular variants of the monetary transmission mechanism, as part of a symposium on this issue. A review of these mechanisms and a consideration of how to capture the interest rate influences in each, serves as a starting point for the model development in this study.

The Money View of Monetary Transmission

Several variants of what has become known as the "money view" of monetary transmission appear in the literature. Each emphasizes direct and indirect effects of changes in money growth on economic variables, assuming smoothly functioning credit markets. These include: the interest rate channel, the exchange rate channel, Tobin's q-theory effects on investment, and wealth effects on consumption.

The Interest Rate Channel

According to the simple Keynesian model, an increase in the money supply (M) reduces interest rates (i). These lower interest rates stimulate investment spending by firms (NI) as the cost of financing capital investment falls relative to the expected return on investment. The increased investment, in turn, generates an increase in aggregate output (Y). This schema is:

$$\uparrow M \Rightarrow \downarrow i \Rightarrow \uparrow NI \Rightarrow \uparrow Y$$

While this version of the transmission mechanism focuses on business investment, similar reactions might be expected in other interest-sensitive assets. Accordingly, Taylor (1995) and others have postulated additional interest rate effects on business inventories (BI), residential housing investment (RI), and consumer durables (CD).[1] These additional interest rate effects can be similarly modeled as:

$$\uparrow M \Rightarrow \downarrow i \Rightarrow \begin{matrix} \uparrow RI \\ \uparrow BI \\ \uparrow CD \end{matrix} \Rightarrow \uparrow Y$$

Thomas (1997, p. 588) and Mishkin (1992, p. 654) find that the empirical literature tends to support a relatively small effect on consumer durables. Similarly, while Taylor (1995) asserts that interest rates exert a significant influence on business and

[1] Inventories are likely to be interest sensitive to the extent they are financed by external funds, such as bank credit or commercial paper, the cost of which often moves in response to Fed policy.

consumer investment spending, others, such as Bernanke and Gertler (1995), refer to multiple empirical studies which have been unsuccessful in establishing the quantitative importance of such a link. Obviously, the extent to which these transmission mechanisms exert any influence on income, employment, and prices remains the subject of considerable debate.

While the transmission of monetary policy through interest rate effects on business and consumer investment is traditionally referred to as *the* interest rate transmission mechanism, other channels of monetary policy can be discussed in terms of interest rate influences as well. In fact, while Romer and Romer (1993, p. 76) argue that "the interest rate channel of the transmission mechanism is the most significant way in which decisions by the Federal Reserve affect the real economy," the hypothesis of this study is that interest rate effects can be transmitted through various channels, warranting a study of the relative and cumulative effects on the real economy.

The Exchange Rate Channel

The combined effects of globalization and the transition to flexible exchange rates have broadened the analysis of monetary policy influences to include its effects on exchange rates. Taylor (1995) and Obstfeld and Rogoff (1995) highlighted the importance of including this mechanism in any analysis of policy effects on economic activity. Essentially this channel recognizes that stimulative monetary policy, which exerts downward pressure on domestic interest rates (i), causes depreciation in the domestic currency (E), which increases export trade (EX) and aggregate output (Y).

This schema is:

$$\uparrow M \Rightarrow \downarrow i \Rightarrow \downarrow E \Rightarrow \uparrow EX \Rightarrow \uparrow Y$$

While the magnitude of this effect might be assumed to be significant in light of the increase in international trade in recent years, Thomas points out that the growth of the worldwide capital pool has somewhat blunted the effect of policy on exchange rates (1997, p. 595). This is because stimulative policy lowers interest rates, increasing capital outflows and exerting upward pressure back on interest rates. Thus, the net effect on output depends on the relative magnitudes of these pressures.

Tobin's q-Theory Effects on Investment

In addition to the direct effect of stimulative policy on business investment, changes in the market valuation of firms may also influence investment. Tobin (1969) posits that business investment is directly related to q, the ratio of a firm's market value to its replacement cost of capital. This theory has important implications for the analysis of the effects of monetary policy, since policy actions typically alter the market valuation of firms. Expansionary policy, for example, lowers interest rates, increasing the returns on equities (relative to fixed-income securities) and their demand and price (PE). This, in turn, increases the market value of firms and, thus, q and investment (NI). (This is in addition to the stimulus to debt financing provided by lower interest rates, as noted above). This schema is:

$$\uparrow M \Rightarrow \downarrow i \Rightarrow \uparrow PE \Rightarrow \uparrow q \Rightarrow \uparrow NI \Rightarrow \uparrow Y$$

Wealth Effects on Consumption

Changes in the market value of equities also may exert an influence on consumption by altering the perceived wealth of consumers. Modigliani (1971) developed a model that expresses consumption as a function of an individual's lifetime resources (human capital and real wealth). Because expansionary monetary policy can be expected to increase equity values, financial wealth (W) rises as a result. In fact, the decrease in interest rates increases the capitalized value of the entire asset portfolio. The resulting increase in consumption (CT) generates an expansion of aggregate output. This schema is:

$$\uparrow M \Rightarrow \downarrow i \Rightarrow \uparrow PE \Rightarrow \uparrow W \Rightarrow \uparrow CT \Rightarrow \uparrow Y$$

The Credit View of Monetary Transmission

The growing interest in the interpretation of monetary policy effects in light of information asymmetries, as highlighted by the work of Bernanke (1986), Bernanke and Blinder (1988,1990), Romer and Romer (1990, 1993), Kashyap, et. al. (1993), and Bernanke and Gertler (1995), has broadened both the possible channels of monetary influence and the disagreement regarding the relative importance of alternative channels. As Bernanke describes it:

> The credit view is consistent with the money view that an expansionary Fed policy reduces the overall level of interest rates. But the credit view emphasizes that the banks' decisions about how to manage their asset portfolios determine whether the policy's impact will fall primarily on open-market interest rates or on effective bank loan rates. And this, in turn, determines which sectors of the economy increase their spending the most in response to Fed stimulus (1986, p. 329).

The credit channel considers the response of banks to monetary policy actions, specifically their response to changes in adverse selection and moral hazard. Accordingly, as factors contribute to greater adverse selection and moral hazard problems, banks (and other financial intermediaries) are reluctant to lend. To the extent firms are dependent on banks for financing, the resulting "credit crunch" translates into a decline in investment and thus aggregate output. Smaller firms are likely to be the most vulnerable to these effects, since they often have less cost-effective access to alternative forms of financing.[2] The theory is viewed as symmetric; thus factors contributing to reductions in adverse selection and moral hazard should be stimulative to some degree. Specifically, as the Fed loosens monetary policy, the resulting decline in interest rates increases equity prices and strengthens firms' capital positions (net worth), as well as corporate and consumer cash flows (CF_{cp} and CF_{cn}, respectively). These factors, in turn, reduce adverse selection (AS) and moral hazard (MH) for banks, increasing their lending activity (L) and thus consumer residential and durable investment, corporate fixed and inventory investment and aggregate output.[3] The credit channel schema is:

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[2]It follows, then, that the extent to which this channel generates effects on output and employment will depend, at least in part, on the size and relative importance of this sector to total GDP.

[3]Mishkin, for example, says that higher equity prices generate a lower estimate of "the likelihood of suffering financial distress," subsequently increasing consumer expenditures on long-term investments such as durable goods and housing. This is also supported by Samuelson (1967, p. 52). For a detailed discussion of the postulated influence of policy shocks on cash flows and information asymmetries see Bernanke and Gertler (1995). They point to higher interest costs and lower operating margins as factors contributing to lower cash flows, following a policy tightening (p. 38). They argue that these factors, in turn, reduce the credit quality of firms and make it particularly difficult for small firms to obtain credit.

$$
\begin{array}{lllllll}
 & \uparrow PE \Rightarrow \uparrow NW & & & \uparrow BI & & \\
\uparrow M \Rightarrow \downarrow i \Rightarrow & \uparrow CF_{cp} & \Rightarrow \downarrow AS,MH \Rightarrow & \uparrow L \Rightarrow & \uparrow NI & \Rightarrow & \uparrow Y \\
 & \uparrow CF_{cn} & & & \uparrow RI & & \\
 & & & & \uparrow CD & &
\end{array}
$$

The extent to which the credit channel influences consumer vs. commercial sectors remains the subject of debate. Morris and Sellon (1995) indicate that the large number of non-bank sources of credit and securitization for consumer and real estate lending weakens the case that banks are "special" for these sectors. In other words, the link between L and RI and CD is weak. This implies that it would be more appropriate to concentrate on commercial lending and its effects on corporate inventory and fixed investment. Gertler and Gilchrist (1993) find that "consumer and real estate loans contract after tight money but that commercial and industrial loans barely respond." In other words, the components of L (commercial, consumer and real estate loans) respond in varying degrees to changing asymmetric information conditions. They also confirm that smaller commercial firms are more likely to experience a decline in credit than their larger counterparts and attribute this dichotomy to frictions in the credit markets.

A critical assumption of the credit channel, as presented above, is that policy-induced information asymmetries influence bank lending. The extent of the Fed's influence through the credit channel, however, is dependent on bank allocations of investment between securities and loans.[4] Therefore, while expansionary policy may increase bank lending and thus investment and output, to the extent that banks purchase securities and funnel credit away from bank dependent borrowers the expansionary impact will be lessened.[5] This is because the expansion of credit in the financial markets will not directly benefit potential borrowers that are dependent on bank financing. Likewise, restrictive monetary policy will be somewhat muted if banks choose to restrict security investments rather than loans. The significance of the lending channel is the subject of continuing debate.[6]

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[4]Samuelson noted this back in 1967 at a symposium held by the American Bankers Association when he stated: "even conduits (of monetary policy) have their effects upon the system; depending upon how the banking industry administers the changed credit situation, you can get different effects." (1967, p. 43)

[5]This is true even though the impact on the money supply is the same.

[6]See for example, Edwards and Mishkin (1995), Meltzer (1995), and Bernanke and Gertler (1995). Romer and Romer (1993, p. 74) note that in recent monetary tightenings the Fed has relied more on interest rate movements than direct (regulatory) credit actions.

A Comprehensive Framework

The channels of monetary policy outlined above may be summarized as:

$$\uparrow M \Rightarrow \begin{array}{l} \uparrow NI \\ \uparrow RI \\ \uparrow BI \\ \uparrow CD \\ \downarrow E \Rightarrow \uparrow EX \\ \uparrow PE \Rightarrow \uparrow q \Rightarrow \uparrow RI \\ \uparrow PE \Rightarrow \uparrow W \Rightarrow \uparrow CT \\ \uparrow PE \Rightarrow \uparrow NW \Rightarrow \downarrow AS,MH \Rightarrow \uparrow L \Rightarrow \uparrow BI \\ \uparrow CF_{cp} \Rightarrow \downarrow AS,MH \Rightarrow \uparrow L \Rightarrow \uparrow NI \\ \uparrow CF_{cn} \Rightarrow \downarrow AS,MH \Rightarrow \uparrow L \Rightarrow \uparrow RI,CD \\ \uparrow L \Rightarrow \uparrow NI \end{array} \Rightarrow \uparrow Y$$

where:

M	=	Money supply
NI	=	Gross private domestic fixed investment: non-residential
RI	=	Gross private domestic fixed investment: residential
BI	=	Business inventories
CD	=	Personal consumption expenditures: durable goods
E	=	Exchange value of the U.S. dollar
EX	=	Exports
PE	=	Equity prices
L	=	Bank loans
CT	=	Personal consumption expenditures: total
q	=	Tobin's q
W	=	Wealth
NW	=	Corporate net worth
CF_{cp}	=	Corporate cash flow
CF_{cn}	=	Consumer cash flow
Y	=	Output

Stability and Relative Importance of the Transmission Mechanisms

Mauskopf examined the monetary transmission components of the MPS model of the U.S. economy, which is used by the Federal Reserve's Board of Governors in conducting monetary policy, to determine whether the "key links between monetary policy and economic activity appear to have changed appreciably" during the 1980s (1990, p. 985). She finds first that the short-term (1-2 years) effect of monetary policy on aggregate output has remained fairly constant; although the interest sensitivity of output in the longer term is slightly less. Second, both residential and non-residential construction appear to be less sensitive to interest rates more recently, largely attributed to less credit rationing by intermediaries. However, the direct effect of interest rates on housing demand appears to remain significant. Third, "the traded goods sector has become more responsive to changes in interest rates because the exchange rate has become more sensitive to differences between U.S. and foreign interest rates" (p. 986). This results from the increasing integration of world capital markets. Fourth, the overall effect of monetary policy on consumption and durable goods purchases has remained stable. And finally, long-term interest rates appear to respond more quickly to changes in short-term rates than they did prior to the 1980s.

She also estimated the relative impacts of changes in the fed funds rate by spending category and by transmission mechanism, assuming constant wages and prices and the ability of policy-makers to peg the rate for an extended period.[7] She found that a

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[7]Mauskopf notes (p. 989) that these assumptions tend to "exaggerate the actual influence on the sustainable level of real output."

one percentage point reduction in the fed funds rate generated increases in total spending after 4 quarters and 20 quarters of $15.3 (0.4% of GNP) and $62.8 billion (1.5% of GNP), respectively. Of this increase, residential construction accounted for 33%(21%), business fixed investment 7%(33%), inventory for 10%(1%), consumption 32%(42%), and net exports 18%(4%). Over the 20 quarter period, cost of capital effects (via investment and consumption expenditures) accounted for an average of 55% of the total increase in spending, wealth effects on consumption 28% and exchange rate effects on exports 17%. These findings provide a useful perspective on the relative contributions over time, of the reviewed transmission mechanisms and their respective components, toward aggregate output.

Alternative Modeling Strategies

Structural Equation Models

Analysis and estimation of relationships such as those expressed in these transmission mechanisms, prior to 1980, relied on structural equation techniques.[8] As Runkle mentions, "traditionally, economists have tried to explain (these) relationships using structural models that imposed *a priori* restrictions on the intercorrelations of the data." (1987, p. 437) Specification of structural equations is based on relevant economic theory. As Pindyck and Rubinfeld (1991, p. 353) point out, however, economic theory is

[8] Diebold (1997) presents an excellent overview of the evolution and recent trends in structural and non-structural equation modeling and forecasting.

often incapable of delineating clearly the appropriate structural specification. This may be due to the complicated nature of the theory or disagreement as to the appropriate underlying theory or lag specification. These specification issues are significant because they increase the potential for biased estimation, invalid hypothesis testing, and inaccurate interpretations of policy effectiveness. Hakkio and Morris point out that "the severity of the bias increases with the number of restrictions imposed on the estimated model" (1984, p. 52). This is particularly problematic in a study such as this, where the model includes a large number of variables. With the breakdown of such critical structural equation components as the money demand function and the Phillips Curve in the 1970s, these issues became more than just hypothetical concerns. Subsequently, some researchers began to search for superior techniques. This led to the development of vector autoregressive models.

VAR Models

A widely used alternative to the estimation of structural equation models, vector autoregression (VAR) estimation, was developed by Sims (1980).[9] He viewed the identifying restrictions necessary in structural models as "inappropriate" and "incredible" (1980, p. 1) and offered an alternative that places minimal theoretical demands on the model

[9]Incidentally, Sims' pioneering work on VARs was illustrated by examining the effect of money "innovations" or shocks on real income, unemployment and the price level, in addition to wages and import prices.

structure.[10] VARs assume "that in properly chosen sets of economic variables there are fundamental patterns among the variables" (Crone and Babyak, 1996, p. 8) and permit the data to determine the appropriate dynamic structure.[11] In essence, VARs are reduced-form estimates of the underlying structural equation model. VAR specification requires only a distinction between exogenous and endogenous variables within the model and determination of the appropriate lag length.

The general form of a VAR, expressed in matrix notation, is as follows[12]:

$$\mathbf{x}_t = \mathbf{A}_0 + \mathbf{A}_1\mathbf{x}_{t-1} + \ldots + \mathbf{A}_p\mathbf{x}_{t-p} + \mathbf{B}_0\mathbf{z}_t + \mathbf{B}_1\mathbf{z}_{t-1} + \ldots + \mathbf{B}_r\mathbf{z}_{t-r} + \varepsilon_t$$

where:

$\mathbf{x}_t$ is an nx1 vector of endogenous variables

$\mathbf{z}_t$ is an nx1 vector of exogenous variables

$\mathbf{A}_0$ is an nx1 vector of intercept terms

$\mathbf{A}_1$,..., $\mathbf{A}_p$ are nxn matrices of coefficients relating current and lagged values of the endogenous variables to their current values

$\mathbf{B}_0$,..., $\mathbf{B}_r$ are nxm matrices of coefficients that relate current and lagged values of the exogenous variables to current values of the endogenous variables

ε_t is an nx1 vector of error terms

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[10]The primary source of the identification problem, according to Sims (1980, p. 4), is the dynamic nature of the macroeconomic models employed in the estimation of these relationships.

[11]Hakkio and Morris (1984, p. 51) demonstrate that VAR models are more robust to model misspecification than point estimates from a structural model. However, the point estimates from a structural model are more efficient unless the model is badly misspecified.

[12]The notation used here is consistent with Pindyck and Rubinfeld (1991, p. 354).

The error terms or "innovations" may be viewed as shocks to the individual equations, which are correlated with each other but uncorrelated with the exogenous and pre-determined variables. This implies that such innovations are contemporaneously transmitted throughout the system of equations but are not serially correlated. Given these error assumptions, identical lag specification across equations, and stationary data, ordinary least squares (OLS) is a consistent and asymptotically efficient estimator of this system of equations (Pindyck and Rubinfeld, p. 355).[13]

The use of VAR modeling to study the relationship between money and real economic variables was fairly widespread throughout the 1980s. Bernanke and Blinder's (1988, 1990) study of monetary policy effects on the real economy and the transmission mechanisms by which these occur, was typical of VAR-oriented studies during this period. They included various indicators of monetary policy (the fed funds rate or the spread between the fed funds rate and various open market rates[14]) in a VAR with industrial production, personal income, unemployment, capacity utilization, retail sales, durable orders, housing starts and inflation, to examine the relative importance of the credit channel.[15]

One important result of their study is that the fed funds rate is found to be "markedly superior to both monetary aggregates and other interest rates as a forecaster of

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[13]Keating notes that "Zellner (1962) proved that OLS estimates of such a system are consistent and efficient if each equation has precisely the same set of explanatory variables." (1992, p. 39)

[14]The authors' preferred indicator is the spread between the federal funds rate and the Treasury bond rate, since it factors in inflationary expectations and thus approximates the *real* fed funds rate.

[15]Consumption was added in the 1992 study.

the economy" (1988, p. 4). They concur with McCallum's (1983) interpretation of the apparent dominance of interest rates over money as a predictor of the economy, noting that this may not imply policy ineffectiveness, but rather that interest rates are better indicators of policy. They also find tentative support for the assertion that the fed funds rate "is mostly driven by policy decisions," and thus, "while not statistically exogenous, is at least predetermined within a month." (1988, p. 5) Finally, they find that shocks in the fed funds rate do appear to influence the real economy and that the credit channel is significant in the transmission of these effects.

Bernanke and Blinder's (1988) work also generated several interesting results that have particularly important implications for this study. First, they find that not only do interest rate measures tend to dominate money measures as predictors (in the Granger-causal sense) of real activity, but the fed funds rate, in particular, tends to dominate other interest rates (p. 10).[16] This adds credibility to the interpretation of the fed funds rate, as a measure of Fed policy in this study. Second, in testing the elasticity of reserve supply and therefore the extent of Fed influence over the fed funds rate, the authors found non-borrowed reserves were nearly perfectly elastic prior to 1979, supporting the contention that the Fed operated under an interest rate targeting rule (p. 28). However, during the period following October 1979, when the Fed was supposed to have de-emphasized

[16]Friedman and Kuttner also indicate that the predictive ability of interest rates has strengthened over time (1992, p. 475). Boschen and Mills support Bernanke and Blinder's view that the federal funds rate is a good indicator of monetary policy; noting that "the federal funds rate is the money market variable that responds most directly to contemporaneous policy decisions, particularly in the post-Bretton Woods era" (1991, p. 25). Because their study relied on an examination of FOMC documents to determine policy shifts, rather than on innovations in the fed funds rate itself, this adds an important element of credibility to reliance on this rate as a measure of policy shifts.

interest rate targeting, the correlation between required reserve innovations and funds rate innovations was essentially zero (.01) and the correlation between non-borrowed reserve innovations and funds rate innovations was negative (-.10). This finding, in conjunction with their unexpected discovery that the response of the fed funds rate to inflation and unemployment shocks did not break down in the post-1979 period, indicates that despite a highly publicized de-emphasis of interest rate targets the Fed may have continued to rely on interest rate innovations to influence the economy.[17] Brunner reaches a similar conclusion, noting that "monetary policy shocks over the past several years have primarily affected the federal funds rate, even during periods when the Fed was reportedly targeting reserves." (1994, p. 4) These findings are consistent with the theme of this study.

Dale and Haldane (1995) attempted to model the interaction between an interest rate measure of monetary policy and intermediate and target policy variables. Their study estimated a small sectoral VAR model of the UK economy. They used the "stop rate" (minimum discount rate) as the measure of interest rate policy and examined its effects on exchange rates, stock prices, lending deposits, real activity and the price level, in both the personal and corporate sectors. In general, they found the relationships as postulated in the above transmission mechanisms, noting significant sectoral differences.

[17]This begs the question of whether the switch to "monetarist" operating procedures was actually an attempt to justify the higher interest rates which would result from inflation-fighting monetary policy. As Bernanke and Blinder (1990, p. 22) note: "The evidence that there was a major change in policy goals or strategy after 1979 is ... mixed." Melton (1985, p. 94) draws a more definitive conclusion that the new procedures "were merely a more refined form of interest rate targeting."

While VAR estimation was initially hailed as an atheoretical alternative to specification-sensitive structural equation models, Cooley and LeRoy (1985) argue that the assumptions necessary to generate impulse response functions and variance decompositions are often inconsistent with economic theory.[18] Keating indicates that this criticism "led to the development of an identified or "structural" VAR (SVAR) approach by Bernanke (1986b), Blanchard and Watson (1986) and Sims (1986)." (1992, p. 37) This technique utilizes economic theory to generate a structural equation model from the reduced-form estimates obtained in a VAR. Keating also notes that imposing either contemporaneous or long-run structural restrictions on SVARs "yield(s) impulse response functions and variance decompositions that can be given structural interpretations." (1992, p. 37) Unfortunately, like their predecessors, standard structural equation models, SVARs are often sensitive to the theoretical (and frequently controversial) restrictions imposed in the transformation process.[19]

One of the most important identifying restrictions in SVARs is the decomposition of policy actions into exogenous and endogenous components. (Rudebusch, 1996, p. 1) This is typically accomplished by estimating the Federal Reserve's reaction function and attributing the endogenous component to the fitted values in the regression and the exogenous innovation to the residuals. Motivated largely by this approach, several SVAR studies have concentrated on reaction function estimation. The results of these

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[18] They specifically challenged the Cholesky decomposition of the covariance matrix for the VAR residuals, which attributes the common effects to the variable appearing first in the VAR. "This implies that the first variable responds to its own exogenous shock, the second variable responds to the first variable plus an exogenous shock to the second variable, and so on." (Keating, 1992, pp. 37, 43)

[19] Bernanke and Blinder echo this concern: "Unfortunately, inferences drawn from structural models are typically sensitive to the choice of specification and the identifying assumptions." (1988, p. 2)

studies provide some insight into the appropriateness of measuring policy moves with innovations to the fed funds rate and raise some concerns regarding the reliance on reaction function estimation for the specification of SVARs.

Brunner (1994) finds strong support for the use of the fed funds rate as a measure of monetary policy, based on his SVAR estimates of the reaction function. Specifically, he finds that "on balance . . . between 85 and 100 percent of the variance in the funds rate can be attributed to policy shocks." (1994, p. 4) He also finds evidence that the Fed's policy objectives shift over time, implying that reaction functions should incorporate these structural shifts. More generally, his study suggests that SVAR estimation might benefit from the use of dummy variables, which recognize distinct changes in policy regimes. This latter implication is echoed by Webb (1994), who asserts that accounting for changes in regime tends to lessen the evidence of misspecification.

Rudebusch (1996) raises several concerns with the use of SVARs in measuring the effects of monetary policy. First, he argues that they tend to be time invariant; thus they do not adequately capture the effects of changes in regime (as would result from a changing FOMC Committee structure, for example). Second, they rely on a limited information set, despite the fact that the Fed claims to "look at everything." Third, they typically utilize final, revised data in the process of estimating the reaction functions. This is problematic in the sense that such data are not available to policy-makers when voting on policy. Finally, the long distributed lags found in the Fed's reaction function indicate that the Federal Reserve reacts systematically to old information. Sims similarly cautions researchers that: "the extent to which structural VAR analyses are sensitive to misspecification errors has to be carefully considered by the investigator" (1993, p. 339).

Together, these concerns raise serious questions about the reliability of SVAR model conclusions and the relative merits of this estimation procedure.

Comparative Assessment

It seems fair to conclude that each of the estimation techniques reviewed may be sensitive to the assumptions on which it is based. Non-VAR structural equation models appear to be sensitive to the structural equation specification, over which there is usually considerable disagreement. Unrestricted VAR models appear to be sensitive to variable selection and lag specification. The impulse response functions and variance decompositions, which summarize VAR results, also tend to be sensitive to the causal-ordering of the variables in the decomposition of the covariance matrix. Structural VARs also appear to be sensitive to identification restrictions, such as the estimation of the Federal Reserve's reaction function.

Each of these techniques may be appropriate for analyzing the effects of monetary policy, given proper consideration of the assumptions and the sensitivity of the results to these assumptions. This is consistent with the admonition by Sims (1993) and Akhtar who suggests that "in many cases, a careful investigator can compensate for deficiencies in reduced-form (VAR) estimates by utilizing sensitivity tests for changes in specification and in sample period" (1995, p. 114).

Conclusion

The monetary transmission literature reviewed illustrates the breadth of research coverage the study of monetary policy and its transmission mechanisms has received.

While many alternative relationships linking money to real and nominal economic variables have been postulated, little consensus has emerged regarding their relative importance or even the means by which monetary policy-makers initiate such influences.

The framework in most of the reviewed studies has emphasized the influence of changes in the money supply (usually via fluctuations in bank reserves). In fact, much of the empirical work has explored the influence of money and reserve targets on both the intermediate components of these transmission mechanisms and the economic targets (income, employment and inflation). Others, such as Bernanke and Blinder (1988, 1990), have emphasized the significance of a particular channel of monetary policy (the credit channel in their case). While their study comes closest to the goal of this study (measuring the effectiveness of the Fed's interest rate policy), it falls short of examining the relative merits of the postulated alternative interest rate transmission mechanisms.

Sometimes in the process of exploring these aspects of policy effects, researchers have explored the issue of the appropriate measure of policy action. Bernanke and Blinder (1988, 1990) for instance, test the predictive power of various measures such as the fed funds rate, T-bill and T-bond rates, and various interest rate spreads, within a VAR model. Similarly, Friedman and Kuttner (1992) test the commercial paper rate, T-bill rate, and the spread between the two within a VAR model. Likewise, Brunner (1994) estimates the Federal Reserve's reaction function. Together these studies provide some useful insights into the response of a wide-range of economic variables to various policy shocks, and support (to varying degrees) reliance on the fed funds rate as an indicator of monetary policy. However, they fall short of examining the relative and cumulative effects of the alternative transmission mechanisms simultaneously.

The comprehensive monetary transmission framework developed in this section, serves as the basis for the statistical testing of these relationships. The comparative review of the alternative modeling strategies and the relevant literature that has been presented provide justification for using the VAR estimation technique to generate the data necessary to critically evaluate these important issues. The results of this evaluation should provide insight into whether policy discourse and, more importantly policy actions, are justified in emphasizing interest rate adjustments as a means of achieving income, employment, and inflation objectives. In the process, the results of this study will contribute to our understanding of the relative significance of the alternative channels of interest rate influences.

The following chapter presents the methodology used to examine these important relationships, including a review of the key specification assumptions and the techniques used to interpret the estimation results.

CHAPTER III

METHODOLOGY

Any of the reviewed modeling strategies may be appropriate for analyzing the effects of monetary policy, given proper consideration of the assumptions and appropriate measurement of the sensitivity of the results to these assumptions. The attractiveness of the VAR technique used in this particular study is the minimal structural specification necessary, in light of the considerable disagreement over monetary transmission mechanisms. This lack of consensus introduces considerable *a priori* bias into each of the other techniques, to which the results and conclusions are likely to be fairly sensitive. In fact, Hakkio and Morris present evidence that point estimates from VARs are "more robust to misspecification than point estimates from a structural model" (1984, p. 51).

As discussed earlier, VARs assume "that in properly chosen sets of economic variables there are fundamental patterns among the variables" (Crone and Babyak, 1996, p. 8) and essentially permit the data to determine the appropriate dynamic structure of a model. The VAR procedure would appear to be particularly well-suited for the task of examining the nature of the postulated transmission mechanisms, since these mechanisms represent a vector of intermediate variables linking money and/or interest rate manipulation to changes in real income, employment and inflation. Most statistical packages are capable of estimating a VAR model, since it is essentially an application of OLS to multiple equations. This study utilizes the EViews statistical software package for estimation.

Specification Issues

Several methodological issues must be addressed to study effectively the transmission relationships using the VAR procedure. First, in order for the VAR to be properly specified, the appropriate variables and sources of time series data must be carefully selected. Second, it must be determined whether each variable is more appropriately modeled endogenously or exogenously. Third, the appropriate number of lags to include for each variable must be carefully considered. Finally, data stationarity and cointegration and its implications must be addressed.

Variable Selection

The consolidated monetary transmission framework developed in Chapter 1 is summarized in Figure 1, with slight modification. Since the assumed tool of monetary policy is the fed funds rate, it is modeled as the "trigger mechanisms" and the money supply is a function of fed funds policy. The revised framework also includes the assumed policy transmission influences on prices and unemployment, along with output, in order to capture the effects on the three policy target variables. This framework serves as the basis of variable selection for the VAR in this study.

$$\downarrow FF \Rightarrow \begin{matrix} \uparrow M \\ \\ \downarrow \mathbf{i} \end{matrix} \Rightarrow \begin{matrix} \uparrow NI \\ \uparrow RI \\ \uparrow BI \\ \uparrow CD \\ \downarrow E \Rightarrow \uparrow EX \\ \uparrow PE \Rightarrow \uparrow \mathbf{q} \Rightarrow \uparrow NI \\ \uparrow PE \Rightarrow \uparrow \mathbf{W} \Rightarrow \uparrow CT \\ \uparrow PE \Rightarrow \uparrow \mathbf{NW} \Rightarrow \downarrow \mathbf{AS,MH} \Rightarrow \uparrow L \Rightarrow \uparrow BI \\ \uparrow \mathbf{CF_{cp}} \Rightarrow \downarrow \mathbf{AS,MH} \Rightarrow \uparrow L \Rightarrow \uparrow NI \\ \uparrow \mathbf{CF_{cn}} \Rightarrow \downarrow \mathbf{AS,MH} \Rightarrow \uparrow L \Rightarrow \uparrow RI,CD \\ \uparrow L \Rightarrow \uparrow NI \end{matrix} \quad \begin{matrix} \Rightarrow \uparrow Y \\ \Rightarrow \downarrow U \\ \Rightarrow \uparrow \pi \end{matrix}$$

M	=	Money supply
FF	=	Fed funds rate
NI	=	Gross private domestic fixed investment: non-residential
RI	=	Gross private domestic fixed investment: residential
BI	=	Inventories
CD	=	Personal consumption expenditures: durable goods
E	=	Exchange value of the U.S. dollar
EX	=	Exports
PE	=	Equity prices
L	=	Bank loans
CT	=	Personal consumption expenditures: total
q	=	Tobin's q
W	=	Wealth
NW	=	Corporate net worth
CF_{cp}	=	Corporate cash flow
CF_{cn}	=	Consumer cash flow

Additionally, aggregate output (Y) is comprised of real GDP and the associated deflator and unemployment is assumed to respond inversely (according to a Phillips-Curve relationship) to fluctuations in aggregate output:

Y	=	Real gross domestic product
π	=	Inflation [represents the rate of growth in the price level (P)]
U	=	Unemployment rate

Note: The links in the transmission mechanisms indicated by bold notation are assumed relationships and are not explicitly modeled in this study.

Figure 1. Comprehensive Monetary Policy Transmission Framework

This model recognizes that arbitrage among a broad range of money market interest rates typically has them move in tandem, in response to movements in the fed funds rate.[1] The term structure implies similar movement in long-term interest rates as well.[2] Also, given the reasonable assumption that wages and prices adjust only sluggishly, real interest rates are positively correlated with nominal adjustments in the short run.

Time series data for the key components of these transmission mechanisms are available from the DRI Basic Economics Mini Database, formerly known as Citibase. The series utilized in this particular study to represent these key components are summarized in Table 1. The money supply (FM2), federal funds rate (FYFF), stock index (FSNCOM), unemployment rate (LHUR), bank loans and leases (FCLL), the inventory/sales ratio (IVT), and the value of the dollar (EXVUS) are available as monthly data and transformed into quarterly averages for the purposes of this study. The remaining variables are reported as quarterly series. The data sample covers the period from 1974:I to 1996:IV. This sample period, therefore, excludes the period of fixed exchange rates.

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[1]See Goodfriend and Whelpley (1986, p. 61).

[2]Akhtar (1995, p. 110) argues that the influence on long-term rates works through both substitution and expectation effects and that, with the exception of the Fisher effect, the tendency is to push both short-term and long-term rates in the same direction. His fairly comprehensive review of empirical studies of the relationship between short-term and long-term interest rates concludes that monetary policy changes influence long-term rates as well as short-term. However, there is little consensus as to their relative magnitudes.

TABLE 1
SOURCES OF TIME SERIES DATA

Transmission Component Being Modeled	DRI Variable Name	DRI Variable Description
M	**FM2**	***Monthly, seasonally adjusted M2*** as reported by the Federal Reserve Board of Governors in the *Statistical Release: Money Stock Measures and Liquid Assets*
FF	**FYFF**	***The effective Federal Funds rate***, % per annum, non-seasonally adjusted as reported by the Federal Reserve Board of Governors in *Selected Interest Rates and Bond Prices.*
PE	**FSNCOM**	***The New York Stock Exchange composite common stock price index*** as reported by the New York Stock Exchange in their News Release.
NI	**GINQ**	***Gross private domestic fixed investment: non-residential***, seasonally adjusted and in constant dollars as reported by the Department of Commerce, Bureau of Economic Analysis.
RI	**GIRQ**	***Gross private domestic fixed investment: residential,*** seasonally adjusted and in constant dollars as reported by the Department of Commerce, Bureau of Economic Analysis.
BI	**IVT**	***Inventory/sales ratio,*** seasonally adjusted as reported by the Department of Commerce, Bureau of Economic Analysis in the *Survey of Current Business*.
Y	**GDPQ**	***Gross domestic product***, seasonally adjusted and in constant dollars as reported by the Department of Commerce, Bureau of Economic Analysis.

TABLE 1 (Cont.)
SOURCES OF TIME SERIES DATA

Transmission Component Being Modeled	DRI Variable Name	DRI Variable Description
P	**GDPD**	***Gross domestic product implicit price deflator***, seasonally adjusted as reported by the Department of Commerce, Bureau of Economic Analysis.
L	**FCLL**	***Total loans and leases at all commercial banks***, seasonally adjusted as reported by the Federal Reserve Board of Governors in *Loans and Securities at all Commercial Banks.*
E	**EXVUS**	***United States index of weighted average exchange value of U.S. dollar*** against the currencies of the industrial countries, monthly average of daily rates, not seasonally adjusted, as reported by the Federal Reserve Board of Governors in *Foreign Exchange Rates*.
EX	**GEXQ**	***Exports of goods and services***, seasonally adjusted and in constant dollars, as reported By the Department of Commerce, Bureau of Economic Analysis.
CD	**GCDQ**	***Personal consumption expenditures: durable goods***, seasonally adjusted and in constant dollars as reported by the Department of Commerce, Bureau of Economic Analysis.
CT	**GCQ**	***Personal consumption expenditures: total***, seasonally adjusted and in constant dollars as reported by the Department of Commerce, Bureau of Economic Analysis.
U	**LHUR**	***Unemployment rate: all workers, 16 years & over,*** seasonally adjusted and expressed as a percentage as reported by the U.S. Department of Labor, Bureau of Labor Statistics.

The standard convention in VAR studies is to express quantity variables in natural logs and interest rate and ratio variables in level form.[3] As discussed by Dale and Haldane, this allows for impulse responses of the logged quantity variables to be "interpreted as cumulative growth rates relative to base." (1995, p. 1618) Thus, a positive response indicates an increase in the rate of growth relative to its rate at the time of an innovation, and vice versa. They also express interest rates in log form, giving these impulse responses an interpretation as percentage point movements relative to base. Consistent with the approach and interpretation used by Dale and Haldane, the first step in the transformation of the data is to express all of the variables in natural log form.

Endogeneity vs. Exogeneity of the Variables

Sims (1980) built a strong argument for modeling *all* of the variables in a VAR endogenously. As Pindyck and Rubinfeld point out:

> Specifying some of the variables to be exogenous introduces restrictions on the model, because such variables will be able to affect the endogenous variables only directly, and not indirectly through feedback from the endogenous variables themselves. A purist would argue that restrictions of this kind are an unwarranted imposition of the modeler's theoretical biases and prevent the data from speaking freely. (1991, p. 354)

In this particular study, the primary variable for which endogeneity is at issue is the Federal Reserve's assumed policy instrument: the fed funds rate. The view that the fed funds rate should be modeled endogenously can be supported on multiple grounds.

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[3] See comments by Brunner (1994, p. 15). This approach is followed by Sims (1980, 1992), Webb (1994), Braun and Mittnik (1993), Rudebusch (1996), Leeper, Sims and Tao Zha (1996), Gertler and Gilchrist (1993), and Bernanke and Blinder (1988). In the reviewed studies, only Dale and Haldane (1995) and Clements and Mizon (1991) depart from this approach. Dale and Haldane express the interest rate in log form in order to interpret its impulse responses as percentage point movements relative to base. Clements and Mizon express the unemployment rate in log form but do not explain their reasoning.

First, even if the Fed *does* largely influence this rate it still seems reasonable to assume that they adjust it based on some type of feedback mechanism, utilizing information from past values of the other modeled variables, such as the price level, the level of unemployment or fluctuations in exchange rates. This was Sims' argument against modeling policy variables as exogenous. (1980, p. 6) A similar argument was advanced by Bernanke and Blinder, in their defense of isolating the fed funds rate as a "direct measure of monetary policy" in a VAR:

> Suppose there was a variable whose innovations could be interpreted as "policy shocks." (The systematic portion of the variable could depend in any arbitrary fashion on lagged economic variables.) Suppose further that, perhaps because of information lags, these measurable policy shocks could reasonably be assumed to be independent of contemporaneous economic disturbances. Under these assumptions, the reduced-form (VAR) responses of the economy to observed policy shocks would correctly measure the dynamic structural effects of a monetary policy change. (1988, p. 2)

Bernanke and Blinder find strong support for their assertion that the fed funds rate is a good measure of monetary policy and thus, "should be a good reduced-form predictor of major macroeconomic variables." (1988, pp. 4-5) They find that this rate is "markedly superior to (other variables) as a forecaster of the economy" and that it is responsive to the Fed's perception of the economy. They also find that the fed funds rate is relatively insensitive to "within-month reserve demand shocks... which supports the idea that the funds rate is mostly driven by policy decisions (within the period)." They conclude that it is reasonable to "interpret the estimated dynamic responses of the economy to (fed funds) shocks . . . as reflecting the structural effect of monetary policy innovations."

Modeling the fed funds rate as an endogenous variable also allows explicit testing for exogeneity via variance decompositions and Granger causality tests, and permits the analysis of the impact of fed funds shocks on the other variables via impulse response functions, variance decompositions and Granger causality tests. In contrast, modeling the fed funds rate as exogenous biases the VAR results (by ignoring the apparent feedback effects that have prompted considerable research into the Federal Reserve's "reaction function") and limits exploration of the very dynamics that are of primary interest. This study, then, takes each of the relevant variables as endogenous and then explores the questions of exogeneity and system dynamics simultaneously.

Lag Length Determination

Another important specification issue is the determination of the appropriate lag length. As Pindyck and Rubinfeld (1991, p. 355) caution, "when choosing p and r (the lags for the endogenous and exogenous variables respectively) one wants lags long enough to fully capture the dynamics of the system being modeled." Unfortunately, as the number of lags increases, the number of degrees of freedom (and hence efficiency) decreases. Thus, the selection of the appropriate lag length involves a tradeoff between sufficient lag length and degrees of freedom.[4]

The importance of considering the appropriate lag length should not be underestimated. Hafer and Sheehan (1991) have shown that the VAR results and policy implications tend to be quite sensitive to changes in the lag structure. Several statistical

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[4]Thus, one of the valid criticisms of VAR models is that they end up invoking the very *a priori* restrictions they set out to avoid in structural models.

procedures may be employed to help specify the appropriate lag length. The Akaike (1970) Final Prediction Error (FPE) criterion and Mallows' (1973) C_p statistic are based on the minimization of mean squared error, balancing the bias caused by insufficient lag length specification with the inefficiency caused by excessive lag specification. Bayesian techniques such as the Bayesian Information Criterion or the Bayesian Estimation Criterion may also be utilized.[5] One of the more frequent lag specification techniques involves the use of a series of F-tests as lag length is increased, in order to identify the lag beyond which little new information is provided.[6, 7]

Each of these techniques has the flexibility to specify different lag lengths for each endogenous variable; however, standard VAR estimation specifies equal lag lengths across all variables (and thus equations) and relies on OLS to estimate the equations.[8] Judge, et. al (1988, p. 761) recommends using the Akaike Information Criterion (AIC) and Schwartz Criterion (SC) to determine optimal lag length. Each of these procedures

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[5]Geweke and Meese (1981) conclude that these Bayesian techniques tend to under-fit in small samples, since they place more weight on efficiency in the bias-efficiency tradeoff. See related discussion in Hafer and Sheehan (1986, pp. 3-4). They also argue (p. 56) that the C_p and FPE criterion "have the advantage that asymptotically the chosen model is never too small... (however, they are also) in general asymptotically inefficient."

[6]Hafer and Sheehan (1991) explore the effects of each of these lag specification techniques and find that "the Bayesian criteria yield parsimonious lag structures, the F the longest and C_p and FPE somewhere in between." (p. 47)

[7]Hafer and Sheehan assert that "the evidence suggests that relatively short-lagged models generally are more accurate than models with relatively long lags." (1987, p. 2) Also, Litterman (1986, p. 27) warns that statistical approaches to lag specification "ignore... the (fact) that the reason one wants to choose a lag length in the first place is because one has prior information that more recent values of the variables in question have more information than now distant values."

[8]Sims (1980), for example uses lags of four quarters for all variables, based on an F-test comparing lags of four and eight quarters. Similarly, Bernanke and Blinder (1990) used lags of six months.

determines the optimal lag length by minimizing the estimated residual covariance matrix obtained from the VAR model, over a range of lag lengths. Thus, in contrast to the other lag selection criteria, only the AIC and SC approaches take advantage of the comprehensive VAR model interrelationships. This study, therefore, calculates the optimal lag length according to the AIC and SC criterion. The results of these tests are examined, in light of the degree of freedom constraints imposed by the model structure and available data, and an optimal lag length was determined. The results of these tests are summarized in Table 2. According to the AIC approach the optimal lag length is two quarters, while the SC approach found four-quarter lags to be optimal. Because the "cost" of under-specifying lag length is biased estimates and unreliable inference, while the cost of over-specifying lag length is a loss of efficiency, the four-quarter length was selected for the model in this study.

TABLE 2

AIC AND SC TESTS FOR OPTIMAL LAG LENGTH

Lags	AIC	SC
1	115.71	109.99
2	**115.59**	104.46
3	115.73	99.12
4	118.61	**96.45**
5	130.89	103.10

Note: The numbers in bold indicate the lag length for which the relevant criterion is minimized, and thus the optimal lag length based on that test.

Suggested Optimal Lag Length = 2 Quarters (via AIC)

Suggested Optimal Lag Length = 4 Quarters (via SC)

Data Stationarity

One critical assumption in the application of OLS is that the data are stationary. This implies that the effects of innovations to the endogenous variables tend to dissipate over time. The effect of regressing nonstationary variables on one another (using OLS) is that the OLS estimator no longer has the usual asymptotic distribution.

Dickey and Fuller (1979, 1981) employ a statistical test (that bears their name) to determine if a series is stationary and, if not, what type of transformation is appropriate in order to conform with the OLS assumptions.[9] Typically, differencing the data one or more times is the preferred approach to achieving stationarity. Using the Dickey-Fuller test, Nelson and Plosser (1982) found that they could not reject the null hypothesis that many macroeconomic variables, such as GNP, industrial production, employment, consumer prices, wages, and common stock prices, followed a random walk process; therefore, they are not stationary in their unadjusted form.

The results of the Augmented Dickey-Fuller (ADF) unit root test, for data stationarity of the raw data used in this model, are summarized in Table 3. The ADF test procedure requires the specification of a trend and/or intercept in the underlying data generation process for each series. Tests on series stated in log-levels specified a trend, which seems consistent with most macroeconomic time series. Tests on series stated in ratio form (BI, E, FF, and U) specified an intercept only. In each case, the 5% level of

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[9]See Griffiths, Hill and Judge (1993, pp. 696-700).

TABLE 3
RESULTS OF THE AUGMENTED DICKEY-FULLER UNIT-ROOT TESTS FOR STATIONARITY

EX (Exports of Goods and Services)
Series is non-stationary in log-levels @ 10% significance level
Series is stationary in log-differences @ 5% significance level

E (Weighted-Average Exchange Value of the U.S. Dollar)
Series is non-stationary in log-levels @ 10% significance level
Series is stationary in log-differences @ 1% significance level

L (Total Loans and Leases at All Commercial Banks)
Series is non-stationary in log-levels @ 10% significance level
Series is stationary in log-differences @ 10% significance level
Series is stationary in log second-differences @ 1% significance level

M (M2 Money Stock)
Series is non-stationary in log-levels @ 10% significance level
Series is stationary in log-differences @ 1% significance level

PE (NYSE Common Stock Composite Price Index)
Series is non-stationary in log-levels @ 10% significance level
Series is stationary in log-differences @ 1% significance level

FF (Federal Funds Rate)
Series is stationary in log-levels @ 10% significance level
Series is stationary in log-differences @ 1% significance level

CD (Personal Consumption Expenditures on Durable Goods)
Series is non-stationary in log-levels @ 10% significance level
Series is stationary in log-differences @ 5% significance level

P (Gross Domestic Product Implicit Price Deflator)
Series is non-stationary in log-levels @ 10% significance level
Series is non-stationary in log-differences @ 10% significance level
Series is stationary in log second-differences @ 1% significance level

Y (Gross Domestic Product)
Series is stationary in log-levels @ 5% significance level
Series is stationary in log-differences @ 1% significance level

TABLE 3 (Cont.)
RESULTS OF THE AUGMENTED DICKEY-FULLER UNIT-ROOT TESTS FOR STATIONARITY

NI (Gross Private Domestic Non-Residential Investment)
Series is stationary in log-levels @ 10% significance level
Series is stationary in log-differences @ 1% significance level

RI (Gross Private Domestic Residential Investment)
Series is stationary in log-levels @ 5% significance level
Series is stationary in log-differences @ 1% significance level

BI (Inventories/Sales Ratio)
Series is stationary in log-levels @ 10% significance level
Series is stationary in log-differences @ 1% significance level

U (Unemployment Rate, Workers 16 and Over)
Series is stationary in log-levels @ 10% significance level
Series is stationary in log-differences @ 1% significance level

CT (Personal Consumption Expenditures)
Series is non-stationary in log-levels @ 10% significance level
Series is stationary in log-differences @ 5% significance level

significance was used. Only residential investment (RI) and output (Y) were found to be stationary in log-level form. Each of the other variables were first-differenced and re-tested to assure stationarity. The price deflator (GDPD) and bank loan (FCLL) series required second-differencing to achieve stationarity at the 5% significance level. Initial examination of the impulse responses of residential investment and output to fed funds innovations also indicated a persistent deviation from their initial level that draws into question the stationarity of these series when expressed in levels. Also, when the ADF test specifies an intercept only (no trend) in the data generation process, both series are found to be I(1) in log-levels. To be conservative then, these series were also first-differenced.

An alternative approach to achieving data stationarity is to test for and specify cointegrating relationships between the levels of the variables. Specifically, two time series, which are nonstationary but a linear combination of which is stationary, are cointegrated. Estimating a cointegrated system in differences ignores the information contained in the levels of the variables. The number of cointegrating equations (or the cointegrating rank) can be estimated using the Johansen test procedure in EViews. Given N endogenous variables, if there are N cointegrating equations, the levels of the time series may be used without violating OLS assumptions. If the Johansen cointegration test indicates cointegration among the time series in the model, a vector error correction (VEC) model may be estimated with EViews to correct for the cointegration. The VEC specification includes lagged levels along with lagged differences in the VAR. The interpretation of the results, using OLS for estimation, will be the same as in a standard

VAR. However, test statistics for models of this size (14 variables) have not been developed.

Considerable disagreement exists as to whether VARs should be pre-tested for stationary and/or cointegrated data. Sims, Stock and Watson (1990) imply that VARs expressed in levels generate consistent and valid test statistics, given a sufficient number of lags, whether the data are cointegrated or not. However, determining the "sufficient" number of lags is impossible, and the resulting estimates are thus subject to potential bias. Similarly, misspecifying a VAR with invalid cointegration restrictions generates biased point estimates and invalid test statistics. Given these considerations, this study ensures stationarity by appropriately differencing the series, as outlined above.

The Model

The model that results from the above diagnostics is a VAR containing the fourteen variables noted in Table 1 above. Each variable is expressed in its differenced-form (first differences for all variables except bank loans and prices, which are second-differenced) to ensure stationarity and validate the OLS estimation procedure. Four lags of each variable are included to reduce the risk of serial correlation. The VAR model is specified in Appendix A.

Interpretation of the Results

Impulse Response Functions

Interpretation of VAR estimation results relies heavily on the use of impulse response functions and variance decompositions. According to Sims, interpreting the estimated coefficients in the equations is difficult due to the oscillation of the coefficients on successive lags and cross-equation feedbacks. (1980, p. 20) As an alternative, impulse response functions measure the effect on current and future values of the endogenous variables of a one standard deviation shock to one of the error terms or "innovations." As mentioned above, expressing the variables in logged form allows for impulse responses of these variables to be "interpreted as cumulative growth rates relative to base."

Because the error terms are likely to be correlated, some type of decomposition technique is necessary to attribute the common effects accordingly. The EViews VAR estimation module utilizes the Cholesky decomposition (consistent with Sims, 1980), attributing the common effects to the variable appearing first in the VAR. Admittedly, this method is arbitrary and the results may be sensitive to the ordering of the variables. However, the technique is widely used and sensitivity analysis is to be employed to investigate the sensitivity of the results to the variable ordering. Examining these impulse response functions should provide important clues as to the extent to which the channels of interest rate transmission influence real income, unemployment, and inflation.

Variance Decompositions

Additional evidence is supplied by examining the variance decompositions, which are also generated by the EViews VAR estimation procedure. The variance decomposition indicates the relative importance of the random innovations. Specifically, it indicates the percentage of the k-step-ahead squared prediction error in the endogenous variables due to innovations in each of these variables for selected lags (values of k).[10] Care must be exercised in drawing conclusions from variance decompositions, since Braun and Mittnik conclude that they are more sensitive to misspecification errors than are impulse response functions. (1993, p. 338) Bernanke and Blinder also point out that variance decompositions are fairly sensitive to the forecast horizon. (1990, p. 11) Sensitivity tests will help identify the impact of variable ordering, and decompositions will be examined across multiple forecast horizons.

One important concern regarding the interpretation of VAR results via both impulse response functions and variance decompositions is expressed by Runkle, who argues that these results are often "sensitive to data selection" and "the confidence intervals for the variance decompositions and impulse response functions are often so large that little useful inference can rely on them." In fact, he considers this "tantamount to using regression coefficients without *t* statistics." (1987, pp. 437-438) He goes on to recommend two different techniques to compute the relevant confidence intervals. This

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[10]As both Hakkio and Morris (1984, p. 38) and Sims (1980, pp. 22-23) suggest, the variance decomposition is also an effective means of identifying exogenous variables. A series is exogenous if 100% of the p-step ahead forecast error variance is due to innovation in the series itself.

study adopts one of these approaches, calculating the relevant standard error bands using a Monte Carlo Simulation with 100 repetitions.

Granger-Causality Tests

A final test of the hypothesized relationships among the variables, especially the relationship between the Federal Reserve's postulated policy instrument (the fed funds rate) and income, inflation and employment, is Granger-causality.[11] (Granger, 1969) A variable *(Y)* is "Granger-caused" by another variable *(X)* if the information in the past and present values of *X* improves the forecast of *Y*. Thus, if *X* Granger-causes *Y*, it implies that *X* improves the statistical prediction of *Y*, not that there is an economic relationship. Nonetheless, in the context of a VAR model, Granger-causality can be identified by testing for zero-constraints on the coefficients of the variables in question.[12] For example, testing for zero coefficients on FF for the income, price and employment equations indicates whether changes in the fed funds rate "Granger-cause" changes in each of these variables. These tests are conducted in this study. Granger causality tests are also employed to examine the extent of the relationships proposed under the various interest rate transmission mechanisms and the exogeneity of the fed funds rate. If the policy variable is (as often implied) exogenous, it should not be Granger-caused by the other variables in the model.

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[11]Bernanke and Blinder (1988, p. 11) find this technique preferable to variance decompositions due to their "dependence on the ordering of the explanatory variables, dependence on the horizon, low levels of statistical significance and subsample instability."

[12]See Bernanke and Blinder (1990, p. 9) for a recent application within a VAR framework.

One significant advantage of Granger-causality tests, over either variance decompositions or impulse response functions, is that they are not dependent on an ordering specification for the variables. Bernanke and Blinder point out a potentially important disadvantage, however (1990, p. 11). They indicate that including two (or more) variables which are causally-related in a VAR with another variable which is, in turn, caused by the interaction between these variables, can distort the measurement of the causal relationships. For example, if the fed funds rate Granger-causes residential investment and, in turn, output, then the Granger-causality of the fed funds rate on output will be masked by including each of these causally-related variables. This caution is particularly relevant to the model used in this study, since its postulates multiple causal relationships simultaneously.

Summary

There were three major items presented in this chapter. First, several important VAR specification issues were addressed. These included variable selection, endogeneity/exogeneity and lag length specification, and assumptions regarding data stationarity. Second, the comprehensive monetary transmission framework, introduced in chapter 2, was used to assemble the critical components of the model VAR. Third, several useful techniques were presented to help interpret the results of the VAR model estimation. In the next chapter, the results of the study are presented.

CHAPTER IV

RESULTS

This chapter presents the results of the estimated VAR model. The first section reviews the initial assumptions made in the VAR estimation. The second section presents the estimated VAR equations. The final sections present the estimated impulse response functions and variance decompositions, the results of the multivariate Granger-causality tests, and a general overview of the implications.

Assumptions

The VAR model is outlined in the previous chapter and presented in Appendix A. The lag length is four quarters. The data are appropriately differenced to ensure stationarity. The variables are all treated as endogenous for the reasons outlined in the previous chapter. All data are converted to log-form to facilitate the interpretation of the resulting impulse response functions.

Estimated VAR Equation

The VAR model was estimated using the VAR estimation procedure in EViews (ordinary least squares) which generates consistent estimates. Each of the estimated equations regressed a current variable's value on four lagged values of that variable and each of the other variables. A constant was also estimated. The estimated equations and relevant summary statistics are presented in Appendix B. As noted earlier, interpreting the estimated coefficients in these equations is difficult due to the oscillation of the coefficients on successive lags and cross-equation feedback. Thus, these estimates themselves offer little help for the interpreting fed funds policy effects. Instead the study relies on the impulse response functions, variance decompositions, and Granger-Causality tests associated with this VAR model. The results of these analytical tools and a general overview of the implications are presented in the following section.

Estimated Impulse Response Functions

Impulse response functions measure the effect on current and future values of the endogenous variables of a one standard deviation shock to one of the error terms, that is, the "innovations." Because the error terms in the VAR model are typically correlated, the Cholesky decomposition is used to attribute the common effects to the variable appearing first in the VAR. The variable ordering is: FF, M, PE, CT, E, EX, L, RI, NI, CD, BI, P, Y, and U. This ordering implies that the fed funds rate does not respond to contemporaneous movements in the other variables within the quarter, but rather responds to innovations in the other variables with a lag. If this is a reasonable interpretation of Federal Reserve policy response (perhaps due to information lags) then, Bernanke and Blinder argue, the responses to fed funds innovations may be interpreted as "the dynamic structural effects of monetary policy change." (1990, p. 3)[1]

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[1] The most extreme alternative ordering specification would reverse the order, placing U first and FF last. This would imply no information lags in the conduct of fed funds policy, but longer effectiveness lags. This is because the reverse interpretation implies that the fed funds rate responds to other variable shocks instantly, while the other variables respond only with a lag. The sensitivity to the model results to the ordering specification will be examined later. For an excellent discussion of the implications of alternative orderings see Bernanke and Blinder (1990, pp. 3-4) and Todd (1990, pp. 35-37).

Appendix C presents the estimated impulse response functions that result from this specification. Because this study is particularly concerned with the effects of fed funds policy on the model variables, figure 2 summarizes the responses of each of the variables to a one standard deviation shock (innovation) to the fed funds rate (FF). Since each of the variables is converted into logarithms, the impulse responses are interpreted as cumulative growth rates relative to base (Dale and Haldane, 1995, p. 1618). In other words a positive impulse response is interpreted as an increase in the rate of growth relative to the rate at the time of the innovation.[2] The exceptions are the unemployment and fed funds rate impulse responses, which because they are percentage series, may be interpreted as percentage point movements relative to base. Each of the impulse responses is shown over a three-year period (12 quarters). To address the concerns raised by Runkle (1987), related to the sensitivity of impulse responses to data selection, this study follows his recommended procedure of calculating standard errors using the Monte Carlo technique (100 replications).[3] Standard error bands of +/- two standard deviations are reflected on each impulse response graph.

In general, the responses to a tightening of policy via a shock to the fed funds rate are consistent with economic theory. Very few of the responses are statistically significant, according to the calculated error bands. Most of the responses tend to zero out by the eighth quarter following a policy adjustment.

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[2] The response of the GDP deflator variable (P) thus reflects the *level* of inflation relative to its level at the time of the policy innovation.

[3] Standard errors were also recalculated using 1000 replications and using Hamilton's (1994, p.339) asymptotic analytical formula, with no significant differences in the results.

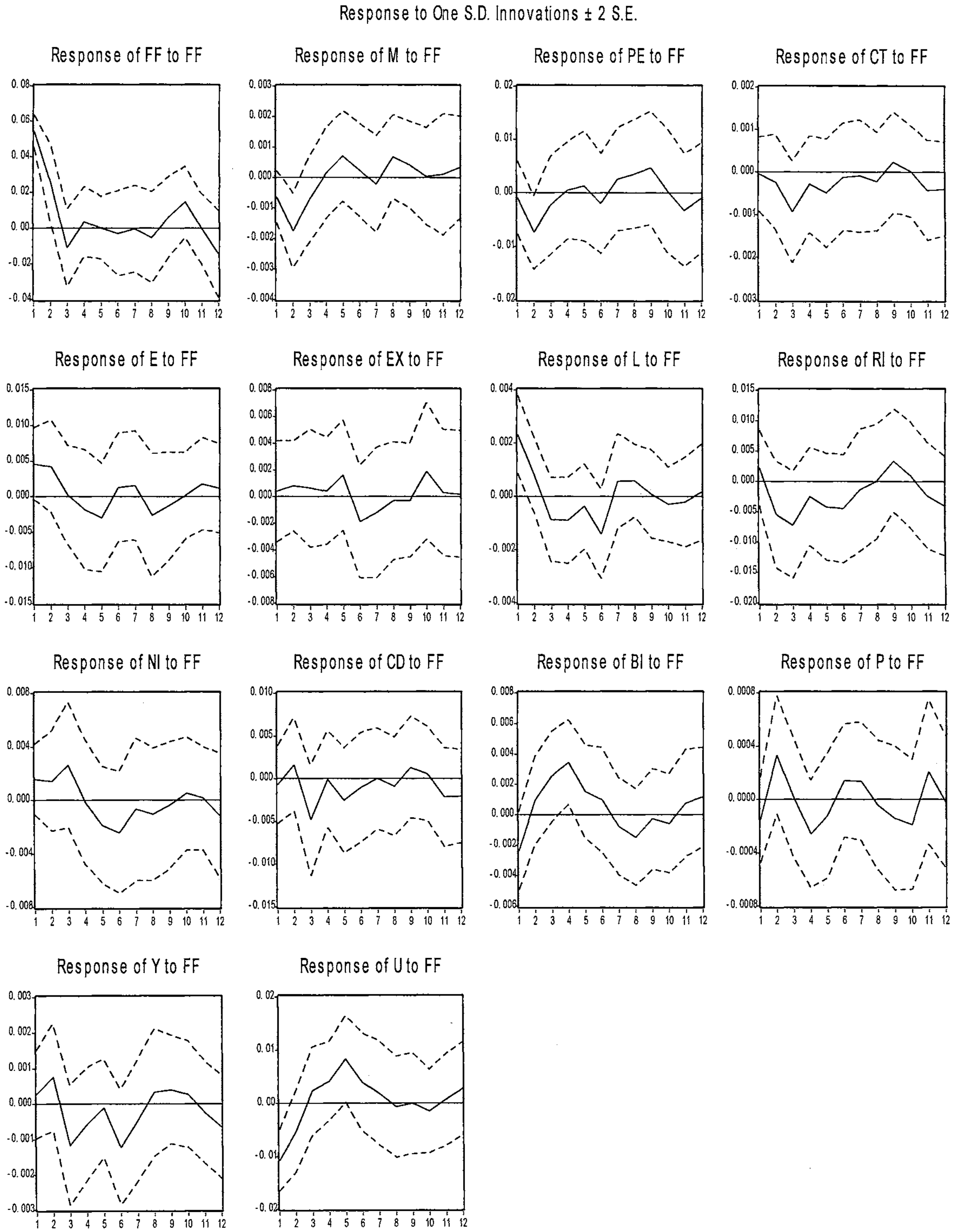

Figure 2. Responses to a Fed Funds Innovation

Following a slight initial decline, the growth of the ratio of business inventories to sales (BI) rises above its initial level through the seventh quarter. The positive response may, however, be indicative of declining sales growth rather than an increase in inventory investment. The ratio tends to zero by the end of the second year. Consumption, consumer durables investment, and residential investment (CT, CD and RI, respectively), respond negatively to tighter policy over most of the first two years. Again, these responses tend to zero after about eight quarters. The initial positive response of non-residential investment (NI) is harder to reconcile with theory. However, as will be explored later, this may be partly attributable to the slow response of bank lending to tighter policy. Nonetheless, non-residential investment eventually does decline after about a year and remains below its initial level through quarter eleven, when the effects tend to zero.

As expected, equity prices (PE) decline in response to more restrictive policy, returning to trend by the fourth quarter. Also as expected, the dollar exchange value (E) strengthens in response to tighter policy, with the effect remaining positive through three quarters. Exports (EX) do not seem to correspondingly decline, instead remaining above trend through the first five quarters. The sharp decline between the fifth and sixth quarters does, however, parallel a second spike in the exchange value of the dollar.

The negative response of money (M) to tighter policy is statistically significant by the second quarter and money growth remains below trend through the fourth quarter.[4] This is consistent with the apparent duration of policy tightening, as reflected in the

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[4] The impulse responses are considered to be statistically significant at a particular forecast horizon if the response and its respective error bands are either all greater than or less than zero.

response of fed funds to its own innovations, which indicates an easing of policy by the third quarter. However, the subsequent increase in money growth in quarters four through ten coincides with relatively neutral fed funds policy.

Growth in prices (P), or inflation, rises in the first few quarters following an increase in the fed funds rate. It then appears to slow after about three quarters. There is some evidence of a Phillips curve tradeoff between inflation and unemployment, with an initial decline in unemployment (U) and subsequent increase after three quarters, roughly corresponding to the timing of inverse responses in inflation. The peak of unemployment in the fifth quarter also follows the inflation rate minimum in the fourth quarter. Interestingly, the initial decline in unemployment is one of the few statistically significant responses identified. Output (Y) responds negatively to tighter policy through most of the first eight quarters, after a slight initial increase. Overall, the three target policy variables (U, Y, and P) seem to respond slowly to policy adjustments, with lags of two to three quarters. The real effects of the policy adjustments seem to dissipate after about eight quarters, with most variables returning to their initial trends.

Estimated Variance Decompositions

Additional evidence regarding the effects of fed funds policy is supplied by examining the variance decompositions generated by the VAR model. Variance decomposition indicates the relative importance of each of the innovations. Specifically, it indicates the percentage of the k-step ahead squared prediction error in the endogenous variables explained by innovations in each of these variables. Variable ordering is identical with that used to generate the impulse response functions. Care, however, must be exercised in drawing conclusions from the variance decomposition output. Braun and Mittnik (1993) conclude that they are more sensitive to misspecification errors than are impulse response functions. As a result, the evidence offered by the variance decompositions is given less qualitative significance than the impulse responses in the overall analysis of fed funds policy effects.

The variance decompositions are presented in Appendix D. Each table indicates the percentage of forecast error variance (FEV) in that particular variable which is explained by each of the column variables across periods. The average FEVs explained by each variable are indicated in bold, to facilitate comparison across variables, and are summarized in Table 4.

The most critical observation is that fed funds rate adjustments explain, at most, 24 percent of the FEV in the other variables over the entire twelve quarter horizon (this reflects the one-quarter-ahead FEV of unemployment in Table 24). In fact, for most of the variables, fed funds adjustments explain less than ten percent of the FEV. According to Table 4, fed funds adjustments are most important in explaining the FEVs of unemployment (17% on average), the money supply (13%), residential investment (11%), and bank lending (10%).

It is also interesting to note that the fed funds rate explains more of the FEV than money in only seven of the fourteen variables. Money seems particularly important to the explanation of the FEV in non-residential investment, inflation, equity prices, and money itself. This contradicts the findings of Sims (1980), Todd (1990), and Bernanke and Blinder (1988, 1990), all of whom found money inferior to interest rates in

TABLE 4
AVERAGE PERCENTAGE OF FEV EXPLAINED BY EACH VARIABLE

	BI	**CD**	**CT**	**E**	**EX**	**FF**	**L**
BI	18.32	3.75	16.46	10.15	5.35	9.09	4.58
CD	4.21	21.55	24.93	6.78	1.90	5.95	4.82
CT	6.64	10.10	30.34	6.75	1.64	9.00	4.15
E	0.99	2.66	7.14	37.78	8.06	8.78	2.11
EX	7.27	4.57	7.70	7.60	41.44	5.21	4.94
FF	4.93	2.00	9.55	7.57	3.80	35.03	3.27
L	1.94	2.08	8.50	2.79	4.99	9.73	25.96
M	11.53	0.69	1.13	7.40	5.40	12.97	3.90
NI	1.80	5.21	15.17	5.71	3.59	7.89	4.66
P	3.80	2.53	5.71	6.35	7.99	4.47	8.34
PE	4.75	4.44	9.48	4.33	8.65	3.97	3.32
RI	3.39	3.65	15.13	9.63	2.23	10.98	7.90
U	6.38	1.64	17.86	6.03	3.25	17.09	3.60
Y	3.12	6.20	22.22	4.89	8.83	7.42	1.75
Average	***5.65***	***5.08***	***13.67***	***8.84***	***7.65***	***10.54***	***5.95***

	M	**NI**	**P**	**PE**	**RI**	**U**	**Y**
BI	7.01	2.82	1.98	3.96	10.02	3.60	2.90
CD	8.19	3.89	1.93	1.91	8.89	3.09	1.98
CT	8.67	3.85	1.97	4.49	7.82	3.10	1.49
E	2.70	7.85	8.38	6.95	3.67	2.31	0.64
EX	2.65	1.81	2.94	3.54	5.12	3.70	1.50
FF	7.35	3.19	5.18	1.84	8.31	5.31	2.67
L	9.15	3.73	6.50	10.93	5.29	5.78	2.63
M	34.63	3.43	1.77	3.53	6.36	4.83	2.43
NI	11.13	19.86	1.45	7.72	9.77	3.55	2.48
P	16.08	5.46	28.44	4.08	1.82	0.81	4.12
PE	11.02	4.14	1.76	31.54	6.06	3.79	2.76
RI	11.58	3.65	1.22	4.12	20.35	3.00	3.18
U	6.90	3.68	5.40	1.21	15.03	9.00	2.94
Y	7.48	4.71	1.92	7.43	10.11	4.26	9.65
Average	***10.32***	***5.15***	***5.06***	***6.66***	***8.47***	***4.01***	***2.96***

Note: Each number represents the average percentage of the forecast error variance (FEV) in the row variable explained by the respective column variable. See Appendix D for more detail.

explaining movements in several macroeconomic variables. It also raises some questions regarding the uniformity of their findings when applied to models with a larger set of economic variables.

Examining the variance decompositions of the Fed's three primary target policy variables is also insightful (rows P, U, and Y in Table 4). Unexpected variation in price growth (inflation) is largely explained by its own innovations (28% on average) and innovations in money (16%), bank lending (8%), and exports (8%). Unexpected variation in unemployment is explained primarily by shocks to consumption (18%), the fed funds rate (17%), and residential investment (15%). Output fluctuations are mostly explained by shocks to consumption (22%), residential investment (10%), and exports (9%).

A final observation relates to the relative degrees of exogeneity of the variables. By definition, the greater the average percentage of FEV explained by a variable's own shocks, the greater should be the degree of exogeneity of that variable. Exports appear to be the "most nearly exogenous" with an average FEV of 41 percent. Other variables exhibiting relatively high percentages of FEV explained by their own innovations are the fed funds rate (35%), the money supply (35%), equity prices (32%), and consumption (30%).

Results of Granger-Causality Tests

Possibly the most significant evidence to consider, in assessing the effects of fed funds policy, are the multivariate Granger-causality tests of the VAR model's components. Bernanke and Blinder find this technique preferable to variance decompositions (1988, p. 11). This is because both impulse responses and variance decompositions are sensitive to the causal-ordering of the variables and forecast horizon.

In the context of a VAR model, Granger-causality is examined by testing for zero constraints on the coefficients of the variables in question. For example, testing whether fed funds Granger-causes residential investment involves a test of the joint significance of the coefficients on the lagged values of fed funds in the residential investment equation. Thus, a standard F-test is utilized to examine Granger-causality among the model variables. In EViews, this is accomplished by estimating each of the VAR model equations separately with OLS and jointly testing the lags of each variable for significance.

The results of the Granger-causality tests are presented in Table 5. The values shown are the *p*-values associated with the relevant F-test. Low *p*-values indicate that the row variable Granger-causes the column variable. Variables that are Granger-causal at the 5% significance level are in bold and shaded in the table. Those significant at the 10% level are noted in bold. Referring to the example above, to determine whether fed funds Granger-causes residential investment involves examining the *p*-value in row FF in column RI. Thus, fed funds appears to Granger-cause residential investment at the 5% significance level. To facilitate the examination of the effects of fed funds rates on the other variables, the relevant Granger-causal results are indicated on the rows designated FF.

The results of these tests indicate that fed funds Granger-causes residential investment and equity prices at the five and ten percent levels of significance, respectively. Non-residential investment is nearly significant at the ten percent level

TABLE 5
RESULTS OF GRANGER-CASALITY TESTS

Dependent Variable

(p-values shown indicate whether the row-variable Granger-causes the column variable)

	BI	CD	CT	E	EX	FF	L
BI	0.4660	0.1561	0.1264	0.4911	0.6270	0.4726	0.9818
CD	0.3145	0.0060	**0.0109**	0.5768	0.3394	0.3639	0.8285
CT	0.3729	0.1472	0.0574	0.6945	0.2281	0.4849	0.6532
E	0.4984	0.3105	0.4869	0.1646	0.5933	0.6067	0.9878
EX	0.5915	0.7811	0.7781	0.6978	0.5088	0.2445	0.9768
FF	0.3801	0.7230	0.2970	0.4805	0.8577	0.6401	0.9814
L	0.9441	0.2673	0.3100	0.8940	0.4535	0.4541	0.3241
M	0.6466	0.3443	0.3653	0.4670	0.8070	0.3229	0.6729
NI	0.8132	0.9762	0.8404	0.3357	0.7245	0.7543	0.7815
P	0.6027	0.9068	0.8960	**0.0560**	0.8071	0.3468	0.6953
PE	0.3450	0.6100	0.2190	**0.0506**	0.9503	0.5502	0.9545
RI	0.2243	**0.0082**	0.3570	0.6055	0.8637	0.7249	0.7138
U	0.7692	0.3779	0.1713	0.1113	0.1631	**0.0691**	0.3739
Y	0.2558	0.7687	0.7530	0.9945	0.8972	0.5239	0.6346

	M	NI	P	PE	RI	U	Y
BI	0.3664	0.2762	**0.0196**	0.4925	0.4344	0.2301	0.8485
CD	0.7897	**0.0479**	0.9456	**0.0665**	0.4600	0.2878	0.2392
CT	0.4260	0.1450	0.7640	0.6225	0.4374	0.6027	0.2138
E	0.3444	0.2196	0.9424	0.3587	0.8944	0.3869	0.6592
EX	0.4209	0.8399	0.1490	0.2005	0.6563	0.2332	0.6386
FF	0.1450	0.1042	0.4646	**0.0934**	**0.0365**	0.8791	0.7936
L	0.9841	0.8138	0.6014	0.6800	0.3528	0.6469	0.8934
M	0.0011	0.1230	**0.0136**	0.5181	0.6865	0.5554	0.6005
NI	0.5662	0.1528	0.2947	0.3360	0.4236	0.7645	0.7935
P	0.6375	0.8322	0.0018	0.9623	0.8835	0.5594	0.3704
PE	0.4992	0.3604	0.4501	0.1551	0.9047	0.7127	0.7435
RI	0.3870	**0.0523**	0.1980	0.2195	0.1614	0.5784	0.2253
U	0.1074	0.2451	0.2546	0.5917	0.7638	0.2451	0.5286
Y	0.9514	0.7403	0.1864	0.9585	0.3259	0.5395	0.2828

Note: This series of F-tests examines whether each row variable makes a significant contribution to the explanation of each column variable. The results may be interpreted as Granger-causality tests, generated by separately testing the joint restriction that the lagged coefficients on each variable are equal to zero. The results shown are the p-values associated with the relevant F-test. Thus, low p-values indicate that the row variable Granger-causes the column variable. Variables that are Granger-causal at the 5% significance level are in bold and shaded in the above diagram. Those that are significant at the 10% level are noted in bold. Also, note that several of the diagonal elements are significant but are not meaningful in this analysis.

(p=0.1042). Unemployment is the only variable that Granger-causes the fed funds rate at the ten percent level of significance (p=0.0691), indicating that the Fed responds primarily to lagged unemployment data when adjusting the fed funds rate. Finally, the strong causality from money to prices (p=0.0136) is consistent with the quantity theory.

It is important to reemphasize that care should be exercised in drawing conclusions from Granger-causality test results, particularly in the case where expected causal relationships are not found to be statistically significant. As noted in the previous chapter, Bernanke and Blinder (1990, p. 11) argue that including two (or more) variables which are causally-related in a VAR with another variable which is, in turn, caused by the interaction between these variables, can distort measurement of the causal relationships.

Summary

This chapter presented the results of the estimated VAR model. The initial assumptions made in the VAR estimation were reviewed. The estimated VAR equations, impulse response functions and variance decompositions, and the results of the multivariate Granger-causality tests, were presented. A general overview of the implications of these findings was also presented. The next chapter will discuss policy responses to economic shocks and provide a more thorough assessment of the influences of fed funds rate adjustments on the target policy variables and the implications of these results for alternative policy transmission channels.

CHAPTER V

INTERPRETATION OF RESULTS

This chapter examines the relationships between the model variables. The first section reviews the stated objectives of monetary policy and examines the Federal Reserve's policy responses to economic shocks. The second section examines the effects of fed funds rate adjustments on the target policy variables: output, unemployment, and inflation, and the alternative transmission channels through which these effects are carried. This requires presentation of the results within the context of the alternative transmission channels and subsequent analysis of the critical variable interrelationships. The final section reviews the sensitivity of these results to alternative specifications.

The Federal Reserve's Reaction Function

The Employment Act of 1946 and the Full Employment and Balanced Growth Act of 1978 commit the Federal Reserve to policies consistent with promoting high employment and stable prices. Because of an assumed tradeoff between unemployment and inflation, policy-makers attempt to foster a rate of economic growth that simultaneously achieves these objectives. This study assumes that these policy objectives are achieved by adjusting the federal funds rate. This section begins, therefore, by examining the Fed's response to economic shocks.

The variance decomposition and Granger-causality test results, in conjunction with the impulse responses summarized in Figure 3, provide valuable insight into the Federal Reserve's reactions to economic shocks. According to the variance

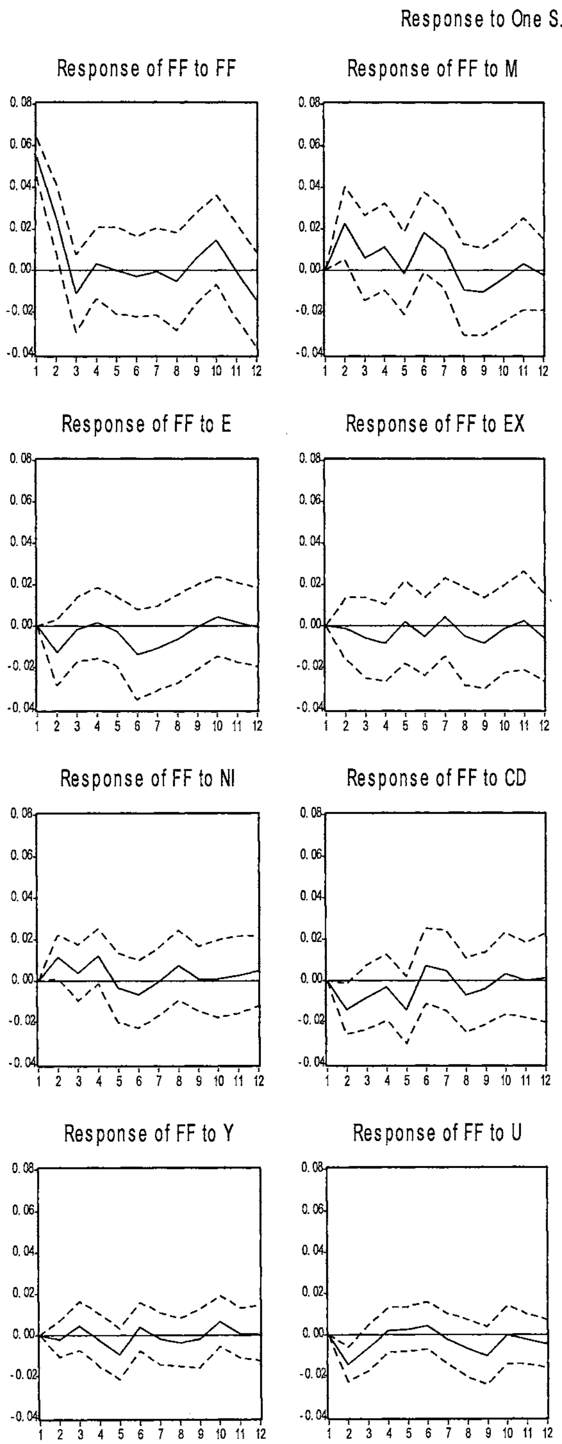

Figure 3. Fed Funds Impulse Responses
(Federal Reserve Reaction Function)

decomposition of fed funds (row FF in Table 4), 35 percent of its average FEV is explained by its own shocks. This is largely due to placing fed funds first in the causal ordering specification used to generate the FEV decompositions and impulse responses. This specification makes the fed funds rate exogenous within the quarter. Consumption (10%), residential investment (8%), and the exchange rate (8%) also explain relatively high percentages of the FEV in the fed funds rate. Among the three target policy variables, unemployment and price level (both at 5%) explain more of the variation in the fed funds rate than output (2%). According to the Granger-causality test results, the fed funds rate is Granger-caused only by unemployment, at the 10% level of significance (p=0.0691).

The associated impulse response functions provide further evidence of the Fed's policy responses and indicate the timing of these responses. The initial response to an unemployment shock is a (statistically significant) reduction in the fed funds rate. This policy easing reaches its maximum cumulative effect in the second quarter following the shock and dissipates by the fourth quarter. Unexpected increases in output growth do not generate a statistically significant policy response. Interestingly, the initial policy response to an inflation shock is a (statistically significant) reduction in the fed funds rate. Policy does eventually tighten, but not until nearly three quarters after the initial shock. The delayed response may indicate a recognition lag or the lack of a clear anti-inflationary policy commitment during the sample period. Once the tightening begins it is not statistically significant and lasts for only two to three quarters. The Fed appears to respond to unexpected increases in consumption, money growth, and to a lesser extent non-residential investment, with considerably tighter policy. They also appear to react to unexpected increases in the business inventories/sales ratio with an easing of policy. None of the other responses is statistically significant.

Overall, the responses are consistent with the Fed's objective of promoting high employment. The relative concern attached to unemployment is consistent across all three analytical tools used. The Fed also appears, to a lesser extent, to be committed to price stability, although the response to inflation shocks is comparatively slow. There is little evidence of a strong commitment to economic growth. The Fed does seem to be relatively responsive to consumption, investment, and money shocks, although none of these variables Granger-cause fed funds. Since the Fed does appear to respond to changing economic conditions by adjusting the fed funds rate, it is important to examine the extent to which these responses influence their target policy variables, and the channels by which these effects are carried.

The Economic Effects of Fed Funds Adjustments

The alternative explanations for the effects of fed funds rate adjustments on the monetary policy target variables were summarized in chapter two as monetary policy transmission mechanisms. A distinction was made between the money and credit channels of policy transmission. The money channels include the interest rate channel, the exchange rate channel, Tobin's q-theory effects on investment, and Modigliani's wealth effects on consumption. Each of the money channels emphasizes the direct and indirect effects of policy adjustments on the target economic variables, assuming smoothly functioning credit markets. The credit channel emphasizes the effects of information asymmetries and credit policies on policy transmission.

Evidence regarding the relative importance of the alternative transmission channels and components of these channels relied on interpretation of the impulse response functions, variance decompositions, and Granger-causality tests. These channels and their respective individual components were each examined individually. The impulse responses to an innovation in the fed funds rate were grouped to reflect the key components of each transmission channel. These responses and the relevant variance decompositions were then examined individually and in relationship with one another, to help establish the significance of each channel. Finally, the results were compared to the findings of the Granger-causality tests and overall conclusions were drawn as to the channels through which fed funds policy adjustments influence the target variables.

The Money View

The first transmission channels examined were the money channels. These included the interest rate channel, the exchange rate channel, Tobin's q-theory effects on investment, and Modigliani's wealth effects on consumption. Each of these channels emphasizes the direct and indirect effects of policy adjustments on the target economic variables, assuming smoothly functioning credit markets.

The Interest Rate Channel

According to the model used in this study, the interest rate channel can be represented as follows:

$$\uparrow FF \Rightarrow \begin{matrix} \downarrow M \\ \\ \uparrow i \end{matrix} \Rightarrow \downarrow NI, \downarrow RI, \downarrow BI, \downarrow CD \Rightarrow \begin{matrix} \downarrow Y \\ \downarrow \pi \\ \uparrow U \end{matrix}$$

where:

M	=	The money supply
FF	=	The fed funds rate
i	=	Market-determined interest rates
NI	=	Gross private domestic fixed investment: non-residential
RI	=	Gross private domestic fixed investment: residential
BI	=	Inventories
CD	=	Personal consumption expenditures: durable goods
Y	=	Real gross domestic product
π	=	Inflation (gross domestic product implicit price deflator growth rate)
U	=	The unemployment rate

The interest rate channel indicates that a tightening of fed funds policy decreases non-residential, residential, business inventory, and consumer durables investment; and accordingly, output and prices should decline and unemployment should rise.

The impulse responses of the key components of the interest rate channel, presented in Figure 4, show that residential and consumer durables investment growth declines in the quarters following a tightening of the fed funds rate. This is consistent with the interest rate channel. Non-residential investment growth and business inventories/sales growth, however, remain (unexpectedly) above their initial levels for several quarters. As mentioned earlier, the response of business inventories/sales is difficult to interpret because of the difficulty in isolating the inventory investment and sales responses. Subsequently, the initial negative response may be due to an increase in both variables, where the increase in sales exceeds the increase in inventory investment. Likewise, the subsequent increase in BI may represent declines in both variables, declining sales exceeding declining inventory investment.

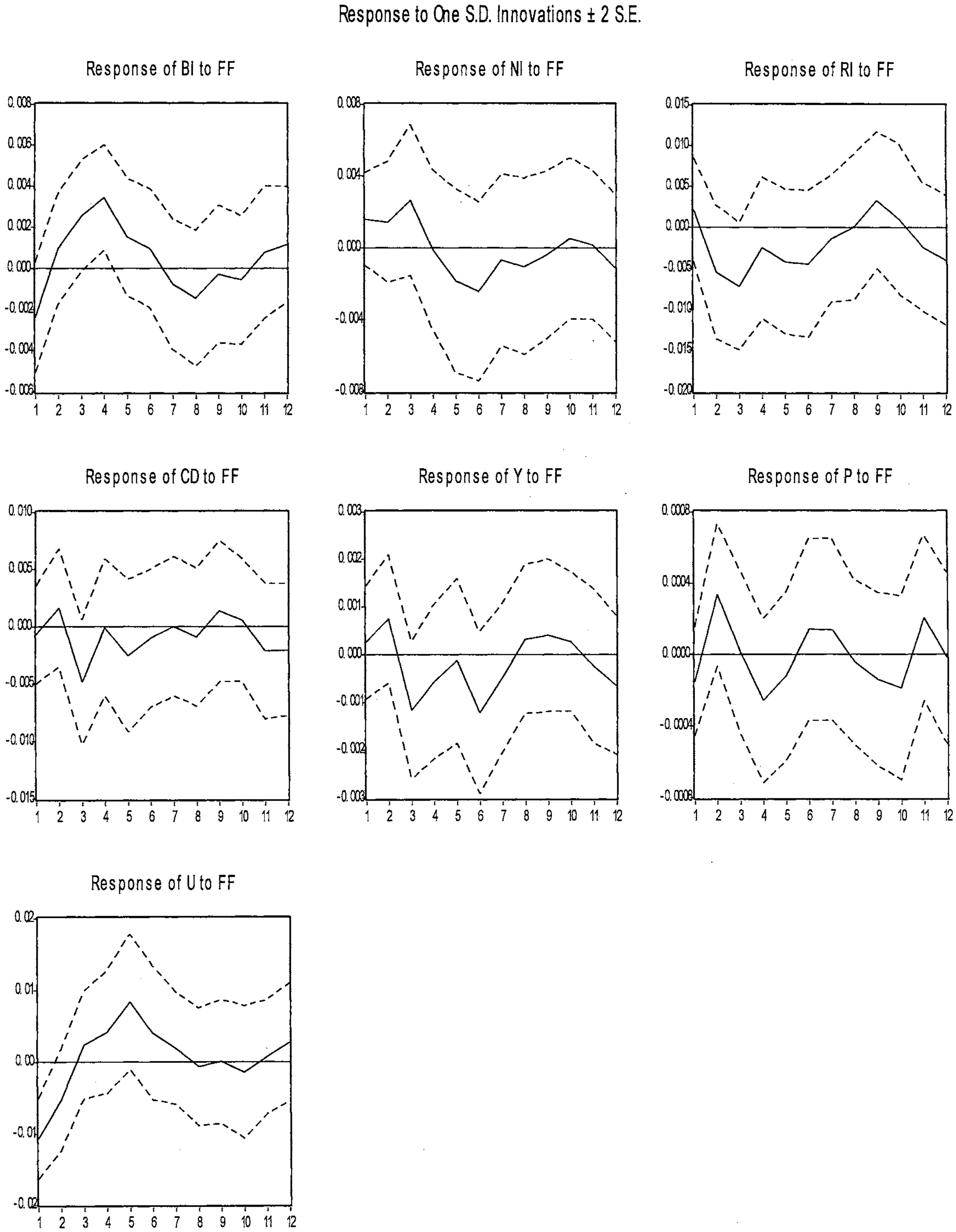

Figure 4. Responses of Key Interest Rate Channel Components to Fed Funds Innovations

This may explain, in part, the slow responses of output, unemployment, and inflation to tighter policy. By the fifth quarter, non-residential investment growth begins to decline and appears to contribute to slower output and employment growth. Overall, the responses of output and unemployment appear to be the most sensitive to the consumer investment variables (durables and residential investment). The return of both output growth and unemployment to their initial levels parallels closely the stabilization of both consumer investment variables, nearly eight quarters after the policy action. It is important to note that few of these observations are statistically significant according to the calculated error bands. It is helpful, therefore, to compare this evidence to that provided by the variance decompositions and Granger-causality tests.

A closer examination of the link between the fed funds rate and the four investment components of the interest rate channel indicates a relatively strong relationship between the fed funds rate and residential investment. The fed funds rate Granger-causes residential investment at the five percent level of significance (Table 5). None of the other investment variables is Granger-caused by the fed funds rate, at the ten percent level of significance. Fed funds innovations explain an average of eleven percent of the FEV in residential investment, nine percent of the FEV in business inventory investment, six percent of the FEV in consumer durables investment, and eight percent of the FEV in non-residential investment (Table 4).

The strength of the relationships between the investment variables and the target policy variables is more difficult to measure. This is because causal relationships are difficult to estimate precisely in large macroeconomic models such as the one used in this study. This is particularly true in the case of aggregate variables. Neither output nor unemployment is Granger-caused by any of the investment variables. Residential investment does explain an average of fifteen percent of the FEV in unemployment, while non-residential, consumer durable, and business inventory investment explain four, two, and six percent respectively. Similarly, residential investment explains an average of ten percent of output's FEV, while none of the other investment variables explain more than six percent. None of the investment variables, including residential investment, are important in explaining the FEV of prices, which appear to be much more closely related to money shocks.

A final series of Granger-causality tests (results not shown) indicates that the key components of the interest rate channel (FF, NI, RI, BI, and CD) together do not jointly Granger-cause any of the three target policy variables at the 10% level of significance. [1] Taken together, these results show only moderate support for the interest rate channel. Residential investment appears to be most responsive to fed funds rate adjustments and also explains a relatively large proportion of the variations in unemployment and output. The ratio of business inventories to sales Granger-causes prices, but explains a relatively small proportion of their variability and appears to be only slightly responsive to the fed funds rate. There is little evidence to support a strong relationship between the fed funds rate and either consumer durables or non-residential investment. Likewise, there is little evidence to support a strong relationship between these variables and the target policy variables.

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[1] When the money supply variable was included none of the tests for joint significance indicated significance at the 10% level. In both cases the interest rate channel was most significant in the explanation of prices, followed by unemployment and output.

The Exchange Rate Channel

According to the model used in this study, the exchange rate channel can be represented as follows:

$$\uparrow FF \Rightarrow \begin{matrix}\downarrow M \\ \\ \uparrow i\end{matrix} \Rightarrow \uparrow E \Rightarrow \downarrow EX \Rightarrow \begin{matrix}\downarrow Y \\ \downarrow \pi \\ \uparrow U\end{matrix}$$

where:

M	=	The money supply
FF	=	The fed funds rate
i	=	Market-determined interest rates
E	=	Exchange value of the U.S. dollar
EX	=	Exports
Y	=	Real gross domestic product
π	=	Inflation (gross domestic product implicit price deflator growth rate)
U	=	The unemployment rate

The exchange rate channel indicates that a tightening of fed funds policy increases the exchange value of the dollar and, accordingly, decreases exports, output and prices, and increases unemployment.

The impulse responses of the key components of the exchange rate channel are presented in Figure 5. The growth in the exchange value of the dollar in the quarters following a tightening of the fed funds rate is consistent with the exchange rate channel. The corresponding positive response of exports is contradictory, however. Export growth does eventually decline relative to its initial rate, but not until the sixth quarter.[2] Further,

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[2] Although this is inconsistent with the form of the exchange rate channel outlined here, the perverse response of exports in the short run is consistent with the J-Curve effect. For example, Meade (1988) and Krugman (1989) find that in the short-run, the combined effects of currency appreciation and sluggish price adjustments cause net exports to increase. In the long run, this trend reverses as domestic and foreign prices adjust.

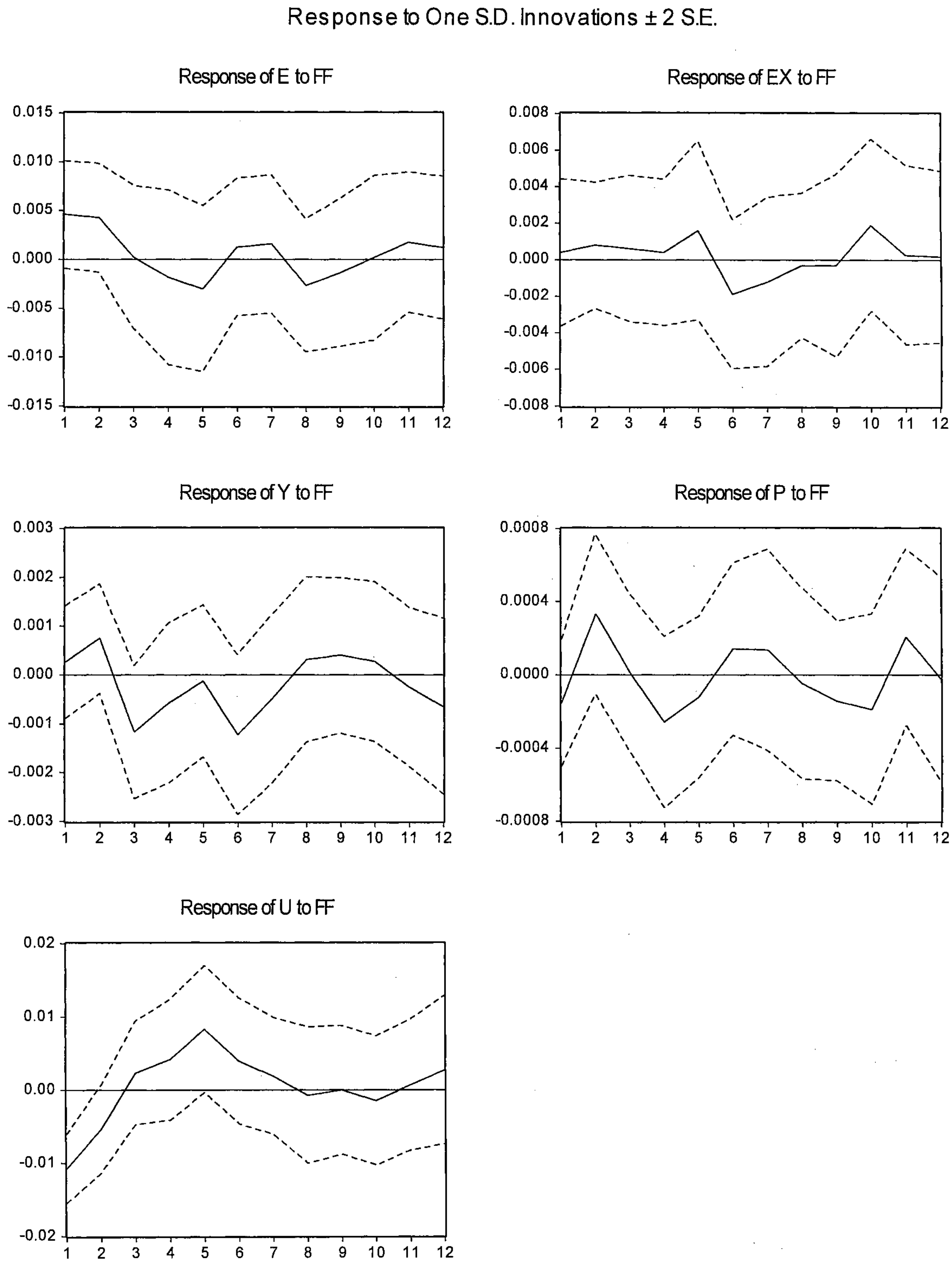

Figure 5. Responses of Key Exchange Rate Channel Components to Fed Funds Innovations

there seems to be no clear correlation between the movements in exports and those of the target policy variables. Specifically, lower inflation, rising unemployment, and slower output growth accompany the increase in export growth between the fourth and fifth quarters; and the subsequent decline in export growth coincides only with the output response.

Clearly, the impulse response evidence does not support a strong relationship among the exchange rate channel components. This does not mean that the exchange rate fails to influence exports, only that there is insufficient evidence that fed funds adjustments play an important causal role in this relationship. In fact, the response of exports to innovations in the exchange rate is negative through most of the first nine quarters and statistically significant in the third quarter (see Figure 17 in Appendix C).

There is also evidence that exports play a role in the determination of output, unemployment, and to a smaller extent prices. The initial responses of unemployment and output to an export innovation are negative and positive, respectively, and both are statistically significant (Figures 24 and 25). The inflation response is also (as predicted) positive over most of the first few quarters and statistically significant. Exports are also relatively important to the explanation of FEV in output and prices, but less important in explaining the FEV of unemployment (Table 4). None of the target policy variables is Granger-caused by exports, however.

A final series of Granger-causality tests (not shown) indicates that the key components of the exchange rate channel (FF, E, and EX) do not jointly Granger-cause any of the three target policy variables.[3] Together, these results do not support the exchange rate channel of monetary policy. Despite the fact that exports appear to be important in the determination of output and (to a lesser extent prices) prices and modest evidence of a relationship between the fed funds rate and exchange rate, the evidence of a relationship between the exchange rate and exports is relatively weak.

Tobin's q-Theory Effects on Investment

According to the model used in this study, Tobin's q-theory investment effect can be represented as follows:

$$\uparrow FF \Rightarrow \begin{matrix} \downarrow M \\ \\ \uparrow i \end{matrix} \Rightarrow \downarrow PE \Rightarrow \downarrow q \Rightarrow \downarrow NI \Rightarrow \begin{matrix} \downarrow Y \\ \downarrow \pi \\ \uparrow U \end{matrix}$$

where:

M	=	The money supply
FF	=	The fed funds rate
i	=	Market-determined interest rates
PE	=	Equity prices
q	=	Tobin's q (ratio of firm market value to replacement cost of capital)
NI	=	Gross private domestic fixed investment: non-residential
Y	=	Real gross domestic product
π	=	Inflation (gross domestic product implicit price deflator)
U	=	The unemployment rate

This channel indicates that a tightening of fed funds policy decreases the relative demand for equities and thus equity prices and q; accordingly, output and prices decline and unemployment rises.

[3] When the money supply variable was included, none of the tests for joint significance indicated significance at the 10% level of significance. In both cases the exchange rate channel was most significant in the explanation of prices, followed by unemployment and output.

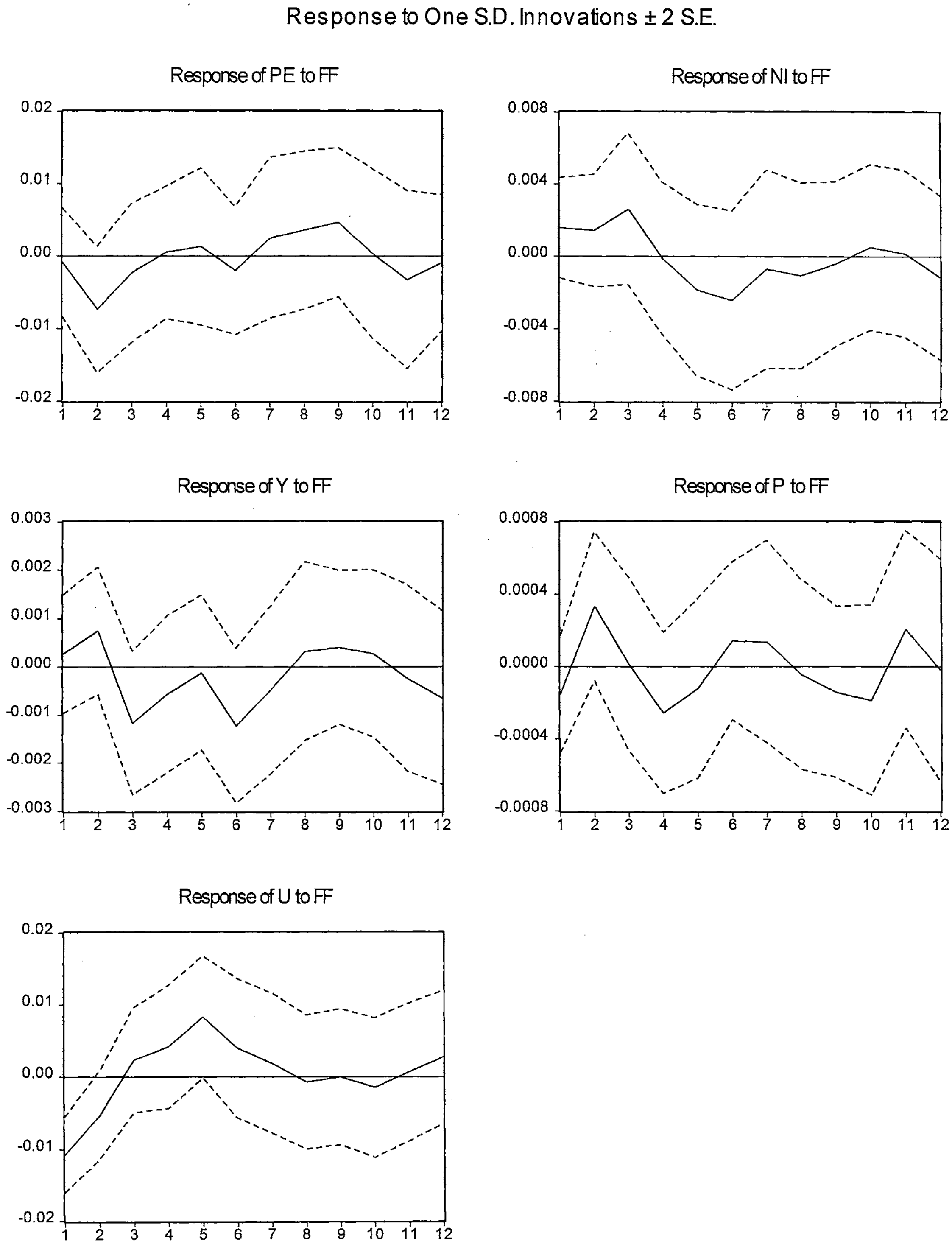

Figure 6. Responses of Key q-Theory Channel Components
to Fed Funds Innovation

The impulse responses of the key components of this channel are presented in Figure 6. The decline in equity prices in the first three quarters following a tightening of the fed funds rate is consistent with Tobin's q-theory of investment, and is statistically significant in the second quarter. This relationship is further supported by the fact that the fed funds rate Granger-causes equity prices at the ten percent level of significance (Table 5). The fed funds rate does not explain much of the FEV in equity prices (Table 4). There does appear to be sufficient evidence, however, to establish an important link between the fed funds rate and equity prices.

The decline in equity prices does not coincide with a reduction in non-residential investment, output, inflation, and employment, as the q-theory transmission channel predicts. Unless there are considerable lags between equity devaluation and investment response by firms, it is difficult to find much evidence that this channel exerts significant influence on either non-residential investment or the Fed's target policy variables. The response of non-residential investment to equity price innovations (Figure 20) is in the expected direction and is statistically significant. It is entirely possible, then, that equity prices may decline substantially within two quarters following a policy tightening, with non-residential investment responding with a two to three quarter lag. This would explain the slow response of non-residential investment. Equity prices, however, do not explain a large proportion of the FEV in non-residential investment (Table 4), and are not Granger-causal. The evidence, therefore, does not support a significant causal relationship between equity prices and non-residential investment.

The final link in the q-theory channel connects non-residential investment to the three target policy variables. While the near-term impulse responses of unemployment and output to non-residential investment innovations are both in the expected direction, only the output response is statistically significant (see Figures 24 and 25), and the response of inflation is significant but not in the expected direction (see Figure 21). Further, the Granger-causality tests and variance decompositions provide no supporting evidence. Granger-causality tests (results not shown) also indicate that the key components of the q-theory investment channel (FF, PE, and NI) do not jointly Granger-cause any of the three target policy variables.[4] Together, these results support the influence of fed funds on equity prices, but not the influence of equity prices on non-residential investment and subsequently on output and unemployment. There is little overall support, therefore, for the q-theory investment channel.

Wealth Effects on Consumption

According to the model used in this study, the wealth effects on consumption channel can be represented as follows:

$$\uparrow FF \Rightarrow \begin{matrix} \downarrow M \\ \\ \uparrow i \end{matrix} \Rightarrow \downarrow PE \Rightarrow \downarrow W \Rightarrow \downarrow CT \Rightarrow \begin{matrix} \downarrow Y \\ \downarrow \pi \\ \uparrow U \end{matrix}$$

where:

M	=	The money supply
FF	=	The fed funds rate
i	=	Market-determined interest rates
PE	=	Equity prices
W	=	Wealth
CT	=	Personal consumption expenditures: total

[4] When the money supply variable was included none of the tests for joint significance indicated significance at the 10% level. In both cases the q-theory channel was most significant in the explanation of prices, followed by unemployment and output.

Y = Real gross domestic product
π = Inflation (gross domestic product implicit price deflator growth rate)
U = The unemployment rate

The impulse responses of the key components of this channel are presented in Figure 7. The decline in equity prices in the first three quarters following a tightening of the fed funds rate is consistent with the wealth-effect-consumption channel theory, and is statistically significant in the second quarter. This relationship is further supported by Granger-causality evidence, but not by variance decomposition evidence. There does appear to be sufficient evidence, however, to establish an important link between the fed funds rate and equity prices. As predicted, the initial decline in equity prices is mirrored by consumption. Consumption expenditures rebound more slowly than equity prices, however. The strength of this relationship is further supported by the response of consumption to equity price innovations (Figure 15), which reflects a statistically significant initial response in the expected direction. This response dissipates by the third quarter, however, which indicates that the persistent below-trend growth in consumption (following tighter policy) is partly driven by other factors. Granger-causality and variance decomposition results do not lend support to a strong causal relationship between equity prices and consumption, however. Overall, there is sufficient evidence that the fed funds rate influences equity prices and moderate support for a causal relationship between equity prices and consumption.

There is also significant evidence that consumption is an important determinant of output and unemployment, although inflation does not seem to be very responsive. The impulse responses of unemployment and output, to innovations in consumption, are strongly significant over the first three quarters and in the direction expected (Figures 24

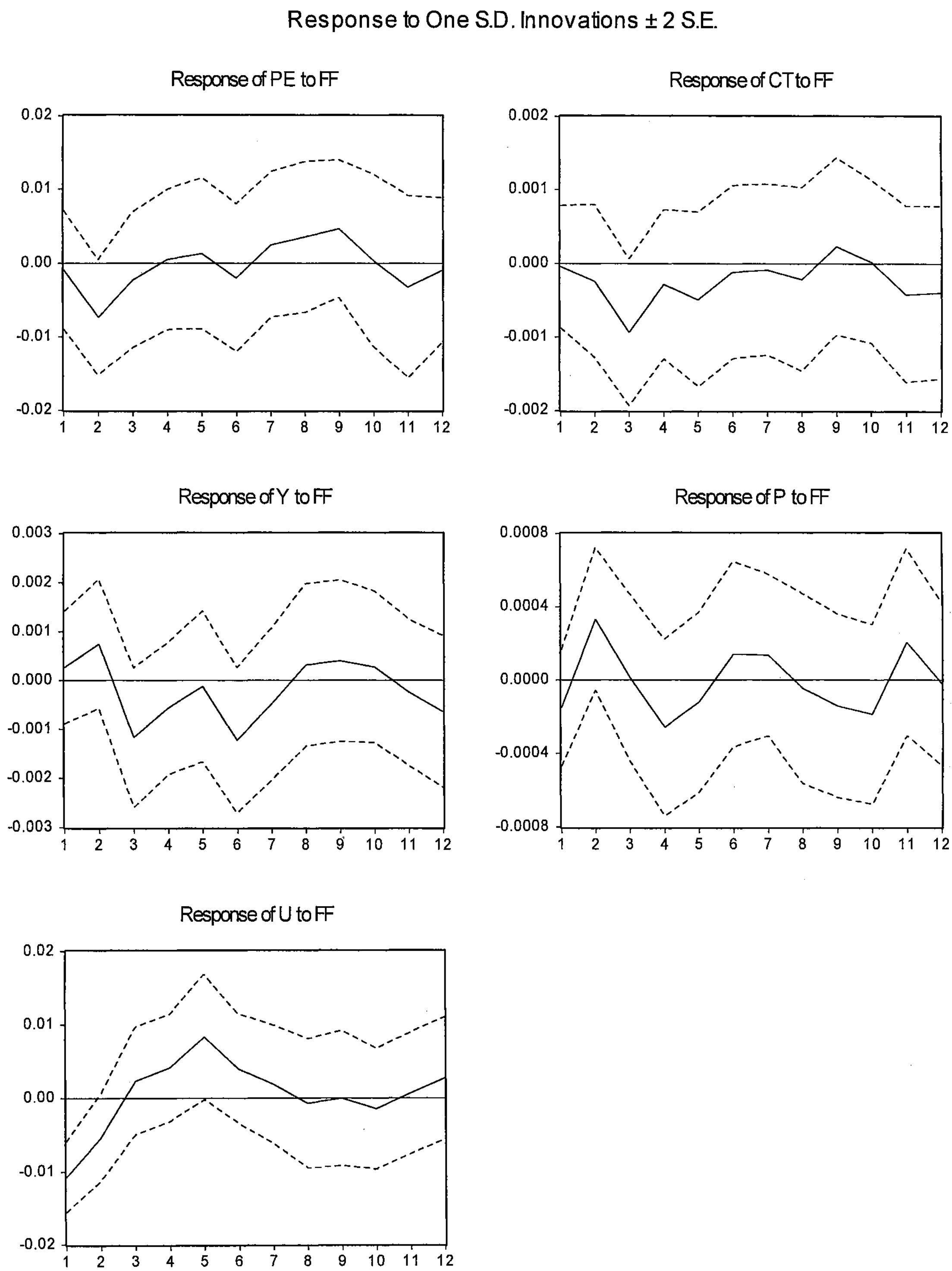

Figure 7. Responses of Key Wealth Effect Channel Components
to Fed Funds Innovations

and 25). These observations are supported by the strong explanatory power of consumption in the variance decompositions of unemployment and output (Table 4). The initial response of inflation to a consumption innovation (Figure 21) is in the expected direction, but is not statistically significant. Further, consumption innovations are relatively important in explaining the FEV of prices. Consumption does not Granger-cause any of the target policy variables.

A final series of Granger-causality tests (results not shown) indicates that the key components of the wealth-effect-consumption channel (FF, PE, and CT) do not jointly Granger-cause any of the three target policy variables.[5] Overall, however, these results provide relatively strong support for the wealth-effect-consumption channel of monetary policy, particularly in its effects on output and unemployment.

<u>The Credit View</u>

The credit channel, as noted above, emphasizes the effects of information asymmetries and credit policies on monetary policy transmission. According to the model used in this study, the credit channel is represented schematically as:

$$\uparrow FF \Rightarrow \begin{matrix}\downarrow M \\ \\ \uparrow i\end{matrix} \Rightarrow \begin{matrix}\downarrow PE \\ \downarrow CF_{cp} \\ \downarrow CF_{cn}\end{matrix} \Rightarrow \downarrow L \Rightarrow \begin{matrix}\downarrow BI \\ \downarrow CD \\ \downarrow NI \\ \downarrow RI\end{matrix} \Rightarrow \begin{matrix}\downarrow Y \\ \downarrow \pi \\ \uparrow U\end{matrix}$$

where:

M	=	The money supply
FF	=	The fed funds rate
i	=	Market-determined interest rates

[5] When the money supply variable was included, none of the tests for joint significance indicated significance at the 10% level. In both cases, the wealth-effect channel was most significant in the explanation of prices, followed by output and unemployment.

PE	=	Equity prices
CF_{cp}	=	Corporate cash flow
CF_{cn}	=	Consumer cash flow
L	=	Bank lending (loans)
BI	=	Business inventories
NI	=	Gross private domestic fixed investment: non-residential
RI	=	Gross private domestic fixed investment: residential
CD	=	Personal consumption expenditures: durable goods
Y	=	Real gross domestic product
π	=	Inflation (gross domestic product implicit price deflator growth rate)
U	=	The unemployment rate

The credit channel indicates that a tightening of fed funds policy should decrease the relative demand for equities (and thus equity prices) and decrease both consumer and corporate cash flows, as balance sheets deteriorate. These combined effects should lead to a decline in bank lending; and to the extent that individual consumers and firms are dependent on bank financing, this should cause declines in the investment variables. In turn, output growth and inflation should subside and unemployment should rise.

The impulse responses of the key components of this channel are presented in Figure 8. As already discussed, there is sufficient evidence to establish a short-term inverse relationship between the fed funds rate and equity prices. Together with the cash flow effects assumed under credit channel theory, this should lead to a decline in bank lending as consumer and commercial balance sheets deteriorate in quality. However, loan growth actually increases following a tightening of the fed funds rate, which is inconsistent with this theory. As noted in chapter 2, it is likely that banks respond to policy tightening, in part, by initially adjusting their securities portfolio rather than their loan portfolio. To the extent this occurs, it is not unreasonable to expect a delayed response of bank lending. Lending does decline relative to its initial level by the third quarter and continues to decline through the sixth quarter. The initial response of lending

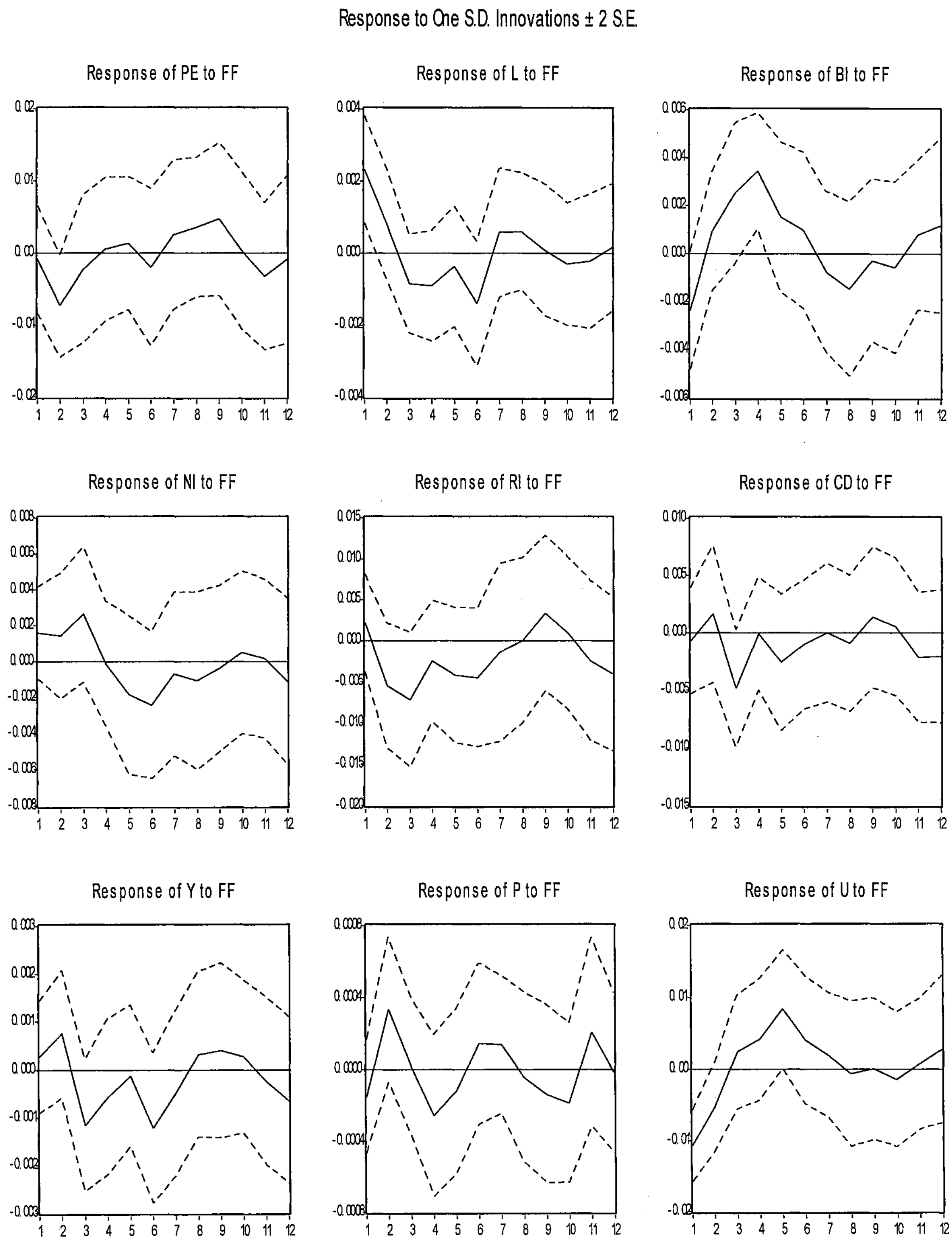

Figure 8. Responses of Key Credit Channel Components to Fed Funds Innovations

to an equity price innovation is in the expected direction and statistically significant, though very short-lived (Figure 18). There is no evidence of a Granger-causal relationship between the two variables (Table 5), but strong evidence of the explanatory power of equity prices in the FEV of lending (Table 4). Therefore, although equity prices appear responsive to policy adjustments, evidence of the subsequent effects on bank lending is inconclusive.

Assuming for a moment that bank lending is responsive to policy adjustments, albeit with a lag, it is important to examine whether lending is a significant influence in the determination of consumer and commercial investment. The timing of the consumer durable, residential, and non-residential investment responses (to policy tightening) provide circumstantial evidence of a link between lending and investment. The initial increase in lending may help explain the initial response of non-residential investment, in particular. The decline in lending (relative to trend) in the third quarter, corresponds with sharp declines in consumer investment (consumer durables and residential). The return of lending to trend, during the sixth quarter, coincides with trend reversals in residential and non-residential investment.[6] The variance decomposition evidence supports a slightly stronger link between lending and residential investment, with lending explaining eight percent of FEV in residential investment, compared to less than five percent for each of the other investment variables (Table 4). Examination of the responses of each investment variable to an innovation in bank lending (Figures 13, 14, 20, and 23 in Appendix C) reveals responses in the expected direction. However, only the non-

[6] This discussion has abstracted from the responses of business inventories/sales because of the difficulty in interpreting these responses, as discussed earlier. Nonetheless, given the assumption that sales and inventories are positively correlated and sales are relatively more responsive to policy adjustments, the long-term response of BI seems reasonable.

residential and residential investment responses are statistically significant, and they remain significant over one and three quarters, respectively. None of the investment variables is Granger-caused by bank lending. In conclusion, there does appear to be some evidence of a link between bank lending activities and investment. The evidence provides strongest support for the influence of lending on residential and non-residential investment, respectively.

The links between the investment variables and the target policy variables were explored in conjunction with the interest rate transmission channel. It was noted that residential investment explains a relatively large proportion of the variations in unemployment and output, but not prices, which are largely driven by money growth. There is little evidence, however, that consumer durables, business inventories, or non-residential investment influence the target policy variables.

A final series of Granger-causality tests (results not shown) indicates that the key components of the credit channel (FF, PE, L, BI, NI, RI, and CD) do not jointly Granger-cause output, unemployment, or prices.[7] Together these results provide little overall support for the credit channel of monetary policy. While there is evidence that policy tightening does cause a deterioration of credit quality (as equity prices erode net worth), the evidence that this causes a decline in bank lending is mixed. In fact, though lending does decline relative to trend by the third quarter, it initially increases. This could reflect a preference by banks to respond initially to policy tightening by adjusting their securities portfolio, and only later by slowing lending. To the extent that borrowers rely on banks rather than credit markets for financing, this may frustrate policy attempts to slow economic activity. The evidence supports a relatively strong causal link from lending to residential investment, and from residential investment to output and unemployment. There is evidence supporting the link between lending and non-residential investment, but it is not convincing. The evidence does not support a strong causal link from lending to the other investment variables and, subsequently, the target policy variables.

Sensitivity Tests

Because VAR estimation results may be sensitive to alternative specifications, the robustness of the results presented in this chapter needs to be examined. Todd argues that tests of robustness "involve proposing a seemingly innocent modification [to the model] and showing that the modified model gives results that are sufficiently different from those [of the study] to call into question the validity of [the] results." (1990, p. 24) In other words, tests for robustness should not deviate markedly from the economic and statistical construct of the original model. He indicates that, in the context of VAR-based studies, examining robustness to lag length specification, causal ordering, or variable selection, is appropriate. The following section explores the sensitivity of the results to alternative specifications of this type.

Sensitivity to the Specification of Lag Length

The sensitivity of the results in this chapter to the specification of four-quarter lags is examined by re-estimating the model with three and five-quarter lags. The

[7] When the money supply variable was included none of the tests for joint significance indicated significance at the 10% level. In both cases, the credit channel was most significant in the explanation of prices, followed by unemployment and output.

resulting impulse responses are shown in Figures 9 and 10, and the respective average FEV decompositions are shown in Table 6. Table 7 presents the standard deviations for the average FEV decompositions across the alternative lag specifications.

A comparison of the impulse responses resulting from both shorter and longer lag length specifications with those examined earlier (Figure 2), reveals generally consistent results. Neither the direction nor timing of the responses to fed funds innovations appears to be especially sensitive to the lag length specification. Similarly, the FEV decompositions appear to be relatively insensitive to lag length specification. The average deviation in the FEV decompositions is 2.7 percent (Table 7). The FEV decompositions of each variable explained by its own innovations are most sensitive to lag length, as can be seen by examining the diagonal elements of Table 7. The explanatory power of equity prices (PE), consumption (CT), and money (M) are most sensitive to lag length specification.[8] Based on these observations, the results presented earlier in the chapter are robust across the alternative lag lengths examined.

Sensitivity to the Causal Ordering of the Variables

The ordering used to generate the impulse responses and variance decompositions in this study is: FF, M, PE, CT, E, EX, L, RI, NI, CD, BI, P, Y, and U. This assumes that the fed funds rate responds to innovations in the other variables with a lag, but does not respond to contemporaneous movements in the other variables within the quarter. Because impulse responses and variance decompositions are usually sensitive to the ordering of the variables, the sensitivity of the results to ordering is examined.

[8] This is reflected in the above average deviations shown in the respective columns of Table 7.

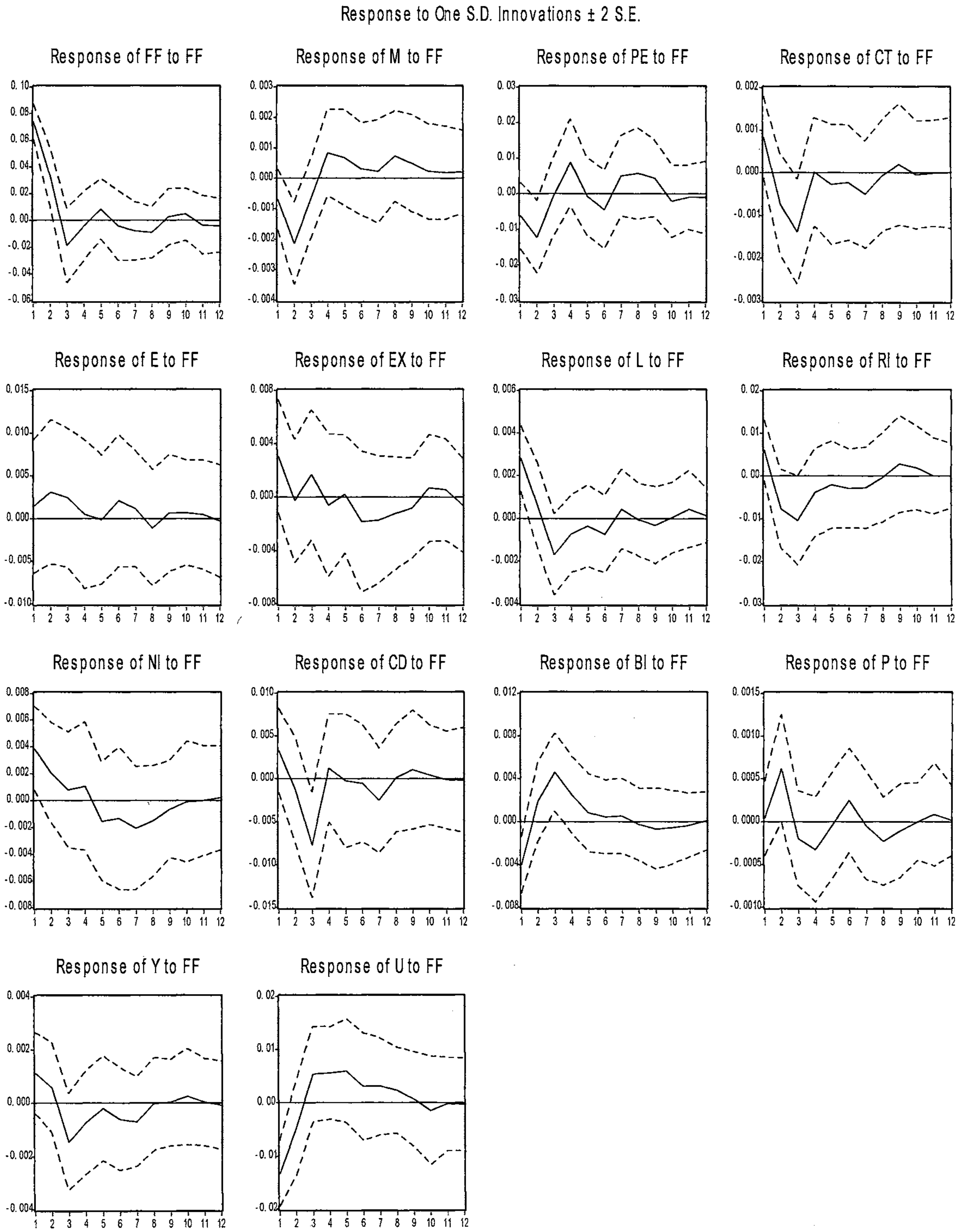

Figure 9. Responses of Model Variables to Fed Funds Innovations
Under an Alternative Lag Specification of Three Quarters

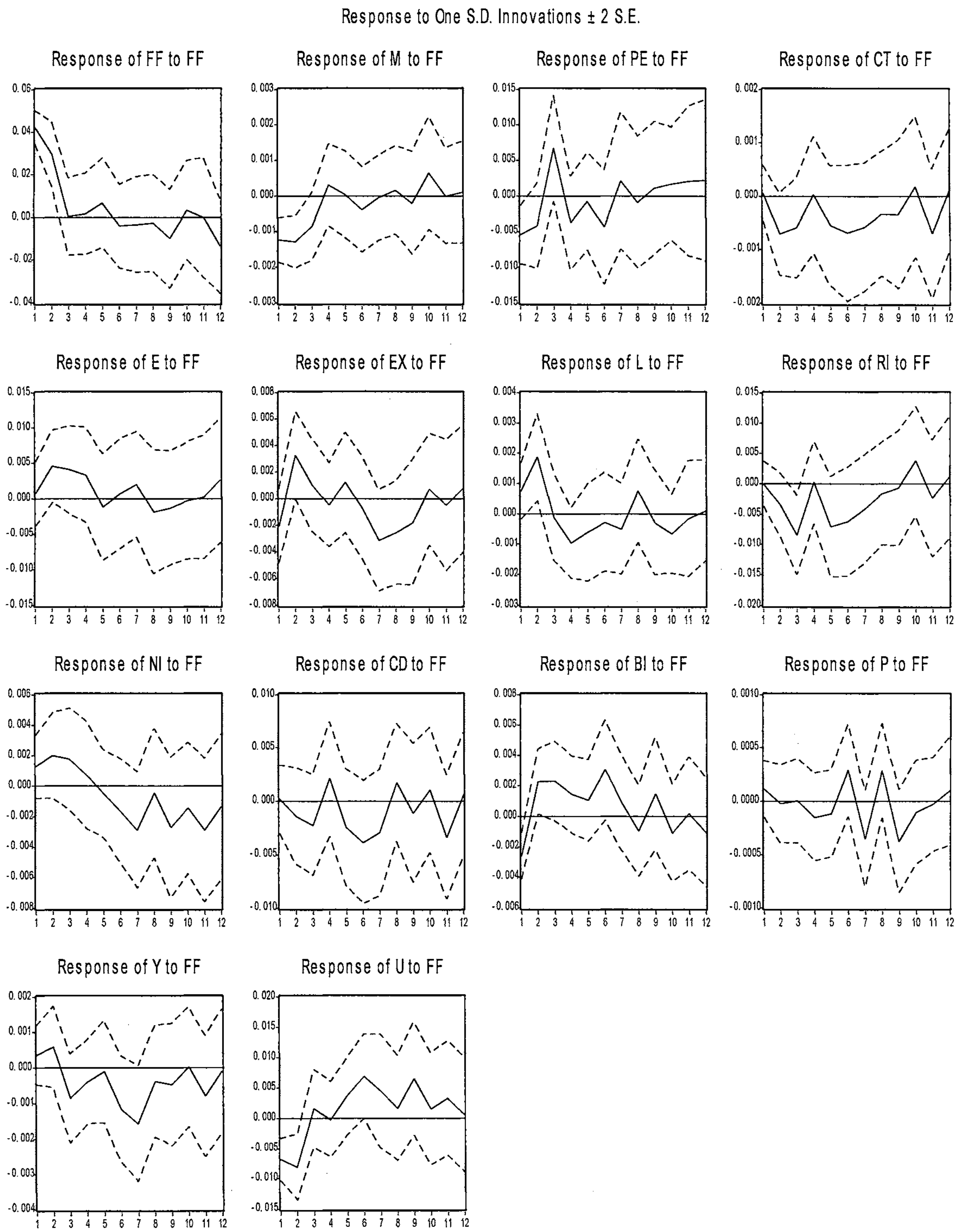

Figure 10. Responses of Model Variables to Fed Funds Innovations
Under an Alternative Lag Specification of Five Quarters

TABLE 6
AVERAGE FEV DECOMPOSITIONS UNDER ALTERNATIVE LAG SPECIFICATIONS

	Lag	BI	CD	CT	E	EX	FF	L	M	NI	P	PE	RI	U	Y
	3 Qrtrs	24.6	2.2	13.7	4.2	2.7	15.2	2.1	5.3	5.8	2.8	8.1	5.8	4.1	3.4
BI	*4 Qrtrs*	18.3	3.8	16.5	10.2	5.4	9.1	4.6	7.0	2.8	2.0	4.0	10.0	3.6	2.9
	5 Qrtrs	4.4	6.1	21.6	6.0	3.1	16.8	6.9	11.5	9.0	2.2	2.7	7.7	0.5	1.4
	3 Qrtrs	3.2	19.0	32.1	3.6	3.2	6.9	6.0	4.7	2.4	2.4	3.4	6.6	4.3	2.1
CD	*4 Qrtrs*	4.2	21.6	24.9	6.8	1.9	6.0	4.8	8.2	3.9	1.9	1.9	8.9	3.1	2.0
	5 Qrtrs	1.9	18.7	18.0	3.8	6.6	5.0	1.6	9.8	11.1	0.4	8.7	13.1	0.4	1.0
	3 Qrtrs	6.0	6.0	39.7	4.8	2.4	8.2	4.8	5.5	2.3	2.4	4.5	5.9	4.4	3.2
CT	*4 Qrtrs*	6.6	10.1	30.3	6.8	1.6	9.0	4.2	8.7	3.9	2.0	4.5	7.8	3.1	1.5
	5 Qrtrs	2.4	12.9	26.9	4.6	8.1	6.9	2.1	8.1	7.6	0.4	8.1	10.1	0.6	1.1
	3 Qrtrs	0.8	1.3	2.3	67.3	0.8	1.4	0.8	2.3	4.4	5.1	5.3	1.3	5.2	1.7
E	*4 Qrtrs*	1.0	2.7	7.1	37.8	8.1	8.8	2.1	2.7	7.9	8.4	7.0	3.7	2.3	0.6
	5 Qrtrs	1.2	4.1	5.0	42.0	3.6	6.2	1.1	6.8	4.5	0.8	18.4	4.5	0.6	1.2
	3 Qrtrs	8.2	4.2	6.0	6.0	55.3	3.4	4.3	2.3	1.3	2.3	2.5	1.3	2.3	0.6
EX	*4 Qrtrs*	7.3	4.6	7.7	7.6	41.4	5.2	4.9	2.7	1.8	2.9	3.5	5.1	3.7	1.5
	5 Qrtrs	2.0	4.9	12.0	6.6	35.9	8.6	4.2	5.2	3.4	0.5	5.4	9.3	0.4	1.5
	3 Qrtrs	6.6	1.3	7.6	2.6	1.3	58.8	0.7	6.6	4.3	1.7	4.2	1.1	1.8	1.2
FF	*4 Qrtrs*	4.9	2.0	9.6	7.6	3.8	35.0	3.3	7.4	3.2	5.2	1.8	8.3	5.3	2.7
	5 Qrtrs	1.1	5.7	13.4	5.2	2.2	44.2	2.7	15.0	3.8	1.6	1.9	2.0	0.5	0.7
	3 Qrtrs	1.3	1.0	5.4	3.0	3.2	15.5	44.1	3.6	2.2	2.3	7.8	3.0	5.0	2.5
L	*4 Qrtrs*	1.9	2.1	8.5	2.8	5.0	9.7	26.0	9.2	3.7	6.5	10.9	5.3	5.8	2.6
	5 Qrtrs	0.3	2.6	8.5	1.2	6.9	12.3	24.6	13.6	7.7	1.8	14.6	3.2	1.4	1.2
	3 Qrtrs	14.9	1.2	0.8	1.6	4.0	11.0	0.4	52.3	1.6	0.8	2.9	3.7	2.7	2.3
M	*4 Qrtrs*	11.5	0.7	1.1	7.4	5.4	13.0	3.9	34.6	3.4	1.8	3.5	6.4	4.8	2.4
	5 Qrtrs	1.2	4.6	2.3	3.0	4.9	20.8	6.9	34.9	8.3	1.4	2.5	3.7	1.1	4.3
	3 Qrtrs	3.4	4.3	15.0	2.4	1.3	6.1	1.4	3.9	35.7	1.4	11.3	6.6	6.1	1.1
NI	*4 Qrtrs*	1.8	5.2	15.2	5.7	3.6	7.9	4.7	11.1	19.9	1.5	7.7	9.8	3.6	2.5
	5 Qrtrs	0.9	4.8	22.0	4.4	7.3	7.1	3.0	5.9	23.9	2.5	5.8	10.2	0.7	1.6
	3 Qrtrs	7.2	1.4	1.5	5.2	4.9	7.7	3.0	3.8	3.2	50.9	2.9	2.3	2.1	4.0
P	*4 Qrtrs*	3.8	2.5	5.7	6.4	8.0	4.5	8.3	16.1	5.5	28.4	4.1	1.8	0.8	4.1
	5 Qrtrs	3.0	6.4	2.6	7.9	6.0	6.4	14.9	12.8	12.2	14.3	5.6	7.7	0.1	0.3
	3 Qrtrs	3.7	1.9	2.8	4.3	4.6	9.4	1.3	6.7	4.3	2.7	50.2	3.2	2.2	2.7
PE	*4 Qrtrs*	4.8	4.4	9.5	4.3	8.7	4.0	3.3	11.0	4.1	1.8	31.5	6.1	3.8	2.8
	5 Qrtrs	0.9	6.5	1.8	5.7	9.5	9.3	5.0	10.9	10.6	1.0	33.4	3.6	0.8	0.9

TABLE 6 (Cont.)
AVERAGE FEV DECOMPOSITIONS UNDER ALTERNATIVE LAG SPECIFICATIONS

	Lag	BI	CD	CT	E	EX	FF	L	M	NI	P	PE	RI	U	Y
	3 Qrtrs	5.2	1.8	13.6	3.6	4.1	9.8	7.4	7.9	3.0	1.0	9.2	31.0	1.2	1.3
RI	*4 Qrtrs*	3.4	3.7	15.1	9.6	2.2	11.0	7.9	11.6	3.7	1.2	4.1	20.4	3.0	3.2
	5 Qrtrs	0.6	6.9	19.8	4.9	5.1	11.9	7.3	14.3	3.6	1.9	4.9	17.5	0.4	0.9
	3 Qrtrs	9.4	1.6	14.4	3.6	2.0	16.5	2.6	3.0	2.5	3.6	11.2	9.7	17.9	2.0
U	*4 Qrtrs*	6.4	1.6	17.9	6.0	3.3	17.1	3.6	6.9	3.7	5.4	1.2	15.0	9.0	2.9
	5 Qrtrs	1.1	2.4	22.0	5.5	7.2	19.7	2.4	9.5	7.9	2.2	5.8	9.9	1.6	2.8
	3 Qrtrs	3.1	3.0	24.8	1.9	11.1	6.6	1.7	3.9	4.1	4.3	6.9	7.1	4.1	17.3
Y	*4 Qrtrs*	3.1	6.2	22.2	4.9	8.8	7.4	1.8	7.5	4.7	1.9	7.4	10.1	4.3	9.7
	5 Qrtrs	1.9	7.1	30.9	2.5	12.9	8.4	4.0	7.8	3.8	1.3	5.0	11.2	1.0	2.3

Note: Each number represents the average percentage of the forecast error variance (FEV) in the row variable explained by the respective column variable, under alternative lag length specifications.

TABLE 7
STANDARD DEVIATIONS FOR AVERAGE FEV DECOMPOSITIONS UNDER ALTERNATIVE LAG SPECIFICATIONS

	BI	CD	CT	E	EX	FF	L	M	NI	P	PE	RI	U	Y	Avg
BI	10.3	2.0	4.0	3.1	1.5	4.1	2.4	3.2	3.1	0.4	2.8	2.1	2.0	1.0	***3.0***
CD	1.2	1.6	7.1	1.8	2.4	1.0	2.3	2.6	4.7	1.0	3.6	3.3	2.0	0.6	***2.5***
CT	2.3	3.5	6.6	1.2	3.5	1.1	1.4	1.7	2.7	1.1	2.1	2.1	1.9	1.1	***2.3***
E	0.2	1.4	2.4	16.0	3.7	3.8	0.7	2.5	2.0	3.8	7.1	1.7	2.3	0.6	***3.4***
EX	3.4	0.4	3.1	0.8	10.0	2.6	0.4	1.6	1.1	1.2	1.5	4.0	1.7	0.5	***2.3***
FF	2.8	2.4	2.9	2.5	1.3	12.0	1.4	4.6	0.6	2.1	1.4	3.9	2.5	1.0	***3.0***
L	0.8	0.8	1.8	1.0	1.9	2.9	10.9	5.0	2.8	2.6	3.4	1.3	2.3	0.8	***2.7***
M	7.1	2.1	0.8	3.0	0.7	5.2	3.3	10.1	3.5	0.5	0.5	1.6	1.9	1.1	***3.0***
NI	1.3	0.5	4.0	1.7	3.0	0.9	1.7	3.7	8.2	0.6	2.8	2.0	2.7	0.7	***2.4***
P	2.2	2.6	2.2	1.4	1.6	1.6	6.0	6.4	4.7	18.5	1.4	3.3	1.0	2.2	***3.9***
PE	2.0	2.3	4.2	0.8	2.6	3.1	1.9	2.5	3.7	0.9	10.3	1.6	1.5	1.1	***2.8***
RI	2.3	2.6	3.2	3.2	1.5	1.1	0.3	3.2	0.4	0.5	2.7	7.1	1.3	1.2	***2.2***
U	4.2	0.5	3.8	1.3	2.7	1.7	0.6	3.3	2.8	1.6	5.0	3.0	8.2	0.5	***2.8***
Y	0.7	2.2	4.5	1.6	2.1	0.9	1.3	2.2	0.5	1.6	1.3	2.1	1.9	7.5	***2.2***
Avg	***2.9***	***1.8***	***3.6***	***2.8***	***2.8***	***3.0***	***2.5***	***3.8***	***2.9***	***2.6***	***3.3***	***2.8***	***2.4***	***1.4***	***2.7***

Note: Each number represents the standard deviation of the average forecast error variances across the alternative lag length specifications. For example, the average FEV in output (Y) explained by innovations in the fed funds rate (FF), deviates 0.9 percent from its average value across the three alternative lag specifications.

Figure 11 presents the impulse responses (to a fed funds shock) that result from reversing the ordering of the variables as: U, Y, P, BI, CD, NI, RI, L, EX, E, CT, PE, M, and FF. This ordering implies that the fed funds rate responds instantly to contemporaneous movements in the other variables, with the other variables responding only with a lag to changes in the fed funds rate. It also implies that there are no information lags in the conduct of fed funds policy, but longer effectiveness lags. This is the most severe alteration of the ordering assumption used in this study. Table 8 compares the average FEV decompositions resulting from this specification to those examined earlier. Table 9 presents the standard deviations of these comparative differences.

Although the directions and patterns of most of the impulse responses are consistent with those examined earlier, there are several notable exceptions. Consumption's short-term negative response is now statistically significant. The responses of the exchange rate, exports, and bank lending are all less pronounced. The short-term response of non-residential investment is now negative and statistically significant. Similarly, the initial responses of both consumer durables and residential investment are more strongly negative. Together these factors help explain the increased responsiveness of output and unemployment to policy tightening, each of which now respond in the expected directions from the outset of policy adjustments. This is because the reverse ordering allows for within-period fed funds rate adjustments in response to changing economic conditions, whereas the specification used in this study treated the fed funds rate as exogenous within the quarter. The inflation response is consistent across both specifications.

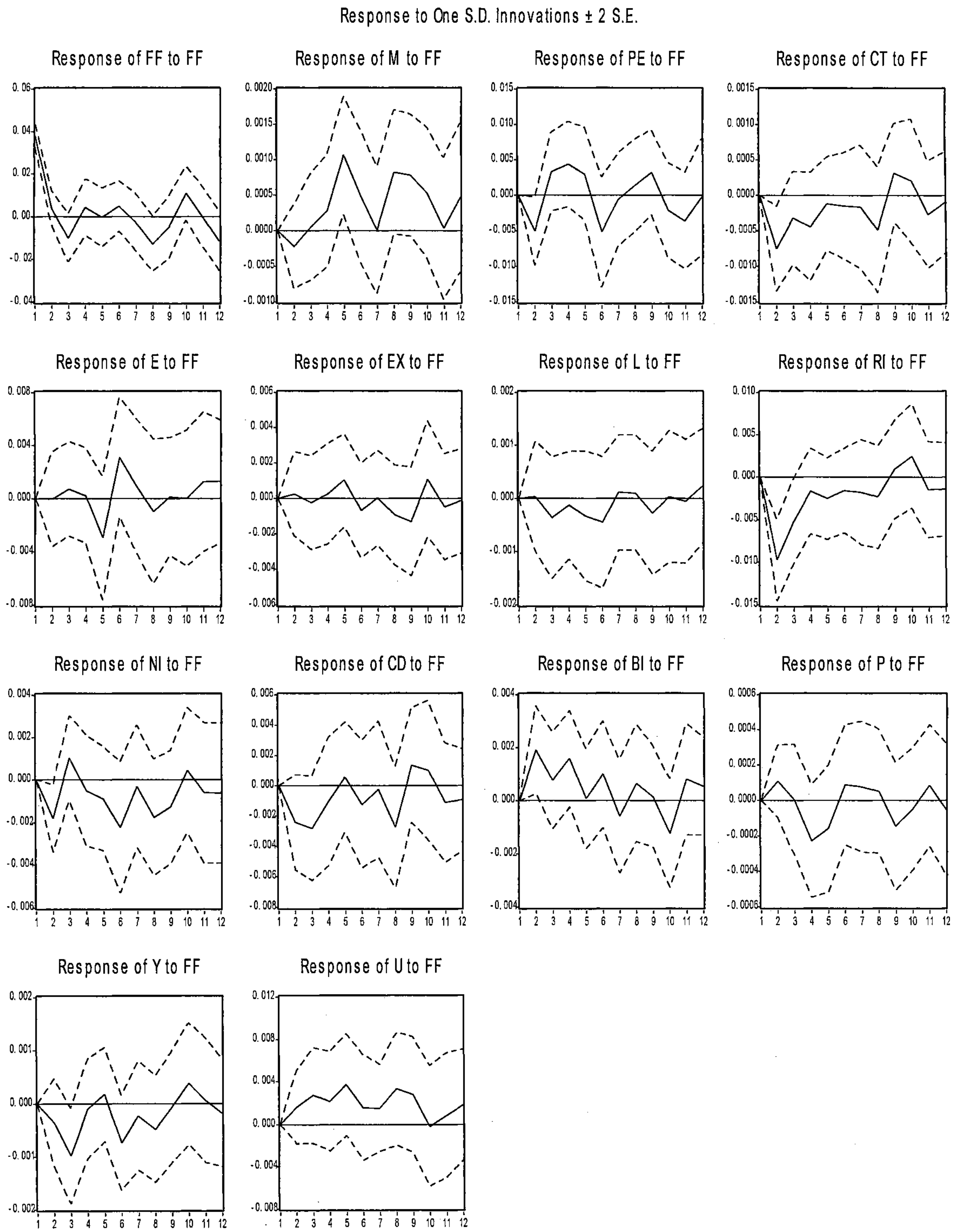

Figure 11. Responses of Model Variables to Fed Funds Innovations Under Reverse Ordering

TABLE 8
AVERAGE FEV DECOMPOSITIONS UNDER REVERSE ORDERING SPECIFICATION

	BI	CD	CT	E	EX	FF	L	M	NI	P	PE	RI	U	Y
BI	18.3	3.8	16.5	10.2	5.4	9.1	4.6	7.0	2.8	2.0	4.0	10.0	3.6	2.9
	22.6	1.7	6.1	4.6	2.2	3.0	1.9	1.7	1.6	1.2	2.2	11.5	34.0	5.7
CD	4.2	21.6	24.9	6.8	1.9	6.0	4.8	8.2	3.9	1.9	1.9	8.9	3.1	2.0
	6.1	37.4	2.8	0.9	5.2	2.2	2.0	2.1	3.3	1.8	1.7	13.6	11.5	9.2
CT	6.6	10.1	30.3	6.8	1.6	9.0	4.2	8.7	3.9	2.0	4.5	7.8	3.1	1.5
	12.4	14.1	12.0	1.7	5.1	2.9	1.9	1.4	1.2	2.4	2.3	14.1	14.5	14.1
E	1.0	2.7	7.1	37.8	8.1	8.8	2.1	2.7	7.9	8.4	7.0	3.7	2.3	0.6
	6.5	5.1	4.7	41.2	6.2	1.0	1.9	1.3	7.6	5.9	1.6	5.5	9.4	1.9
EX	7.3	4.6	7.7	7.6	41.4	5.2	4.9	2.7	1.8	2.9	3.5	5.1	3.7	1.5
	7.2	5.3	4.6	5.5	38.9	0.5	3.8	0.7	2.9	1.7	0.6	3.1	10.0	15.2
FF	4.9	2.0	9.6	7.6	3.8	35.0	3.3	7.4	3.2	5.2	1.8	8.3	5.3	2.7
	4.4	1.7	3.0	2.1	4.0	21.3	7.8	3.2	1.9	2.4	1.5	8.3	33.3	5.1
L	1.9	2.1	8.5	2.8	5.0	9.7	26.0	9.2	3.7	6.5	10.9	5.3	5.8	2.6
	2.1	4.4	1.2	1.0	2.5	0.5	38.1	0.8	3.0	6.6	1.2	8.2	20.2	10.3
M	11.5	0.7	1.1	7.4	5.4	13.0	3.9	34.6	3.4	1.8	3.5	6.4	4.8	2.4
	6.9	8.5	6.2	2.1	2.8	3.2	5.8	31.7	2.8	1.7	1.6	12.3	9.3	5.0
NI	11.5	0.7	1.1	7.4	5.4	13.0	3.9	34.6	3.4	1.8	3.5	6.4	4.8	2.4
	1.5	2.0	4.9	2.9	4.7	2.2	1.3	1.1	23.3	1.7	1.3	14.4	26.7	11.8
P	3.8	2.5	5.7	6.4	8.0	4.5	8.3	16.1	5.5	28.4	4.1	1.8	0.8	4.1
	5.5	4.1	0.6	1.6	4.8	1.6	3.7	7.5	3.1	48.3	0.8	5.6	12.1	0.6
PE	4.8	4.4	9.5	4.3	8.7	4.0	3.3	11.0	4.1	1.8	31.5	6.1	3.8	2.8
	6.4	8.8	7.5	8.1	6.4	3.2	9.8	2.8	4.1	3.9	19.5	6.9	5.2	7.3
RI	3.4	3.7	15.1	9.6	2.2	11.0	7.9	11.6	3.7	1.2	4.1	20.4	3.0	3.2
	5.4	3.1	1.3	2.2	3.6	7.2	1.5	2.3	2.2	1.4	0.9	32.1	27.1	9.7
U	6.4	1.6	17.9	6.0	3.3	17.1	3.6	6.9	3.7	5.4	1.2	15.0	9.0	2.9
	6.5	2.1	1.3	2.1	6.4	1.8	1.1	1.7	3.0	1.4	1.1	11.2	55.5	4.7
Y	3.1	6.2	22.2	4.9	8.8	7.4	1.8	7.5	4.7	1.9	7.4	10.1	4.3	9.7
	4.7	1.7	3.4	2.5	5.7	2.4	0.4	1.9	1.7	2.4	0.5	10.9	29.1	32.6

Note: First row for each variable represents former ordering, second row represents reverse ordering. See notes to Table 6 for interpretation.

TABLE 9
STANDARD DEVIATIONS FOR AVERAGE FEV DECOMPOSITIONS UNDER REVERSE ORDERING SPECIFICATION

	BI	CD	CT	E	EX	FF	L	M	NI	P	PE	RI	U	Y	Avg
BI	3.0	1.5	7.4	4.0	2.3	4.3	1.9	3.7	0.8	0.6	1.3	1.1	21.5	2.0	***4.0***
CD	1.3	11.2	15.6	4.2	2.3	2.7	2.0	4.3	0.4	0.1	0.1	3.3	5.9	5.1	***4.2***
CT	4.1	2.8	12.9	3.6	2.5	4.3	1.6	5.2	1.9	0.3	1.6	4.5	8.1	8.9	***4.5***
E	3.9	1.7	1.7	2.4	1.3	5.5	0.1	1.0	0.2	1.8	3.8	1.3	5.0	0.9	***2.2***
EX	0.1	0.5	2.2	1.5	1.8	3.3	0.8	1.4	0.8	0.8	2.1	1.4	4.5	9.7	***2.2***
FF	0.4	0.2	4.7	3.9	0.1	9.7	3.2	3.0	0.9	2.0	0.2	0.0	19.8	1.7	***3.6***
L	0.1	1.6	5.2	1.3	1.8	6.5	8.6	5.9	0.5	0.1	6.9	2.1	10.2	5.4	***4.0***
M	3.3	5.5	3.6	3.7	1.8	6.9	1.3	2.1	0.4	0.1	1.3	4.2	3.2	1.8	***2.8***
NI	7.1	0.9	2.7	3.2	0.5	7.6	1.8	23.7	14.1	0.1	1.6	5.7	15.5	6.6	***6.5***
P	1.2	1.1	3.6	3.4	2.3	2.1	3.3	6.1	1.7	14.1	2.3	2.7	8.0	2.5	***3.9***
PE	1.1	3.1	1.4	2.7	1.6	0.6	4.6	5.8	0.0	1.5	8.5	0.6	1.0	3.2	***2.6***
RI	1.4	0.4	9.8	5.2	1.0	2.7	4.5	6.6	1.1	0.1	2.3	8.3	17.0	4.6	***4.6***
U	0.1	0.4	11.7	2.8	2.2	10.8	1.8	3.7	0.5	2.8	0.1	2.7	32.9	1.3	***5.3***
Y	1.1	3.2	13.3	1.7	2.2	3.5	1.0	4.0	2.1	0.4	4.9	0.6	17.5	16.2	***5.1***
Avg	***2.0***	***2.4***	***6.8***	***3.1***	***1.7***	***5.0***	***2.6***	***5.5***	***1.8***	***1.8***	***2.6***	***2.8***	***12.2***	***5.0***	***4.0***

Note: Each number represents the standard deviation of the average forecast error variances across the alternative ordering specifications. For example, the average FEV in output (Y) explained by innovations in the fed funds rate (FF), deviates 3.5 percent from its average value across the two alternative ordering specifications.

The FEV decompositions also appear to be relatively sensitive to causal ordering specification. The average deviation in the FEV decompositions is 4.0 percent (Table 9). The FEV decompositions of each variable explained by its own innovations are most sensitive to lag length, as can be seen by examining the diagonal elements of Tables 8 and 9. The explanatory power of unemployment (U), output (Y), consumption (CT), the fed funds rate (FF), and money (M) are most sensitive to lag length specification.[9]

Based on these observations, the results presented earlier in the chapter are less robust to causal ordering specification than to lag length specification. As noted earlier, variance decompositions are generally more sensitive to ordering specification than are impulse responses. The Granger-causality results are independent of the ordering specification. Therefore, the implications drawn from these results offer an attractive alternative to the measurement of the effects of fed funds policy.

Sensitivity to the Selection of Variables

A final test of robustness examines the results generated from the model when several variables are replaced by theoretically comparable series. The M2 money supply series (M) is replaced by the monetary base (MB) series (adjusted for reserve requirement changes). The New York Stock Exchange composite stock price index (PE) is replaced by the S&P composite index (SPPE). The gross domestic product (Y) and gross domestic product deflator (P) series are replaced by the gross national product (GNP) and gross national product deflator (GNPD) series, respectively. Finally, manufacturing and trade inventories (IVT) replace the business inventories/sales ratio (BI).

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[9] This is reflected in the above average deviations shown in the respective columns of Table 9.

Figure 12 presents the impulse responses of the variables in the re-specified model to innovations in the fed funds rate. Most of the responses are consistent with those analyzed in this study. There are several notable exceptions, however. While the monetary base declines relative to trend, similar to money growth, the negative response is more persistent, lasting well past the fourth quarter into the tenth quarter. The initial positive response of residential investment is larger and now statistically significant. This, along with similar responses in non-residential and consumer durables investment, probably contributes to the initial persistence in economic growth reflected in the output and unemployment responses. It also strengthens the argument that bank lending plays an important role in policy transmission, since the initial investment, output, and unemployment responses correspond closely to the bank lending response.

Tables 10 and 11 present the comparative average FEV decompositions and deviations in these decompositions, for both variable selection specifications. The average deviation is 5.1 percent (Table 11). The explanatory power of consumption (CT), exports (EX), consumer durables investment (CD), the fed funds rate (FF), and money (M) are most sensitive to lag length specification.[10]

Overall, the variance decomposition results appear to be fairly sensitive to the series chosen to represent the variables in the model and to the causal ordering specification, but relatively insensitive to the lag length specification. The impulse response functions, as a whole, appear to be much less sensitive to any of the re-specifications, than the FEV decompositions. They appear to be most sensitive to causal ordering. These findings support Braun and Mittnik's observation that variance

[10] This is reflected in the above average deviations shown in the respective columns of Table 11.

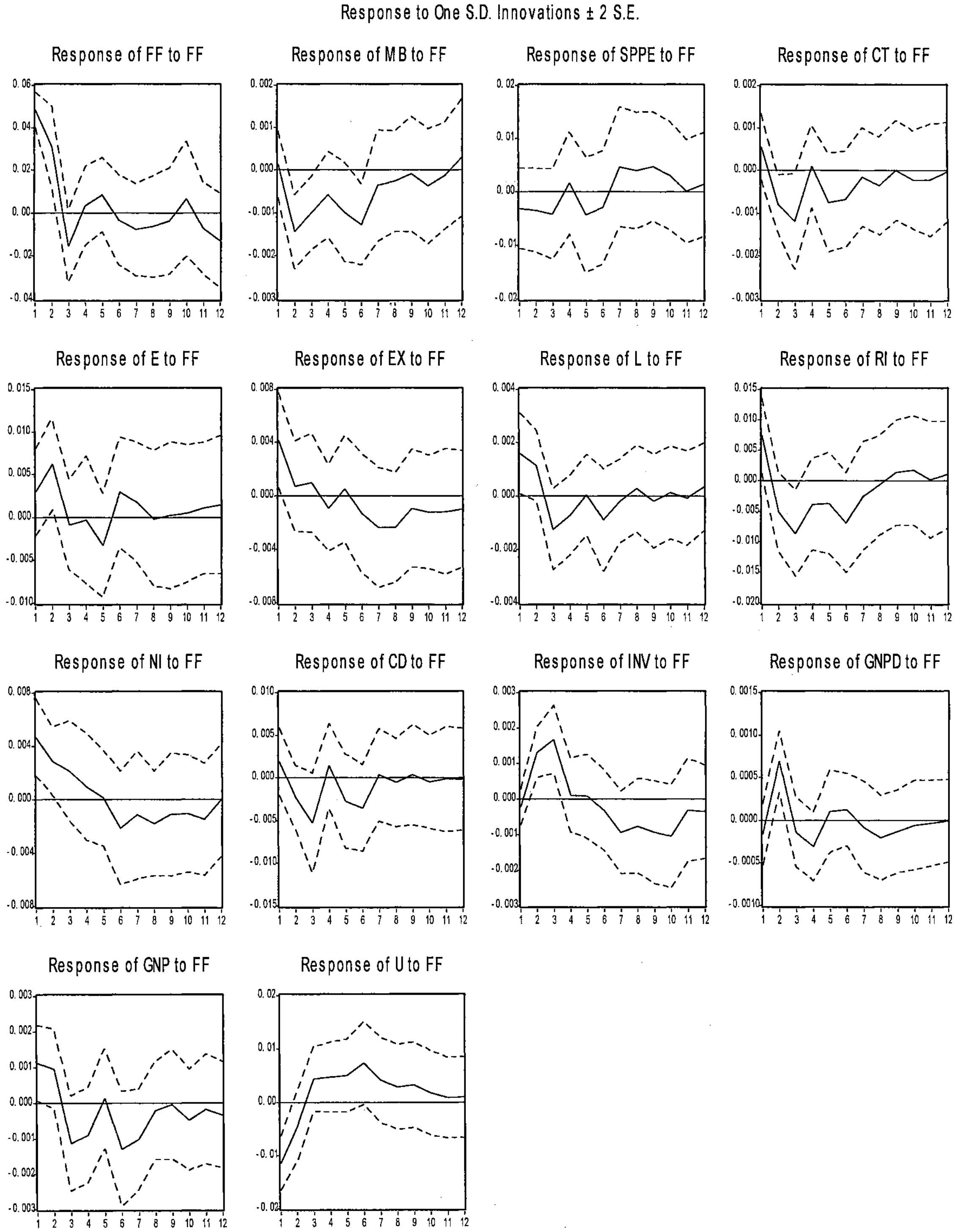

Figure 12. Responses of Model Variables to Fed Funds Innovations
Under Alternative Variable Selection

TABLE 10
AVERAGE FEV DECOMPOSITIONS UNDER ALTERNATIVE VARIABLE SPECIFICATION

	BI	CD	CT	E	EX	FF	L	M	NI	P	PE	RI	U	Y
BI	18.3	3.8	16.5	10.2	5.4	9.1	4.6	7.0	2.8	2.0	4.0	10.0	3.6	2.9
INV	4.1	18.8	1.3	5.7	16.2	2.0	1.0	23.0	4.8	4.6	4.0	8.3	4.4	1.8
CD	4.2	21.6	24.9	6.8	1.9	6.0	4.8	8.2	3.9	1.9	1.9	8.9	3.1	2.0
	20.1	27.8	6.6	6.0	6.5	1.1	2.8	3.5	1.8	8.8	4.2	5.5	3.8	1.6
CT	6.6	10.1	30.3	6.8	1.6	9.0	4.2	8.7	3.9	2.0	4.5	7.8	3.1	1.5
	9.4	33.8	5.2	3.9	9.8	0.9	2.8	4.5	0.9	13.0	3.3	3.7	7.7	1.1
E	1.0	2.7	7.1	37.8	8.1	8.8	2.1	2.7	7.9	8.4	7.0	3.7	2.3	0.6
	3.2	4.2	53.2	2.6	5.2	0.6	2.2	2.8	1.5	3.4	8.5	2.3	7.3	2.8
EX	7.3	4.6	7.7	7.6	41.4	5.2	4.9	2.7	1.8	2.9	3.5	5.1	3.7	1.5
	3.2	8.7	9.3	48.4	6.5	1.1	2.0	2.4	1.7	4.7	4.9	1.4	3.5	2.3
FF	4.9	2.0	9.6	7.6	3.8	35.0	3.3	7.4	3.2	5.2	1.8	8.3	5.3	2.7
	3.2	11.3	5.1	2.2	45.1	0.8	2.5	4.3	1.8	8.7	4.5	3.9	4.1	2.5
L	1.9	2.1	8.5	2.8	5.0	9.7	26.0	9.2	3.7	6.5	10.9	5.3	5.8	2.6
	2.8	15.1	5.1	4.0	10.0	0.8	3.1	3.0	32.9	5.4	2.9	1.7	10.3	2.9
M	11.5	0.7	1.1	7.4	5.4	13.0	3.9	34.6	3.4	1.8	3.5	6.4	4.8	2.4
MB	1.4	5.3	6.3	1.6	16.3	1.1	1.5	6.9	2.4	46.4	2.5	3.7	2.4	2.1
NI	11.5	0.7	1.1	7.4	5.4	13.0	3.9	34.6	3.4	1.8	3.5	6.4	4.8	2.4
	4.4	13.0	2.7	3.5	12.3	2.4	1.8	1.0	0.9	5.1	32.8	10.8	7.7	1.7
P	3.8	2.5	5.7	6.4	8.0	4.5	8.3	16.1	5.5	28.4	4.1	1.8	0.8	4.1
GNPD	5.8	4.6	3.8	4.6	11.5	1.0	25.3	4.0	1.9	11.0	2.7	8.3	13.5	2.1
PE	4.8	4.4	9.5	4.3	8.7	4.0	3.3	11.0	4.1	1.8	31.5	6.1	3.8	2.8
SPPE	7.3	8.1	7.3	4.7	3.4	2.2	1.7	1.7	1.9	3.8	5.0	5.9	46.0	0.9
RI	3.4	3.7	15.1	9.6	2.2	11.0	7.9	11.6	3.7	1.2	4.1	20.4	3.0	3.2
	4.5	13.1	6.6	3.6	12.4	2.6	1.8	1.5	4.5	9.9	2.1	28.2	8.2	1.2
U	6.4	1.6	17.9	6.0	3.3	17.1	3.6	6.9	3.7	5.4	1.2	15.0	9.0	2.9
	2.9	24.4	2.7	4.5	19.6	2.8	5.2	4.6	2.2	4.5	3.5	8.2	6.3	8.7
Y	3.1	6.2	22.2	4.9	8.8	7.4	1.8	7.5	4.7	1.9	7.4	10.1	4.3	9.7
GNP	4.8	22.4	2.7	12.4	10.6	6.1	3.6	9.2	1.4	5.9	3.4	5.9	10.0	1.6

Note: First row for each variable represents former specification, second row represents alternative specification. See notes to Table 6 for interpretation.

TABLE 11
STANDARD DEVIATIONS FOR AVERAGE FEV DECOMPOSITIONS UNDER ALTERNATIVE VARIABLE SPECIFICATION

	BI	CD	CT	E	EX	FF	L	M	NI	P	PE	RI	U	Y	Avg
BI	10.0	10.6	10.7	3.2	7.6	5.0	2.5	11.3	1.4	1.8	0.0	1.2	0.6	0.8	***4.8***
CD	11.2	4.4	12.9	0.6	3.3	3.5	1.4	3.3	1.5	4.9	1.6	2.4	0.5	0.3	***3.7***
CT	2.0	16.8	17.7	2.1	5.8	5.7	1.0	3.0	2.1	7.8	0.8	2.9	3.3	0.3	***5.1***
E	1.6	1.1	32.6	24.9	2.1	5.8	0.1	0.1	4.5	3.5	1.1	1.0	3.5	1.6	***5.9***
EX	2.9	2.9	1.1	28.8	24.7	2.9	2.1	0.2	0.1	1.3	1.0	2.6	0.1	0.6	***5.1***
FF	1.2	6.6	3.2	3.8	29.2	24.2	0.6	2.2	1.0	2.5	1.9	3.1	0.8	0.1	***5.7***
L	0.6	9.2	2.4	0.8	3.5	6.3	16.2	4.4	20.6	0.8	5.7	2.5	3.2	0.2	***5.5***
M	7.1	3.3	3.7	4.1	7.7	8.4	1.7	19.6	0.7	31.5	0.7	1.9	1.7	0.2	***6.6***
NI	5.0	8.7	1.1	2.8	4.9	7.5	1.5	23.8	1.8	2.3	20.7	3.1	2.1	0.5	***6.1***
P	1.4	1.5	1.3	1.3	2.5	2.5	12.0	8.6	2.5	12.3	1.0	4.6	9.0	1.4	***4.4***
PE	1.8	2.6	1.6	0.3	3.7	1.3	1.1	6.6	1.6	1.4	18.7	0.1	29.8	1.3	***5.1***
RI	0.8	6.6	6.0	4.2	7.2	5.9	4.3	7.1	0.6	6.2	1.4	5.5	3.7	1.4	***4.4***
U	2.5	16.1	10.7	1.1	11.5	10.1	1.1	1.6	1.1	0.6	1.6	4.8	1.9	4.1	***4.9***
Y	1.2	11.5	13.8	5.3	1.3	0.9	1.3	1.2	2.3	2.8	2.8	3.0	4.0	5.7	***4.1***
Avg	***3.5***	***7.3***	***8.5***	***5.9***	***8.2***	***6.4***	***3.3***	***6.6***	***3.0***	***5.7***	***4.2***	***2.8***	***4.6***	***1.3***	***5.1***

Note: Each number represents the standard deviation of the average forecast error variances across the alternative variable specifications. For example, the average FEV in output (Y) explained by innovations in the fed funds rate (FF), deviates 0.9 percent from its average value, across the two alternative variable specifications.

decompositions are more sensitive to misspecification errors than are impulse response functions (1993, p. 338), and justifies this study's greater reliance on the impulse responses in interpreting the results.

Summary

This chapter presented the results of the estimated VAR model, examined the relationships between the model variables, and evaluated the robustness of the results. The following chapter will discuss the conclusions of this study, provide suggestions for future research, and examine implications for researchers and practitioners.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

The first section of this chapter summarizes what the findings of this study reveal regarding the economic effects of federal funds rate adjustments. The implications of the findings are discussed next. This is followed by a discussion of the limitations of the study and suggestions for future research. The final section reviews the objectives of the study and the extent to which these objectives have been achieved.

Summary of the Economic Effects of Fed Funds Rate Adjustments

The previous chapters reported and analyzed the evidence provided by the impulse response functions, FEV decompositions, and Granger-causality tests in the examination of the economic effects of fed funds rate adjustments. This section summarizes the Fed's policy responses, the resulting effects on the policy target variables, and the relative importance of the alternative channels through which these effects may be transmitted.

Fed Funds Rate Policy Responses

The evidence supports a relatively strong policy easing (via a reduction in the fed funds rate) in response to unexpected increases in unemployment, which persists through about four quarters (Figure 3). However, higher inflation is initially met with an easing of policy, turning more restrictive only three quarters after the initial shock. This may reflect the increased tolerance toward higher inflation during the mid-to-late 1970s. No statistically significant policy response to output shocks is identified. The Fed does appear to be relatively responsive to unexpected positive shocks to consumption, non-residential investment and money. In each of these cases the Fed responds with more restrictive policy. The response to consumption shocks persists through nine quarters, versus seven for money shocks and four for non-residential investment shocks.

Policy Target Variable Effects

Because the Federal Reserve responds to unexpected shocks to unemployment and, to a lesser degree, inflation, it is important to determine the extent to which the target policy variables respond to the policy adjustments. This section summarizes the response of the target policy variables to fed funds policy adjustments.

The Effect on Unemployment

Although the Federal Reserve responds to unexpected increases in unemployment by decreasing the fed funds rate, the response of unemployment is harder to assess. Unemployment is not Granger-caused by the fed funds rate, nor by any of the other variables in the model. However, the size of this model and the nature of its postulated inter-relationships make it likely that the true extent of economic causality is masked by the inclusion of several causally-related variables. The FEV decomposition evidence points to a relatively large role of the fed funds rate in explaining the FEV of unemployment. However, while this evidence is robust to alternative lag lengths, it does not hold up under reverse causal-ordering or alternative variable selection.[1]

The impulse response of unemployment to an innovation in the fed funds rate indicates that unemployment decreases initially, rising above trend by the third quarter and remaining there through the eighth quarter. The slow response of unemployment may indicate policy effectiveness lags, and is consistent with the slow initial responses of bank lending, exports, and non-residential investment. This pattern of the unemployment response is robust to each of the other specifications, except reverse causal-ordering. In that case, unemployment increases immediately following the policy tightening (bank lending and non-residential investment also respond more quickly). This is to be expected since the reverse ordering (placing unemployment first rather than last) makes unemployment exogenous and, thus, unresponsive to the other variables within the quarter.

Overall, the FEV decomposition and impulse response evidence support the policy effectiveness of the fed funds rate adjustments on unemployment, albeit with a lag. The lack of Granger-causal support can be explained by the nature of the model. However, while the supporting evidence of policy effectiveness (on unemployment) is robust to alternative lag lengths, it is sensitive to the causal-ordering specification.

[1] Refer to column FF, row U in Tables 6, 8, and 10 for a comparison of the average FEV in unemployment accounted for by innovations to the fed funds rate, across alternative specifications.

The Effect on Output

The evidence of policy effectiveness in influencing output is less conclusive. The evidence does not support Granger-causality of the fed funds rate on output. However, this alone is not convincing evidence, given the extent of variable inter-relationships postulated in the model. The FEV decomposition evidence further weakens the case for a significant influence of fed funds rate innovations on output, with fed funds innovations explaining, on average, only seven percent of the FEV in output. This finding is relatively insensitive to the alternative specifications. Fed funds innovations explain, at most, eight percent of the FEV in output (under the five quarter lag assumption).

The impulse response evidence is slightly more supportive of the fed funds rate's influence on output. Similar to the response of unemployment, output growth appears to respond slowly to policy tightening, falling below trend by the third quarter. The timing of the decline in output growth and its return to trend parallels closely the unemployment response. Unlike the unemployment response, however, the output response is not statistically significant. The output response is fairly robust to the alternative specifications, except in the case of reverse causal-ordering, where the positive initial response disappears. Overall, there is weak evidential support for the influence of fed funds adjustments on output, but this evidence is fairly robust.

The Effect on Inflation

Of the three target policy variables, inflation appears to be least impacted by Fed funds rate adjustments. There is no evidence that the fed funds rate Granger-causes inflation. Although the caution related to the reliability of these tests still applies, there is less conflicting evidence in this particular case. The FEV decomposition indicates that fed funds innovations explain only four percent of the FEV in inflation, less than either of the other two target policy variables. This relatively small percentage of inflation's FEV is robust across the alternative specifications examined, explaining at most eight percent of the FEV (in the case of the five quarter lag specification).

The rise in inflation which occurs over most of the first three quarters is consistent with the slow responses of unemployment and output. This finding is also consistent with Sims (1992) and Balke and Emery (1994) who report that recent developments in monetary policy research point to a positive price response to restrictive policy, rather than a negative one. Balke and Emery conclude that because monetary policy in the 1970s often responded with insufficient force to reverse inflationary trends, measures of contractionary policy (such as fed funds rate increases) are correlated with inflation during this period. In other words, the "price puzzle" may be largely explained by the fact that in the past fed funds innovations were followed by higher inflation due, not to the tightening but, to insufficient tightening. This is endorsed by Thornton:

> In the mid-1970s, the Fed targeted the federal funds rate in a narrow band, making frequent and often small adjustments to its funds rate target. In 1977, the Fed began tightening monetary policy by raising its target for the federal funds rate. From April 1977 to October 1979, the Fed adjusted the funds rate target 41 times by a cumulative amount of about 680 basis points. **Despite these adjustments, reserve and monetary base growth accelerated, as did inflation**, which already was high by historical standards. (1997, p. 1, Emphasis added)

Given this interpretation, the impulse response may simply indicate the persistence of inflation once it appears; it underscores the importance of a credible anti-inflationary policy commitment. The eventual decline in inflation near the third quarter, coincides with slower output growth and higher unemployment and is consistent with the predictions of each of the monetary policy transmission mechanisms. Although the inflation response is insignificant over the entire twelve quarter horizon, it is fairly robust across the alternative specifications examined.

Overall, while there is insufficient evidence to support a strong relationship between the fed funds rate and inflation, the impulse responses are consistent with those of the other target variables.

Transmission Channel Effects

Chapter five examined the strength of the various policy transmission channels and their respective components. This section summarizes these results and assesses the relative importance of both the channels and the individual economic variables.

The Interest Rate Channel

The evidence examined provides moderate support for the interest rate channel of monetary policy. The link from the fed funds rate to residential investment is the strongest, among the investment variables considered. Further, there is fairly strong evidence that residential investment is an important determinant of both unemployment and output. Each of these conclusions is fairly robust across the alternative specifications examined, with the greatest sensitivity to the alternative variable selection. This causal link from residential investment does not extend to inflation, however, which is largely determined by money supply innovations. Although the importance of money innovations to the determination of inflation declines in each of the alternative specifications, the strong Granger-causality of money on prices (p=0.0136) adds credibility to this relationship.

The Exchange Rate Channel

The impulse response evidence supports an important component of the exchange rate channel, the link from the fed funds rate to the exchange value of the dollar. The implementation of more restrictive policy by the Federal Reserve strengthens domestic currency over the first three quarters. This finding is robust across the alternative specifications, although the response is negligible in the case of reverse causal-ordering. The FEV decomposition evidence is less convincing, however, with the fed funds rate losing explanatory power across each of the alternative specifications. Similarly, Granger-causality test results do not support this link.

The link between the exchange rate and exports is supported by the impulse response evidence and, to a lesser degree, by the FEV evidence. The percentage of FEV in exports explained by exchange rate innovations, increases significantly under the alternative variable specification (column E, row EX in Table 10). There is also evidence that exports influence output, unemployment, and prices, although this evidence appears to be relatively sensitive to model specification. Overall, the evidence provides weak support for the exchange rate channel of monetary policy.

The q-Theory-Investment Channel

The q-theory channel, which relies heavily on the influence of policy adjustments on equity prices, is supported by strong evidence that policy tightening by the Fed leads to a short-term correction in equity prices, and this evidence is fairly robust. However, the evidence does not support a significant relationship between equity prices and non-residential investment, as postulated by the q-theory channel. The evidence also does not support a strong causal relationship between non-residential investment and the target policy variables. Thus, despite the strong correction of equity prices, the q-theory channel does not appear to contribute significantly to the desired policy objectives.

The Wealth Effect-Consumption Channel

The evidence that policy tightening by the Fed leads to a short-term correction in equity prices also lends support to the wealth effect-consumption channel. The impulse response evidence further establishes support for a statistically significant relationship between equity prices and consumption. Although this evidence is not supported by the Granger-causality and FEV decomposition results, it does add credibility to the postulated transmission channel. There is also significant evidence that consumption is an important determinant of output and unemployment, although inflation appears to be less responsive. Analysis of the robustness of these results indicates that the supportive FEV decomposition evidence is relatively sensitive to both the reverse causal-ordering and the alternative variable selection; in both cases the fed funds rate loses much of its explanatory power. Nonetheless, the wealth effect-consumption channel seems to be relatively important in its transmission of policy effects.

The Credit Channel

There is little overall support for the credit channel of monetary policy. While there is evidence that policy tightening does cause a deterioration of credit quality, the evidence that this causes a decline in bank lending is mixed. The evidence supports a relatively strong link from bank lending to residential investment, and from residential investment to output and unemployment. Inflation does not appear to be significantly influenced by any of the investment variables. The FEV decomposition evidence supporting the links between equity prices and lending and lending and residential investment is not very robust across the alternative specifications. Together, this evidence is insufficient to establish the credit channel as an important factor in the transmission of monetary policy via adjustments to the fed funds rate.

Summary

The Employment Act of 1946 and the Full Employment and Balanced Growth Act of 1978 commit the Federal Reserve to policies consistent with promoting high employment and stable prices. The Fed attempts to achieve a rate of economic growth such that these objectives can be achieved simultaneously. The evidence presented indicates that the Federal Reserve is responsive to shocks in unemployment and inflation, but not output growth. Fed policy-makers appear to react particularly quickly and significantly to unemployment shocks. The response to inflationary shocks appears to be contrary to stated policy in the short run and the eventual policy tightening is not significant.

The evidence presented is far less conclusive in determining the transmission channels by which these policy responses influence the target variables. There is insufficient evidence to establish an important role for any of the transmission channels in the conduct of monetary policy. Several critical observations, however, are made. First, fed funds policy adjustments influence residential investment; and residential investment explains a large part of the forecast-error in both output and unemployment. Second, consumption is important in the determination of both output and unemployment and is relatively responsive to policy-induced equity market adjustments. The relative importance of residential investment and consumption in the determination of output supports the findings of Mauskopf (1990, p. 987), who finds that they accounted for 33 and 32 percent, respectively, of the increase in output, four quarters after a one percent reduction in the fed funds rate. Third, inflation seems to be largely determined by money innovations, rather than any of the postulated transmission effects. Variance decomposition and impulse response evidence and Granger-causality testing supports this observation. Finally, there is stronger evidential support for the "money views" of monetary transmission (especially the interest rate and wealth effect-consumption channels) than for the "credit view." This again supports the findings of Mauskopf, who found that these channels account for 68 and 14 percent, respectively, of the increase in output, four quarters after a one percentage point reduction in the fed funds rate.

The influence of fed funds policy on the target variables is inconclusive. There is insufficient evidence of strong causal relationships between the fed funds rate and output, unemployment, or price level. However, the impulse response and FEV decomposition evidence does support the policy effectiveness of fed funds rate adjustments on unemployment (and to a lesser extent) output, albeit with lags. Inflation, likewise, responds with a lag to tighter policy. However, there is little supporting evidence for this relationship. The lack of conclusive evidence may be partly attributable to the size of the model and the associated loss of efficiency and masking of causal relationships.

Implications

The results of this study have a number of implications for researchers and monetary policy practitioners. One important finding is that the Federal Reserve does not appear to be equally responsive to the policy targets mandated by the Employment Act of 1946 and the Full Employment and Balanced Growth Act of 1978. The impulse responses of the fed funds rate to these target policy variables indicate that policy responds much more quickly and significantly to unexpected increases in unemployment than to unexpected increases in output growth or inflation. This greater relative concern over unemployment shocks may have contributed to inflationary pressures during the sample period.

This study does not find conclusive evidence that any of the policy transmission channels is superior to the others in its ability to influence the target variables. The evidence does support the policy responsiveness of both consumption and residential investment, and, according to the impulse response evidence, these responses influence the target variables in the desired direction. It also indicates that the stabilization of consumption and residential investment, which occurs approximately eight quarters after a policy tightening, tends to coincide with the stabilization of both output and unemployment growth. Policy-makers might benefit from paying particular attention to the adjustment in these variables, since they may provide insight into the anticipated movements in output and unemployment.

While the study does not find a statistically significant role for the credit channel, bank lending does appear to be important to policy effectiveness. The apparent failure of tighter policy to slow the extension of credit through bank lending, in the first three quarters following a policy tightening, appears to contribute to the slow response of non-residential investment. These responses, in turn, seem to reduce the short-term effectiveness of fed funds adjustments, as reflected in higher rates of inflation and output growth, and lower unemployment.

Finally, this study highlights the benefits of using a VAR in the analysis of complex relationships. Although many of the relationships examined in this model were not statistically significant, the direction and timing of most of the impulse responses are consistent with the postulated transmission channels and with economic theory.

Limitations of the Study

Several limitations of this study are discussed in the following sections. The validity and generalizability of the findings may be affected by a variety of model specification assumptions. The sensitivity of the results to alternative specifications was examined in detail in the previous chapters. Those results are summarized here and their relative importance discussed.

Specification of Lag Length

The results of this study are relatively insensitive to both longer and shorter lag specifications. Specifically, the key impulse response functions and FEV decompositions used to interpret the model inter-relationships are robust to alternative lag specifications of three and five quarters.

Specification of Variable Ordering

The specification of variable ordering used in this study is consistent with the view that the Fed does not respond to shocks in the other model variables, within the quarter. This specification has intuitive appeal but may unnecessarily bias the impulse responses and variance decompositions in which it is used. The sensitivity tests conducted (assuming reverse causation) indicate that both the impulse responses and FEV decompositions are relatively sensitive to ordering specification. In particular, the initial positive responses of lending and non-residential investment disappear, as do the effectiveness lags of policy on unemployment and output.

Selection of Variables

The impulse responses in this study are relatively robust to a specification using different series to represent the key variables. In fact, these results strengthen the conclusions of the study. The FEV decompositions, however, are relatively sensitive to this re-specification, decreasing their usefulness in interpreting the effects of policy adjustments.

Conclusions

This study assumed that the Federal Reserve adjusts the fed funds rate to achieve real income, employment, and inflation policy objectives. It then examined the nature of these relationships via alternative transmission channels. The project began with the development of a comprehensive model capturing the key components of the transmission channels. A vector autoregressive model was employed to generate impulse response functions and variance decompositions which, along with Granger-causality tests, helped clarify the extent of the postulated interest rate transmission relationships, as well as the extent to which the Federal Reserve's interest rate adjustments influence its stated objectives. The intent of the VAR analysis was to provide insight into whether policy discourse and, more importantly, policy actions, are justified in placing significant emphasis on interest rates changes as a means of achieving income, employment, and inflation objectives.

The results were inconclusive in the determination of the relative strengths of the alternative policy transmission channels. Several significant relationships were identified, however. First, monetary policy responds more quickly and significantly to unemployment shocks, than to either inflation or output growth shocks. Second, following a policy tightening residential investment and consumption growth subsides significantly. Bank lending increases, however, contributing to the slow responses of non-residential investment and the policy objectives to tighter policy. The three policy variables do respond to tighter policy by the third quarter following the initial policy adjustment, and return to trend around the eighth quarter. This coincides with the returns of consumption and residential investment to their trends.

The implications for monetary policy practitioners and researchers were discussed. The limitations of the study were discussed and suggestions for overcoming those limitations and for furthering knowledge development in the field of monetary economics were presented. As a result, this study contributes to the understanding of the relationship and timing patterns among key monetary and economic variables. This study also contributes to the understanding of which sectors are most responsive to fed funds policy adjustments.

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APPENDICES

APPENDIX A

VAR MODEL

$$\mathbf{PE}_t = a_{10} + \sum_{j=1}^{4} a_{11j}\mathbf{PE}_{t-j} + \sum_{j=1}^{4} a_{12j}\mathbf{NI}_{t-j} + \sum_{j=1}^{4} a_{13j}\mathbf{RI}_{t-j} + \sum_{j=1}^{4} a_{14j}\mathbf{BI}_{t-j} + \sum_{j=1}^{4} a_{15j}\mathbf{L}_{t-j} + \sum_{j=1}^{4} a_{16j}\mathbf{Y}_{t-j} + \sum_{j=1}^{4} a_{17j}\mathbf{P}_{t-j} + \sum_{j=1}^{4} a_{18j}\mathbf{U}_{t-j} + \sum_{j=1}^{4} a_{19j}\mathbf{E}_{t-j} + \sum_{j=1}^{4} a_{1,10j}\mathbf{EX}_{t-j} + \sum_{j=1}^{4} a_{1,11j}\mathbf{CD}_{t-j} + \sum_{j=1}^{4} a_{1,12j}\mathbf{FF}_{t-j} + \sum_{j=1}^{4} a_{1,13j}\mathbf{M}_{t-j} + \sum_{j=1}^{4} a_{1,14j}\mathbf{CT}_{t-j} + \varepsilon_{1t}$$

$$\mathbf{NI}_t = a_{20} + \sum_{j=1}^{4} a_{21j}\mathbf{PE}_{t-j} + \sum_{j=1}^{4} a_{22j}\mathbf{NI}_{t-j} + \sum_{j=1}^{4} a_{23j}\mathbf{RI}_{t-j} + \sum_{j=1}^{4} a_{24j}\mathbf{BI}_{t-j} + \sum_{j=1}^{4} a_{25j}\mathbf{L}_{t-j} + \sum_{j=1}^{4} a_{26j}\mathbf{Y}_{t-j} + \sum_{j=1}^{4} a_{27j}\mathbf{P}_{t-j} + \sum_{j=1}^{4} a_{28j}\mathbf{U}_{t-j} + \sum_{j=1}^{4} a_{29j}\mathbf{E}_{t-j} + \sum_{j=1}^{4} a_{2,10j}\mathbf{EX}_{t-j} + \sum_{j=1}^{4} a_{2,11j}\mathbf{CD}_{t-j} + \sum_{j=1}^{4} a_{2,12j}\mathbf{FF}_{t-j} + \sum_{j=1}^{4} a_{2,13j}\mathbf{M}_{t-j} + \sum_{j=1}^{4} a_{2,14j}\mathbf{CT}_{t-j} + \varepsilon_{2t}$$

$$\mathbf{RI}_t = a_{30} + \sum_{j=1}^{4} a_{31j}\mathbf{PE}_{t-j} + \sum_{j=1}^{4} a_{32j}\mathbf{NI}_{t-j} + \sum_{j=1}^{4} a_{33j}\mathbf{RI}_{t-j} + \sum_{j=1}^{4} a_{34j}\mathbf{BI}_{t-j} + \sum_{j=1}^{4} a_{35j}\mathbf{L}_{t-j} + \sum_{j=1}^{4} a_{36j}\mathbf{Y}_{t-j} + \sum_{j=1}^{4} a_{37j}\mathbf{P}_{t-j} + \sum_{j=1}^{4} a_{38j}\mathbf{U}_{t-j} + \sum_{j=1}^{4} a_{39j}\mathbf{E}_{t-j} + \sum_{j=1}^{4} a_{3,10j}\mathbf{EX}_{t-j} + \sum_{j=1}^{4} a_{3,11j}\mathbf{CD}_{t-j} + \sum_{j=1}^{4} a_{3,12j}\mathbf{FF}_{t-j} + \sum_{j=1}^{4} a_{3,13j}\mathbf{M}_{t-j} + \sum_{j=1}^{4} a_{3,14j}\mathbf{CT}_{t-j} + \varepsilon_{3t}$$

$$\mathbf{BI}_t = a_{40} + \sum_{j=1}^{4} a_{41j}\mathbf{PE}_{t-j} + \sum_{j=1}^{4} a_{42j}\mathbf{NI}_{t-j} + \sum_{j=1}^{4} a_{43j}\mathbf{RI}_{t-j} + \sum_{j=1}^{4} a_{44j}\mathbf{BI}_{t-j} + \sum_{j=1}^{4} a_{45j}\mathbf{L}_{t-j} + \sum_{j=1}^{4} a_{46j}\mathbf{Y}_{t-j} + \sum_{j=1}^{4} a_{47j}\mathbf{P}_{t-j} + \sum_{j=1}^{4} a_{48j}\mathbf{U}_{t-j} + \sum_{j=1}^{4} a_{49j}\mathbf{E}_{t-j} + \sum_{j=1}^{4} a_{4,10j}\mathbf{EX}_{t-j} + \sum_{j=1}^{4} a_{4,11j}\mathbf{CD}_{t-j} + \sum_{j=1}^{4} a_{4,12j}\mathbf{FF}_{t-j} + \sum_{j=1}^{4} a_{4,13j}\mathbf{M}_{t-j} + \sum_{j=1}^{4} a_{4,14j}\mathbf{CT}_{t-j} + \varepsilon_{4t}$$

$$\mathbf{L}_t = a_{50} + \sum_{j=1}^{4} a_{51j}\mathbf{PE}_{t-j} + \sum_{j=1}^{4} a_{52j}\mathbf{NI}_{t-j} + \sum_{j=1}^{4} a_{53j}\mathbf{RI}_{t-j} + \sum_{j=1}^{4} a_{54j}\mathbf{BI}_{t-j} + \sum_{j=1}^{4} a_{55j}\mathbf{L}_{t-j} + \sum_{j=1}^{4} a_{56j}\mathbf{Y}_{t-j} +$$

$$\sum_{j=1}^{4} a_{57j}\mathbf{P}_{t-j} + \sum_{j=1}^{4} a_{58j}\mathbf{U}_{t-j} + \sum_{j=1}^{4} a_{59j}\mathbf{E}_{t-j} + \sum_{j=1}^{4} a_{5,10j}\mathbf{EX}_{t-j} + \sum_{j=1}^{4} a_{5,11j}\mathbf{CD}_{t-j} + \sum_{j=1}^{4} a_{5,12j}\mathbf{FF}_{t-j} +$$

$$\sum_{j=1}^{4} a_{5,13j}\mathbf{M}_{t-j} + \sum_{j=1}^{4} a_{5,14j}\mathbf{CT}_{t-j} + \varepsilon_{5t}$$

$$\mathbf{Y}_t = a_{60} + \sum_{j=1}^{4} a_{61j}\mathbf{PE}_{t-j} + \sum_{j=1}^{4} a_{62j}\mathbf{NI}_{t-j} + \sum_{j=1}^{4} a_{63j}\mathbf{RI}_{t-j} + \sum_{j=1}^{4} a_{64j}\mathbf{BI}_{t-j} + \sum_{j=1}^{4} a_{65j}\mathbf{L}_{t-j} + \sum_{j=1}^{4} a_{66j}\mathbf{Y}_{t-j} +$$

$$\sum_{j=1}^{4} a_{67j}\mathbf{P}_{t-j} + \sum_{j=1}^{4} a_{68j}\mathbf{U}_{t-j} + \sum_{j=1}^{4} a_{69j}\mathbf{E}_{t-j} + \sum_{j=1}^{4} a_{6,10j}\mathbf{EX}_{t-j} + \sum_{j=1}^{4} a_{6,11j}\mathbf{CD}_{t-j} + \sum_{j=1}^{4} a_{6,12j}\mathbf{FF}_{t-j} +$$

$$\sum_{j=1}^{4} a_{6,13j}\mathbf{M}_{t-j} + \sum_{j=1}^{4} a_{6,14j}\mathbf{CT}_{t-j} + \varepsilon_{6t}$$

$$\mathbf{P}_t = a_{70} + \sum_{j=1}^{4} a_{71j}\mathbf{PE}_{t-j} + \sum_{j=1}^{4} a_{72j}\mathbf{NI}_{t-j} + \sum_{j=1}^{4} a_{73j}\mathbf{RI}_{t-j} + \sum_{j=1}^{4} a_{74j}\mathbf{BI}_{t-j} + \sum_{j=1}^{4} a_{75j}\mathbf{L}_{t-j} + \sum_{j=1}^{4} a_{76j}\mathbf{Y}_{t-j} +$$

$$\sum_{j=1}^{4} a_{77j}\mathbf{P}_{t-j} + \sum_{j=1}^{4} a_{78j}\mathbf{U}_{t-j} + \sum_{j=1}^{4} a_{79j}\mathbf{E}_{t-j} + \sum_{j=1}^{4} a_{7,10j}\mathbf{EX}_{t-j} + \sum_{j=1}^{4} ;a_{7,11j}\mathbf{CD}_{t-j} + \sum_{j=1}^{4} a_{7,12j}\mathbf{FF}_{t-j} +$$

$$\sum_{j=1}^{4} a_{7,13j}\mathbf{M}_{t-j} + \sum_{j=1}^{4} a_{7,14j}\mathbf{CT}_{t-j} + \varepsilon_{7t}$$

$$\mathbf{U}_t = a_{80} + \sum_{j=1}^{4} a_{81j}\mathbf{PE}_{t-j} + \sum_{j=1}^{4} a_{82j}\mathbf{NI}_{t-j} + \sum_{j=1}^{4} a_{83j}\mathbf{RI}_{t-j} + \sum_{j=1}^{4} a_{84j}\mathbf{BI}_{t-j} + \sum_{j=1}^{4} a_{85j}\mathbf{L}_{t-j} + \sum_{j=1}^{4} a_{86j}\mathbf{Y}_{t-j} +$$

$$\sum_{j=1}^{4} a_{87j}\mathbf{P}_{t-j} + \sum_{j=1}^{4} a_{88j}\mathbf{U}_{t-j} + \sum_{j=1}^{4} a_{89j}\mathbf{E}_{t-j} + \sum_{j=1}^{4} a_{8,10j}\mathbf{EX}_{t-j} + \sum_{j=1}^{4} a_{8,11j}\mathbf{CD}_{t-j} + \sum_{j=1}^{4} a_{8,12j}\mathbf{FF}_{t-j} +$$

$$\sum_{j=1}^{4} a_{8,13j}\mathbf{M}_{t-j} + \sum_{j=1}^{4} a_{8,14j}\mathbf{CT}_{t-j} + \varepsilon_{8t}$$

$$\mathbf{E}_t = a_{90} + \sum_{j=1}^{4} a_{91j}\mathbf{PE}_{t-j} + \sum_{j=1}^{4} a_{92j}\mathbf{NI}_{t-j} + \sum_{j=1}^{4} a_{93j}\mathbf{RI}_{t-j} + \sum_{j=1}^{4} a_{94j}\mathbf{BI}_{t-j} + \sum_{j=1}^{4} a_{95j}\mathbf{L}_{t-j} + \sum_{j=1}^{4} a_{96j}\mathbf{Y}_{t-j} + \sum_{j=1}^{4} a_{97j}\mathbf{P}_{t-j} + \sum_{j=1}^{4} a_{98j}\mathbf{U}_{t-j} + \sum_{j=1}^{4} a_{99j}\mathbf{E}_{t-j} + \sum_{j=1}^{4} a_{9,10j}\mathbf{EX}_{t-j} + \sum_{j=1}^{4} a_{9,11j}\mathbf{CD}_{t-j} + \sum_{j=1}^{4} a_{9,12j}\mathbf{FF}_{t-j} + \sum_{j=1}^{4} a_{9,13j}\mathbf{M}_{t-j} + \sum_{j=1}^{4} a_{9,14j}\mathbf{CT}_{t-j} + \varepsilon_{9t}$$

$$\mathbf{EX}_t = a_{10,0} + \sum_{j=1}^{4} a_{10,1j}\mathbf{PE}_{t-j} + \sum_{j=1}^{4} a_{10,2j}\mathbf{NI}_{t-j} + \sum_{j=1}^{4} a_{10,3j}\mathbf{RI}_{t-j} + \sum_{j=1}^{4} a_{10,4j}\mathbf{BI}_{t-j} + \sum_{j=1}^{4} a_{10,5j}\mathbf{L}_{t-j} + \sum_{j=1}^{4} a_{10,6j}\mathbf{Y}_{t-j} + \sum_{j=1}^{4} a_{10,7j}\mathbf{P}_{t-j} + \sum_{j=1}^{4} a_{10,8j}\mathbf{U}_{t-j} + \sum_{j=1}^{4} a_{10,9j}\mathbf{E}_{t-j} + \sum_{j=1}^{4} a_{10,10j}\mathbf{EX}_{t-j} + \sum_{j=1}^{4} a_{10,11j}\mathbf{CD}_{t-j} + \sum_{j=1}^{4} a_{10,12j}\mathbf{FF}_{t-j} + \sum_{j=1}^{4} a_{10,13j}\mathbf{M}_{t-j} + \sum_{j=1}^{4} a_{10,14j}\mathbf{CT}_{t-j} + \varepsilon_{10t}$$

$$\mathbf{CD}_t = a_{11,0} + \sum_{j=1}^{4} a_{11,1j}\mathbf{PE}_{t-j} + \sum_{j=1}^{4} a_{11,2j}\mathbf{NI}_{t-j} + \sum_{j=1}^{4} a_{11,3j}\mathbf{RI}_{t-j} + \sum_{j=1}^{4} a_{11,4j}\mathbf{BI}_{t-j} + \sum_{j=1}^{4} a_{11,5j}\mathbf{L}_{t-j} + \sum_{j=1}^{4} a_{11,6j}\mathbf{Y}_{t-j} + \sum_{j=1}^{4} a_{11,7j}\mathbf{P}_{t-j} + \sum_{j=1}^{4} a_{11,8j}\mathbf{U}_{t-j} + \sum_{j=1}^{4} a_{11,9j}\mathbf{E}_{t-j} + \sum_{j=1}^{4} a_{11,10j}\mathbf{EX}_{t-j} + \sum_{j=1}^{4} a_{11,11j}\mathbf{CD}_{t-j} + \sum_{j=1}^{4} a_{11,12j}\mathbf{FF}_{t-j} + \sum_{j=1}^{4} a_{11,13j}\mathbf{M}_{t-j} + \sum_{j=1}^{4} a_{11,14j}\mathbf{CT}_{t-j} + \varepsilon_{11t}$$

$$\mathbf{FF}_t = a_{12,0} + \sum_{j=1}^{4} a_{12,1j}\mathbf{PE}_{t-j} + \sum_{j=1}^{4} a_{12,2j}\mathbf{NI}_{t-j} + \sum_{j=1}^{4} a_{12,3j}\mathbf{RI}_{t-j} + \sum_{j=1}^{4} a_{12,4j}\mathbf{BI}_{t-j} + \sum_{j=1}^{4} a_{12,5j}\mathbf{L}_{t-j} + \sum_{j=1}^{4} a_{12,6j}\mathbf{Y}_{t-j} + \sum_{j=1}^{4} a_{12,7j}\mathbf{P}_{t-j} + \sum_{j=1}^{4} a_{12,8j}\mathbf{U}_{t-j} + \sum_{j=1}^{4} a_{12,9j}\mathbf{E}_{t-j} + \sum_{j=1}^{4} a_{12,10j}\mathbf{EX}_{t-j} + \sum_{j=1}^{4} a_{12,11j}\mathbf{CD}_{t-j} + \sum_{j=1}^{4} a_{12,12j}\mathbf{FF}_{t-j} + \sum_{j=1}^{4} a_{12,13j}\mathbf{M}_{t-j} + \sum_{j=1}^{4} a_{12,14j}\mathbf{CT}_{t-j} + \varepsilon_{12t}$$

$$\mathbf{M}_t = a_{13,0} + \sum_{j=1}^{4} a_{13,1j}\mathbf{PE}_{t-j} + \sum_{j=1}^{4} a_{13,2j}\mathbf{NI}_{t-j} + \sum_{j=1}^{4} a_{13,3j}\mathbf{RI}_{t-j} + \sum_{j=1}^{4} a_{13,4j}\mathbf{BI}_{t-j} + \sum_{j=1}^{4} a_{13,5j}\mathbf{L}_{t-j} + \sum_{j=1}^{4} a_{13,6j}\mathbf{Y}_{t-j} +$$

$$\sum_{j=1}^{4} a_{13,7j}\mathbf{P}_{t-j} + \sum_{j=1}^{4} a_{13,8j}\mathbf{U}_{t-j} + \sum_{j=1}^{4} a_{13,9j}\mathbf{E}_{t-j} + \sum_{j=1}^{4} a_{13,10j}\mathbf{EX}_{t-j} + \sum_{j=1}^{4} a_{13,11j}\mathbf{CD}_{t-j} + \sum_{j=1}^{4} a_{13,12j}\mathbf{FF}_{t-j} +$$

$$\sum_{j=1}^{4} a_{13,13j}\mathbf{M}_{t-j} + \sum_{j=1}^{4} a_{13,14j}\mathbf{CT}_{t-j} + \varepsilon_{13t}$$

$$\mathbf{CT}_t = a_{14,0} + \sum_{j=1}^{4} a_{14,1j}\mathbf{PE}_{t-j} + \sum_{j=1}^{4} a_{14,2j}\mathbf{NI}_{t-j} + \sum_{j=1}^{4} a_{14,3j}\mathbf{RI}_{t-j} + \sum_{j=1}^{4} a_{14,4j}\mathbf{BI}_{t-j} + \sum_{j=1}^{4} a_{14,5j}\mathbf{L}_{t-j} + \sum_{j=1}^{4} a_{14,6j}\mathbf{Y}_{t-j} +$$

$$\sum_{j=1}^{4} a_{14,7j}\mathbf{P}_{t-j} + \sum_{j=1}^{4} a_{14,8j}\mathbf{U}_{t-j} + \sum_{j=1}^{4} a_{14,9j}\mathbf{E}_{t-j} + \sum_{j=1}^{4} a_{14,10j}\mathbf{EX}_{t-j} + \sum_{j=1}^{4} a_{14,11j}\mathbf{CD}_{t-j} + \sum_{j=1}^{4} a_{14,12j}\mathbf{FF}_{t-j} +$$

$$\sum_{j=1}^{4} a_{14,13j}\mathbf{M}_{t-j} + \sum_{j=1}^{4} a_{14,14j}\mathbf{CT}_{t-j} + \varepsilon_{14t}$$

APPENDIX B

VAR MODEL ESTIMATES
AND
SUMMARY STATISTICS

VAR MODEL EQUATION ESTIMATES

	BI	CD	CT	E	EX	FF	L
BI(-1)	-0.0854	0.8370	0.2127	0.2020	0.0470	-1.8101	0.0763
	(-0.32983)	(1.8504)	(2.4379)	(0.3417)	(0.1202)	(-1.25029)	(0.4800)
BI(-2)	0.1469	1.1037	0.1696	-0.4707	-0.4733	-0.8864	0.0896
	(0.4878)	(2.0993)	(1.6719)	(-0.68525)	(-1.04153)	(-0.52677)	(0.4854)
BI(-3)	0.2979	0.2400	-0.0106	-0.7178	-0.4986	-1.6170	-0.0330
	(1.0018)	(0.4622)	(-0.10616)	(-1.05791)	(-1.11078)	(-0.97289)	(-0.18096)
BI(-4)	-0.3874	-0.1010	0.0010	-0.8810	-0.2592	0.3703	-0.0144
	(-1.38386)	(-0.20666)	(0.0102)	(-1.37937)	(-0.61340)	(0.2367)	(-0.08375)
CD(-1)	0.3986	-1.2420	-0.1978	-0.0375	-0.1710	-1.4991	-0.0314
	(2.1663)	(-3.86561)	(-3.19074)	(-0.08931)	(-0.61569)	(-1.45768)	(-0.27814)
CD(-2)	0.0715	-0.5801	0.0025	0.2305	-0.6163	0.2518	0.0308
	(0.3775)	(-1.75388)	(0.0388)	(0.5334)	(-2.15590)	(0.2379)	(0.2653)
CD(-3)	0.2594	-1.1697	-0.2096	-0.6276	-0.1913	-1.9474	-0.1227
	(1.2419)	(-3.20761)	(-2.97912)	(-1.31714)	(-0.60699)	(-1.66841)	(-0.95782)
CD(-4)	0.0060	-0.1677	0.0175	0.0550	-0.2711	-0.2989	-0.0515
	(0.0320)	(-0.51536)	(0.2786)	(0.1293)	(-0.96384)	(-0.28692)	(-0.45050)
CT(-1)	-2.1955	3.5873	0.8277	1.5456	0.6158	7.6796	0.1730
	(-1.93412)	(1.8100)	(2.1647)	(0.5968)	(0.3595)	(1.2106)	(0.2486)
CT(-2)	0.2002	-0.1526	-0.4650	-2.0629	3.6560	-8.1369	-0.0747
	(0.1908)	(-0.08329)	(-1.31597)	(-0.86195)	(2.3092)	(-1.38795)	(-0.11606)
CT(-3)	-0.9477	4.9601	1.1044	3.3830	-0.7754	6.3242	0.9416
	(-0.81990)	(2.4578)	(2.8366)	(1.2829)	(-0.44451)	(0.9791)	(1.3284)
CT(-4)	-0.3805	-0.2695	-0.3547	-1.5743	0.3780	-0.2280	0.2340
	(-0.40396)	(-0.16388)	(-1.11803)	(-0.73259)	(0.2659)	(-0.04331)	(0.4051)
E(-1)	-0.0965	0.0681	-0.0048	0.3116	-0.0669	-0.4063	-0.0090
	(-1.39480)	(0.5635)	(-0.20672)	(1.9744)	(-0.64116)	(-1.05108)	(-0.21257)
E(-2)	0.0563	0.1732	0.0286	0.0843	-0.1325	-0.2788	0.0134
	(0.8463)	(1.4916)	(1.2756)	(0.5554)	(-1.32015)	(-0.75022)	(0.3282)

VAR MODEL EQUATION ESTIMATES

	BI	CD	CT	E	EX	FF	L
E(-3)	0.0083 (0.1113)	0.0481 (0.3689)	0.0048 (0.1918)	0.1145 (0.6717)	0.0224 (0.1985)	0.0630 (0.1510)	-0.0119 (-0.25969)
E(-4)	0.0780 (1.1177)	-0.1424 (-1.16843)	-0.0285 (-1.21218)	-0.2025 (-1.27101)	-0.0230 (-0.21850)	0.3118 (0.7990)	0.0207 (0.4823)
EX(-1)	-0.0399 (-0.27209)	-0.1031 (-0.40294)	-0.0330 (-0.66781)	-0.1716 (-0.51308)	-0.3651 (-1.65020)	-0.8470 (-1.03398)	-0.0188 (-0.20886)
EX(-2)	0.0113 (0.0696)	-0.3621 (-1.27981)	-0.0569 (-1.04300)	-0.3267 (-0.88385)	-0.0923 (-0.37747)	0.1652 (0.1824)	0.0336 (0.3384)
EX(-3)	0.0546 (0.4161)	-0.0455 (-0.19885)	-0.0102 (-0.23001)	-0.0535 (-0.17887)	-0.0347 (-0.17556)	-0.7577 (-1.03380)	0.0331 (0.4120)
EX(-4)	-0.1689 (-1.45187)	0.0939 (0.4623)	0.0332 (0.8478)	0.3327 (1.2537)	0.1718 (0.9783)	1.0616 (1.6329)	0.0305 (0.4280)
FF(-1)	0.0500 (1.6109)	-0.0634 (-1.16931)	-0.0196 (-1.87794)	-0.0009 (-0.01237)	0.0059 (0.1255)	0.1035 (0.5965)	0.0009 (0.0471)
FF(-2)	-0.0370 (-1.09528)	-0.0148 (-0.25148)	0.0051 (0.4465)	0.0824 (1.0682)	0.0005 (0.0105)	-0.0378 (-0.19994)	0.0050 (0.2413)
FF(-3)	0.0323 (0.9990)	-0.0062 (-0.10979)	-0.0071 (-0.65043)	0.0099 (0.1342)	0.0470 (0.9624)	0.0302 (0.1669)	-0.0114 (-0.57430)
FF(-4)	-0.0195 (-0.64555)	0.0293 (0.5574)	0.0103 (1.0181)	-0.0891 (-1.29561)	0.0134 (0.2943)	0.2387 (1.4168)	0.0065 (0.3539)
L(-1)	-0.0397 (-0.11900)	0.7210 (1.2365)	0.1173 (1.0425)	0.0904 (0.1187)	-0.5779 (-1.14651)	0.6178 (0.3310)	-0.4100 (-2.00171)
L(-2)	0.1778 (0.5130)	-0.0585 (-0.09666)	-0.1290 (-1.10470)	0.1402 (0.1773)	-0.7709 (-1.47373)	-1.3218 (-0.68242)	-0.2548 (-1.19886)
L(-3)	0.1715 (0.5022)	-0.2737 (-0.45880)	-0.0470 (-0.40804)	-0.0061 (-0.00780)	-0.1934 (-0.37517)	-0.3984 (-0.20870)	-0.2291 (-1.09333)
L(-4)	0.2130 (0.6940)	-0.9090 (-1.69598)	-0.1450 (-1.40253)	-0.6012 (-0.85835)	0.1662 (0.3586)	-3.0626 (-1.78519)	-0.2250 (-1.19509)

VAR MODEL EQUATION ESTIMATES

	BI	CD	CT	E	EX	FF	L
M(-1)	-0.0519 (-0.11172)	-0.8480 (-1.04518)	-0.1594 (-1.01858)	0.3752 (0.3539)	0.1838 (0.2621)	3.6174 (1.3930)	-0.1688 (-0.59230)
M(-2)	-0.3370 (-0.66546)	0.9313 (1.0534)	0.3155 (1.8498)	1.1787 (1.0203)	0.3171 (0.4150)	1.6332 (0.5772)	0.0965 (0.3108)
M(-3)	0.7725 (1.5339)	-1.2051 (-1.37042)	-0.2274 (-1.34021)	0.1759 (0.1531)	-0.2098 (-0.27607)	-0.8138 (-0.28915)	-0.2812 (-0.91056)
M(-4)	-0.2201 (-0.53700)	0.1650 (0.2306)	0.0066 (0.0481)	-1.2804 (-1.36944)	-0.5422 (-0.87661)	-1.9159 (-0.83654)	0.3729 (1.4836)
NI(-1)	0.1130 (0.6827)	-0.1941 (-0.67157)	-0.0560 (-1.00376)	0.2157 (0.5710)	-0.2233 (-0.89373)	0.4199 (0.4538)	0.1255 (1.2364)
NI(-2)	-0.0981 (-0.58253)	-0.0055 (-0.01859)	-0.0213 (-0.37586)	0.2881 (0.7498)	-0.0317 (-0.12451)	0.4801 (0.5100)	0.0527 (0.5103)
NI(-3)	-0.0605 (-0.33807)	0.0391 (0.1252)	-0.0112 (-0.18604)	0.5693 (1.3934)	0.1580 (0.5848)	0.9743 (0.9736)	-0.0571 (-0.52010)
NI(-4)	-0.1149 (-0.62566)	-0.0113 (-0.03518)	0.0079 (0.1273)	-0.5583 (-1.33207)	-0.3073 (-1.10817)	-0.0189 (-0.01843)	0.0001 (0.0005)
P(-1)	1.0661 (0.9917)	-0.3656 (-0.19478)	0.0949 (0.2621)	-3.8383 (-1.56494)	-0.8685 (-0.53528)	-7.0509 (-1.17361)	-0.8671 (-1.31526)
P(-2)	-0.3647 (-0.34246)	0.9875 (0.5312)	0.1912 (0.5331)	-3.3623 (-1.38402)	-0.7659 (-0.47656)	6.0252 (1.0125)	-0.1294 (-0.19816)
P(-3)	1.1296 (0.9325)	-0.6211 (-0.29365)	-0.2448 (-0.59984)	-5.3299 (-1.92855)	-2.2906 (-1.25289)	-3.0357 (-0.44842)	-0.0868 (-0.11681)
P(-4)	-0.0784 (-0.07276)	0.7954 (0.4227)	0.0198 (0.0544)	2.2154 (0.9010)	-0.8976 (-0.55184)	2.0465 (0.3398)	-0.4581 (-0.69313)
PE(-1)	-0.0077 (-0.12965)	-0.0221 (-0.21313)	-0.0047 (-0.23676)	0.1822 (1.3442)	0.0400 (0.4461)	-0.0029 (-0.00876)	-0.0148 (-0.40527)
PE(-2)	-0.0810 (-1.51443)	0.1059 (1.1344)	0.0235 (1.3060)	-0.0999 (-0.81860)	-0.0391 (-0.48393)	0.1958 (0.6553)	-0.0074 (-0.22424)

VAR MODEL EQUATION ESTIMATES

	BI	CD	CT	E	EX	FF	L
PE(-3)	0.0355 (0.6802)	-0.0327 (-0.35895)	-0.0338 (-1.92025)	-0.3401 (-2.85552)	0.0157 (0.1987)	-0.3623 (-1.24164)	0.0207 (0.6464)
PE(-4)	-0.0546 (-0.87472)	0.0932 (0.8554)	0.0161 (0.7670)	0.2399 (1.6856)	-0.0439 (-0.46658)	-0.3402 (-0.97576)	0.0008 (0.0205)
RI(-1)	-0.1589 (-1.76965)	0.4174 (2.6633)	0.0730 (2.4137)	-0.0371 (-0.18137)	-0.0272 (-0.20059)	-0.1139 (-0.22715)	0.0390 (0.7083)
RI(-2)	-0.0694 (-0.77171)	0.3665 (2.3345)	0.0512 (1.6903)	0.1797 (0.8759)	-0.1435 (-1.05773)	-0.4429 (-0.88138)	0.0218 (0.3962)
RI(-3)	-0.029535 (-0.30791)	-0.0072 (-0.04272)	-0.0058 (-0.17953)	-0.1539 (-0.70324)	0.0101 (0.0701)	0.6078 (1.1338)	0.0587 (0.9971)
RI(-4)	-0.104434 (-1.14979)	0.134285 (0.8467)	0.031410 (1.0266)	-0.2872 (-1.38607)	0.0218 (0.1591)	0.1820 (0.3585)	-0.0024 (-0.04269)
U(-1)	0.1014 (0.8941)	-0.2988 (-1.50953)	-0.0752 (-1.96875)	-0.2701 (-1.04434)	-0.2413 (-1.41061)	-1.5363 (-2.42503)	-0.1424 (-2.04857)
U(-2)	-0.0705 (-0.61463)	0.0157 (0.0782)	0.0094 (0.2429)	0.5313 (2.0308)	-0.2646 (-1.52901)	-0.0509 (-0.07950)	0.0403 (0.5724)
U(-3)	-0.0596 (-0.51218)	-0.1602 (-0.78822)	-0.0359 (-0.91561)	0.1892 (0.7123)	0.0293 (0.1669)	-0.3595 (-0.55261)	0.0377 (0.5284)
U(-4)	0.0867 (0.8076)	0.1214 (0.6481)	0.0208 (0.5755)	-0.4688 (-1.91468)	-0.0967 (-0.59709)	-0.1637 (-0.27291)	0.0018 (0.0271)
Y(-1)	0.5736 (0.9603)	-0.0857 (-0.08222)	0.0955 (0.4749)	-0.5249 (-0.38519)	0.4781 (0.5304)	-1.2200 (-0.36551)	-0.5249 (-1.43289)
Y(-2)	0.7081 (1.0869)	0.9168 (0.8060)	0.2289 (1.0432)	-0.5470 (-0.36799)	-0.3892 (-0.39585)	0.8966 (0.2463)	-0.4211 (-1.05380)
Y(-3)	0.0068 (0.0102)	-0.2276 (-0.19570)	-0.0410 (-0.18289)	-0.1386 (-0.09123)	-0.5499 (-0.54711)	-2.9718 (-0.79843)	-0.1947 (-0.47660)
Y(-4)	0.9009 (1.5407)	-0.7934 (-0.77714)	-0.1449 (-0.73560)	-0.0078 (-0.00586)	-0.6631 (-0.75142)	-4.8358 (-1.47991)	-0.0964 (-0.26871)

VAR MODEL EQUATION ESTIMATES

	BI	CD	CT	E	EX	FF	L
C	0.0062 (0.7213)	0.0047 (0.3154)	0.0045 (1.5501)	-0.0085 (-0.43671)	0.0194 (1.5090)	-0.0047 (-0.09854)	-0.0030 (-0.57153)

Note: Each column in this table represents one of the 14 VAR estimated equations. Thus, the FF column on page 126 represents the regression of contemporaneous Fed funds on four lagged values of each of the other variables and a constant. Each cell lists the estimated coefficient on the row variable for that equation and the relevant t-statistic.

VAR MODEL EQUATION ESTIMATES

	M	NI	P	PE	RI	U	Y
BI(-1)	0.1349 (1.4218)	-0.0123 (-0.04367)	-0.0826 (-2.38870)	0.5821 (0.7196)	-0.0279 (-0.04245)	0.3213 (0.5459)	-0.0049 (-0.03914)
BI(-2)	0.0236 (0.2141)	-0.2421 (-0.73959)	-0.0514 (-1.27981)	-0.9699 (-1.03163)	0.8774 (1.1490)	-1.2217 (-1.78600)	0.1606 (1.1012)
BI(-3)	-0.1313 (-1.20470)	-0.6209 (-1.91999)	-0.0287 (-0.72331)	0.5557 (0.5984)	-0.8386 (-1.11178)	0.2138 (0.3165)	0.0245 (0.1701)
BI(-4)	0.0933 (0.9095)	0.2272 (0.7465)	0.0897 (2.4016)	-0.1772 (-0.20266)	0.1487 (0.2094)	-0.3174 (-0.49905)	-0.0653 (-0.48170)
CD(-1)	0.0065 (0.0969)	-0.5339 (-2.66854)	0.0019 (0.0774)	0.7440 (1.2948)	-0.8401 (-1.79998)	0.4553 (1.0890)	-0.1384 (-1.55223)
CD(-2)	0.0003 (0.0037)	-0.3164 (-1.53651)	-0.0020 (-0.07862)	0.9890 (1.6722)	-0.2345 (-0.48809)	-0.0710 (-0.16491)	-0.0202 (-0.22007)
CD(-3)	-0.0569 (-0.74412)	-0.6407 (-2.82153)	0.0018 (0.0640)	1.9640 (3.0115)	-0.7416 (-1.40011)	0.8107 (1.7087)	-0.2271 (-2.24413)
CD(-4)	0.0479 (0.7009)	-0.0243 (-0.11994)	0.0185 (0.7445)	0.4756 (0.8172)	-0.1127 (-0.23837)	-0.4302 (-1.01600)	-0.0202 (-0.22412)
CT(-1)	0.4759 (1.1443)	3.0914 (2.5047)	-0.0080 (-0.05259)	-4.8672 (-1.37315)	2.1886 (0.7602)	-2.3275 (-0.90255)	0.9293 (1.6900)
CT(-2)	0.3007 (0.7823)	-0.7087 (-0.62132)	-0.1264 (-0.90256)	1.0651 (0.3252)	0.6061 (0.2278)	1.4239 (0.5975)	0.1999 (0.3935)
CT(-3)	0.6713 (1.5854)	2.3716 (1.8872)	-0.1035 (-0.67118)	-0.5365 (-0.14866)	4.0693 (1.3882)	-4.0268 (-1.53363)	1.2104 (2.1618)
CT(-4)	-0.1996 (-0.57846)	-0.5787 (-0.56503)	-0.0731 (-0.58128)	2.6068 (0.8863)	2.1639 (0.9058)	0.3149 (0.1472)	-0.1103 (-0.24177)
E(-1)	0.0208 (0.8219)	0.1345 (1.7876)	0.0000 (0.0037)	0.0763 (0.3534)	-0.0610 (-0.34775)	-0.1157 (-0.73653)	0.0153 (0.4575)
E(-2)	0.0199 (0.8164)	0.0505 (0.6981)	-0.0016 (-0.17568)	-0.4225 (-2.03491)	-0.0585 (-0.34706)	0.1202 (0.7958)	-0.0174 (-0.54008)

VAR MODEL EQUATION ESTIMATES

	M	NI	P	PE	RI	U	Y
E(-3)	-0.0237	0.0196	0.0013	0.1365	0.1432	-0.0166	0.0526
	(-0.86516)	(0.2408)	(0.1321)	(0.5850)	(0.7555)	(-0.09803)	(1.4545)
E(-4)	-0.0335	0.0469	0.0069	-0.1734	-0.1415	0.2857	-0.0215
	(-1.31089)	(0.6176)	(0.7361)	(-0.79552)	(-0.79929)	(1.8014)	(-0.63594)
EX(-1)	-0.0767	-0.1458	0.0316	0.5612	-0.4296	0.6568	-0.0282
	(-1.42805)	(-0.91476)	(1.6132)	(1.2261)	(-1.15558)	(1.9724)	(-0.39701)
EX(-2)	-0.0102	-0.1420	0.0396	-0.6151	-0.2279	0.3105	-0.0503
	(-0.17132)	(-0.80594)	(1.8309)	(-1.21569)	(-0.55463)	(0.8435)	(-0.64088)
EX(-3)	0.0044	0.0429	0.0208	-0.0136	-0.0743	0.1166	-0.0071
	(0.0906)	(0.3010)	(1.1856)	(-0.03324)	(-0.22345)	(0.3912)	(-0.11234)
EX(-4)	-0.0462	0.0733	0.0149	0.4858	0.3404	-0.4148	0.0845
	(-1.08484)	(0.5795)	(0.9594)	(1.3375)	(1.1538)	(-1.56940)	(1.4991)
FF(-1)	-0.0058	-0.0475	0.0028	-0.1331	-0.2551	0.0425	-0.0093
	(-0.50637)	(-1.40844)	(0.6838)	(-1.37304)	(-3.23965)	(0.6030)	(-0.62131)
FF(-2)	0.0164	0.0783	0.0035	0.1700	0.0350	-0.0627	0.0125
	(1.3252)	(2.1310)	(0.7848)	(1.6110)	(0.4079)	(-0.81601)	(0.7624)
FF(-3)	0.0032	0.0269	-0.0031	0.1568	-0.0477	0.0409	-0.0059
	(0.2692)	(0.7643)	(-0.71541)	(1.5521)	(-0.58153)	(0.5565)	(-0.37333)
FF(-4)	0.0253	0.0188	-0.0053	0.0155	0.0410	-0.0347	0.0143
	(2.2865)	(0.5734)	(-1.30487)	(0.1651)	(0.5361)	(-0.50697)	(0.9821)
L(-1)	-0.0344	0.1647	0.0204	-0.8886	1.2110	0.0873	-0.0784
	(-0.28086)	(0.4535)	(0.4586)	(-0.85215)	(1.4297)	(0.1151)	(-0.48477)
L(-2)	0.0409	-0.1733	0.0580	-1.0077	1.1188	0.6578	-0.1681
	(0.3223)	(-0.45986)	(1.2545)	(-0.93115)	(1.2729)	(0.8355)	(-1.00106)
L(-3)	0.0078	-0.0859	-0.0148	-1.5298	-0.3259	0.8245	-0.0434
	(0.0626)	(-0.23134)	(-0.32462)	(-1.43415)	(-0.37611)	(1.0624)	(-0.26236)
L(-4)	0.0393	-0.3427	0.0309	-0.5469	0.8018	0.9789	-0.0353
	(0.3493)	(-1.02661)	(0.7535)	(-0.57060)	(1.0299)	(1.4037)	(-0.23763)

VAR MODEL EQUATION ESTIMATES

	M	NI	P	PE	RI	U	Y
M(-1)	0.3964 (2.3287)	0.1578 (0.3123)	0.2005 (3.2325)	-2.5417 (-1.75170)	-0.6143 (-0.52126)	0.7787 (0.7377)	-0.2801 (-1.24418)
M(-2)	-0.0185 (-0.09963)	0.7662 (1.3917)	-0.1505 (-2.22715)	1.0898 (0.6893)	1.3395 (1.0431)	-1.3365 (-1.16185)	0.3612 (1.4724)
M(-3)	0.0281 (0.1521)	-0.5561 (-1.01559)	0.0191 (0.2836)	0.7443 (0.4733)	-1.5144 (-1.18565)	1.1357 (0.9926)	-0.2161 (-0.88581)
M(-4)	0.1921 (1.2798)	-0.7099 (-1.59328)	0.0387 (0.7070)	-0.0655 (-0.05116)	0.2011 (0.1934)	0.2261 (0.2429)	0.0904 (0.4555)
NI(-1)	0.0167 (0.2749)	-0.1998 (-1.11009)	-0.0072 (-0.32394)	0.3314 (0.6411)	0.2321 (0.5527)	0.0447 (0.1189)	-0.0022 (-0.02801)
NI(-2)	0.0226 (0.3664)	0.3029 (1.6540)	0.0046 (0.2054)	-0.6915 (-1.31471)	0.1802 (0.4220)	-0.4770 (-1.24669)	0.0853 (1.0455)
NI(-3)	-0.1043 (-1.58973)	-0.1287 (-0.66113)	-0.0305 (-1.27756)	0.6679 (1.1944)	-0.6132 (-1.35017)	0.0858 (0.2109)	-0.0042 (-0.04889)
NI(-4)	0.0426 (0.6332)	0.2030 (1.0162)	0.0427 (1.7401)	-0.2244 (-0.39123)	0.6764 (1.4517)	0.2785 (0.6674)	-0.0852 (-0.95714)
P(-1)	0.0518 (0.1315)	-0.6279 (-0.53721)	-0.4706 (-3.27940)	-0.7363 (-0.21936)	-0.3666 (-0.13446)	1.4793 (0.6057)	-0.1198 (-0.22998)
P(-2)	-0.1019 (-0.26110)	-0.6096 (-0.52652)	-0.3704 (-2.60578)	0.8104 (0.2437)	-0.3962 (-0.14670)	-1.8956 (-0.78362)	0.8469 (1.6418)
P(-3)	-0.1792 (-0.40385)	-0.3789 (-0.28771)	-0.2916 (-1.80316)	0.5490 (0.1451)	-3.1091 (-1.01199)	1.5420 (0.5603)	0.0890 (0.1517)
P(-4)	0.4447 (1.1261)	0.7781 (0.6640)	0.1775 (1.2342)	-1.6320 (-0.48492)	-1.8695 (-0.68394)	-1.5316 (-0.62557)	0.4882 (0.9350)
PE(-1)	0.0024 (0.1113)	-0.0689 (-1.06648)	-0.0118 (-1.49274)	0.2415 (1.3023)	0.0300 (0.1993)	-0.0074 (-0.05504)	0.0200 (0.6934)
PE(-2)	-0.0093 (-0.47233)	0.0713 (1.2272)	-0.0034 (-0.47722)	0.2059 (1.2330)	0.0722 (0.5322)	-0.1155 (-0.95071)	0.0030 (0.1153)

VAR MODEL EQUATION ESTIMATES

	M	NI	P	PE	RI	U	Y
PE(-3)	0.0121 (0.6344)	-0.0579 (-1.01976)	-0.0008 (-0.10834)	-0.2686 (-1.64736)	0.0218 (0.1648)	-0.0261 (-0.21967)	-0.0161 (-0.63660)
PE(-4)	0.0369 (1.6148)	0.0666 (0.9824)	-0.0021 (-0.24655)	-0.0933 (-0.47905)	-0.1357 (-0.85725)	-0.0926 (-0.65354)	0.0308 (1.0179)
RI(-1)	0.0437 (1.3285)	0.0758 (0.7770)	0.0009 (0.0727)	0.4865 (1.7358)	0.4965 (2.1811)	-0.2714 (-1.33103)	0.1007 (2.3153)
RI(-2)	-0.0170 (-0.51465)	0.0773 (0.7903)	0.0143 (1.1946)	-0.0690 (-0.24585)	0.1975 (0.8659)	0.0326 (0.1598)	-0.0167 (-0.38230)
RI(-3)	-0.0563 (-1.60221)	-0.0136 (-0.12993)	-0.0069 (-0.54128)	-0.5614 (-1.87446)	-0.0307 (-0.12635)	-0.1377 (-0.63170)	-0.0138 (-0.29728)
RI(-4)	-0.0081 (-0.24304)	0.2808 (2.8433)	0.0227 (1.8684)	-0.0788 (-0.27800)	-0.1438 (-0.62411)	-0.1716 (-0.83150)	0.0508 (1.1551)
U(-1)	0.0880 (2.1199)	-0.2610 (-2.11725)	-0.0006 (-0.03933)	-0.0260 (-0.07351)	-0.3403 (-1.18373)	0.4892 (1.8998)	-0.0950 (-1.72963)
U(-2)	0.0257 (0.6127)	0.1161 (0.9308)	0.0140 (0.9135)	0.4783 (1.3357)	0.1015 (0.3489)	0.0102 (0.0391)	-0.0031 (-0.05625)
U(-3)	0.0061 (0.1430)	0.0206 (0.1627)	-0.0035 (-0.22734)	0.1013 (0.2788)	-0.0475 (-0.16075)	0.0532 (0.2013)	0.0130 (0.2309)
U(-4)	0.0236 (0.6009)	-0.0514 (-0.44070)	-0.0314 (-2.18878)	0.1332 (0.3974)	-0.0041 (-0.01522)	0.1193 (0.4892)	0.0220 (0.4227)
Y(-1)	0.0285 (0.1301)	0.3592 (0.5531)	-0.1046 (-1.31148)	-1.1889 (-0.63747)	-0.1848 (-0.12201)	-0.4248 (-0.31306)	-0.4016 (-1.38794)
Y(-2)	-0.0052 (-0.02180)	0.2931 (0.4138)	-0.0815 (-0.93681)	-1.1465 (-0.56358)	-0.7731 (-0.46790)	-1.3533 (-0.91438)	-0.0025 (-0.00791)
Y(-3)	0.1410 (0.5780)	-0.6009 (-0.82983)	0.0903 (1.0161)	-0.9563 (-0.45985)	0.0186 (0.0110)	0.3451 (0.2281)	-0.0322 (-0.09968)
Y(-4)	0.1308 (0.6108)	-0.6901 (-1.08555)	-0.0574 (-0.73542)	0.0532 (0.0291)	-2.7713 (-1.86881)	1.9138 (1.4408)	-0.3845 (-1.35740)

VAR MODEL EQUATION ESTIMATES

	M	NI	P	PE	RI	U	Y
C	-0.0024 (-0.75655)	0.0050 (0.5367)	-0.0005 (-0.46747)	0.0175 (0.6553)	-0.0078 (-0.36032)	0.0061 (0.3165)	0.0000 (0.0103)

Note: Each column in this table represents one of the 14 VAR estimated equations. Thus, the U column on page 131 represents the regression of contemporaneous unemployment on four lagged values of each of the other variables and a constant. Each cell lists the estimated coefficient on the row variable for that equation and the relevant t-statistic.

VAR ESTIMATED MODEL EQUATION SUMMARY STATISTICS

	BI	CD	CT	E	EX	FF	L
R-squared	0.7377	0.7581	0.7855	0.6957	0.6475	0.8031	0.5907
Adj. R-squared	0.2925	0.3475	0.4216	0.1794	0.0493	0.4690	-0.1038
Sum sq. resids	0.0085	0.0260	0.0010	0.0445	0.0195	0.2667	0.0032
S.E. equation	0.0161	0.0281	0.0054	0.0367	0.0243	0.0899	0.0099
Log likelihood	289.1201	238.9589	387.0512	214.8863	252.0759	134.2546	333.1234
Akaike AIC	-7.9961	-6.8814	-10.1724	-6.3465	-7.1729	-4.5546	-8.9740
Schwarz SC	-6.4129	-5.2982	-8.5891	-4.7632	-5.5897	-2.9714	-7.3907
Mean dependent	-0.0005	0.0103	0.0070	-0.0014	0.0144	-0.0084	-0.0003
S.D. dependent	0.0191	0.0348	0.0071	0.0405	0.0249	0.1234	0.0094

	M	NI	P	PE	RI	U	Y
R-squared	0.8644	0.8111	0.7950	0.7513	0.7862	0.8204	0.7319
Adj. R-squared	0.6343	0.4906	0.4471	0.3292	0.4233	0.5157	0.2770
Sum sq. resids	0.0011	0.0101	0.0002	0.0833	0.0549	0.0441	0.0020
S.E. equation	0.0059	0.0175	0.0021	0.0502	0.0408	0.0365	0.0078
Log likelihood	379.4930	281.5886	470.3643	186.6420	205.3606	215.2715	354.3501
Akaike AIC	-10.0044	-7.8287	-12.0238	-5.7188	-6.1348	-6.3550	-9.4457
Schwarz SC	-8.4212	-6.2455	-10.4405	-4.1356	-4.5516	-4.7718	-7.8624
Mean dependent	0.0163	0.0088	-0.0002	0.0231	0.0046	0.0001	0.0064
S.D. dependent	0.0097	0.0245	0.0029	0.0613	0.0537	0.0525	0.0092

Determinant Residual Covariance	6.11E-60
Log Likelihood	4347.702
Akaike Information Criteria	-118.6125
Schwarz Criteria	-96.44756

Sample(adjusted): 1974:3 1996:4

Included observations: 90 after adjusting endpoints

APPENDIX C

IMPULSE RESPONSE FUNCTIONS

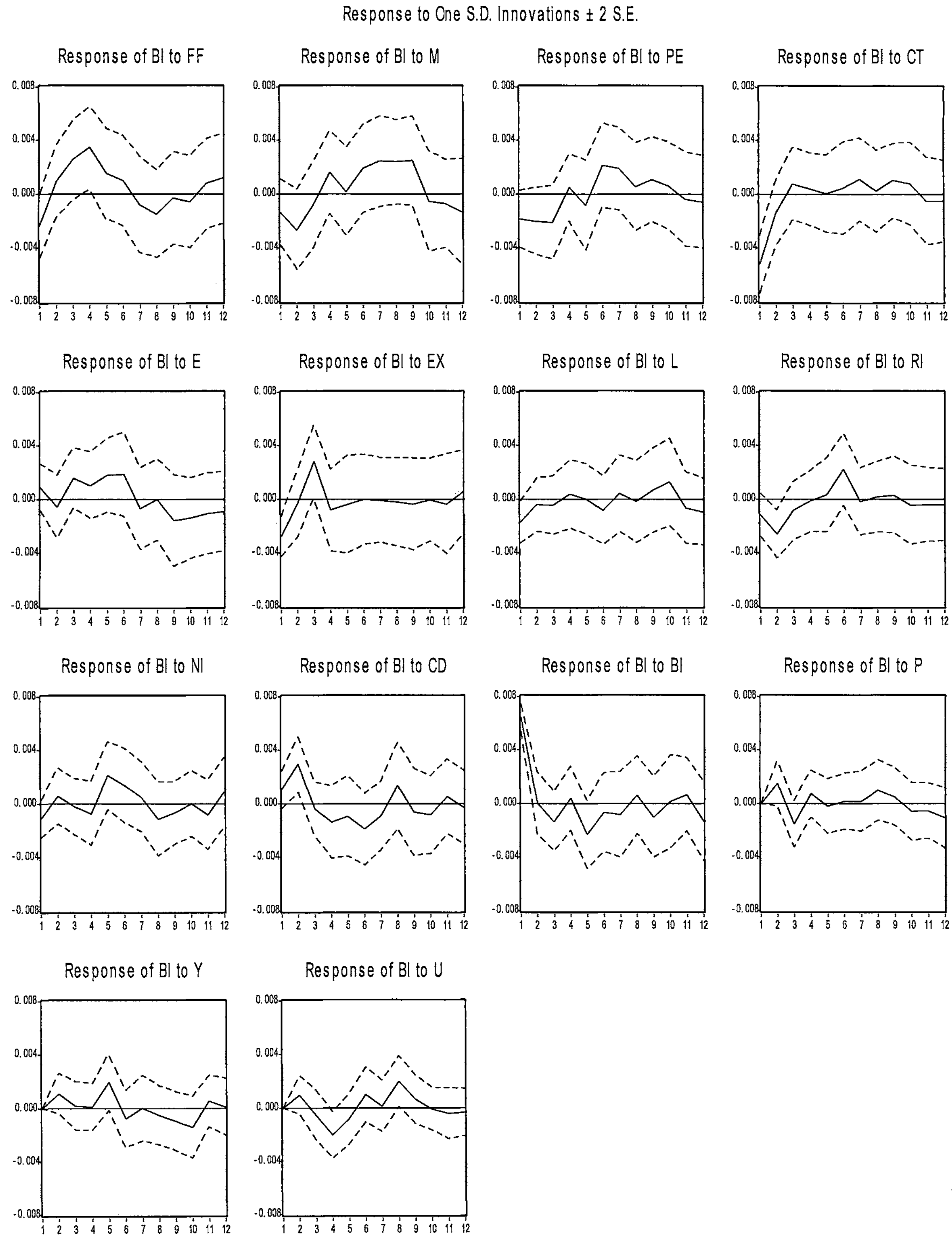

Figure 13. Business Inventory Impulse Responses

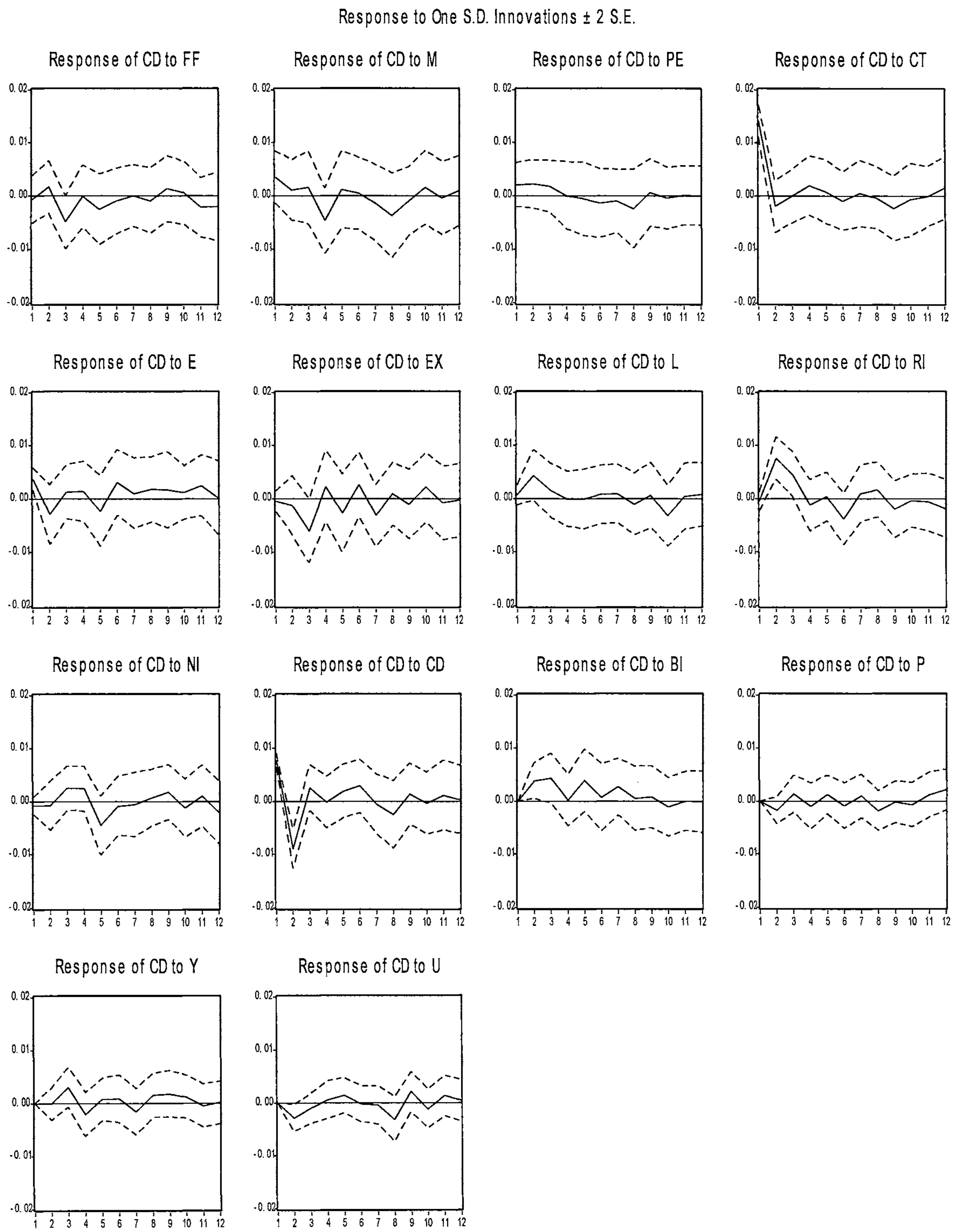

Figure 14. Consumer Durables Impulse Responses

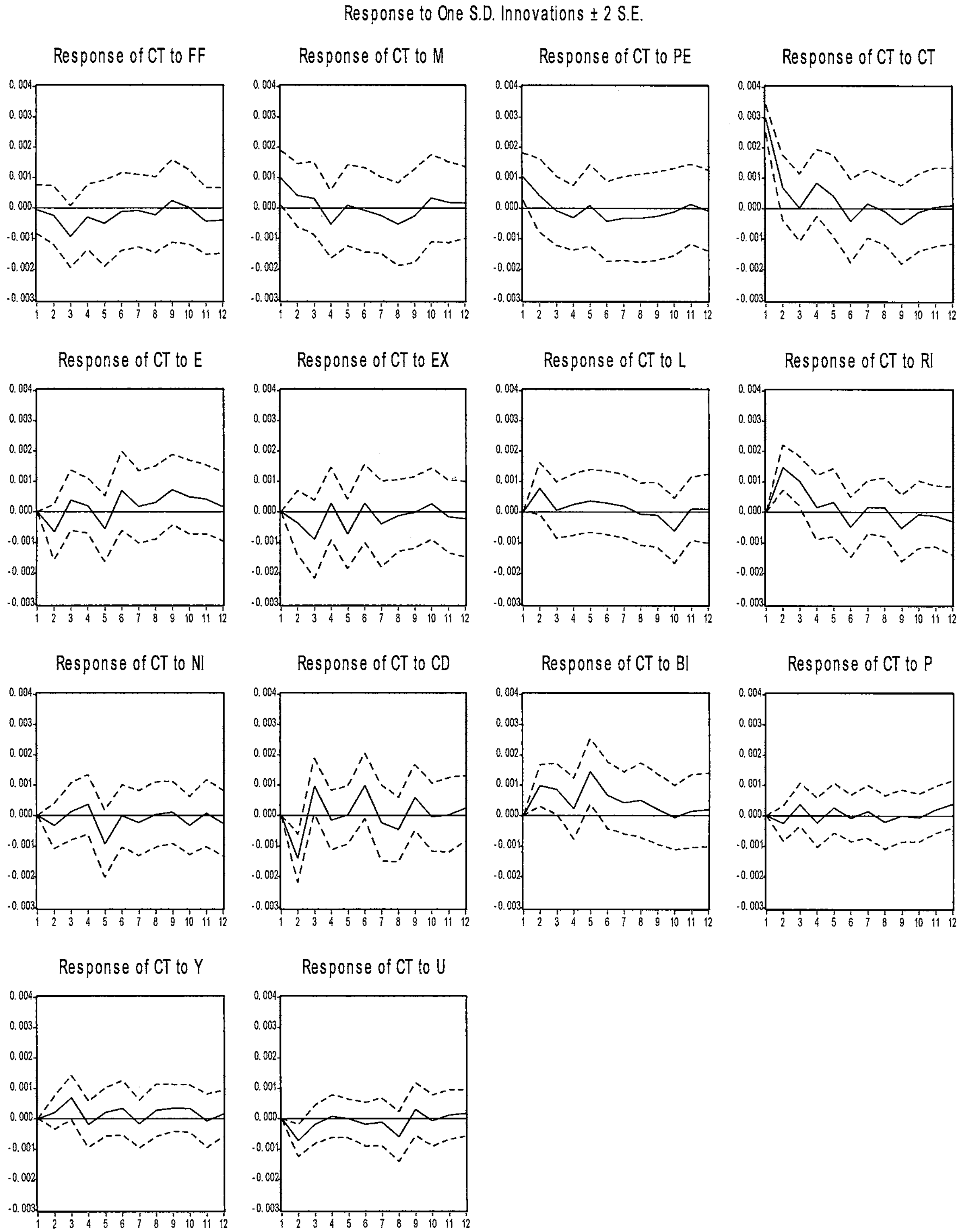

Figure 15. Consumption Impulse Responses

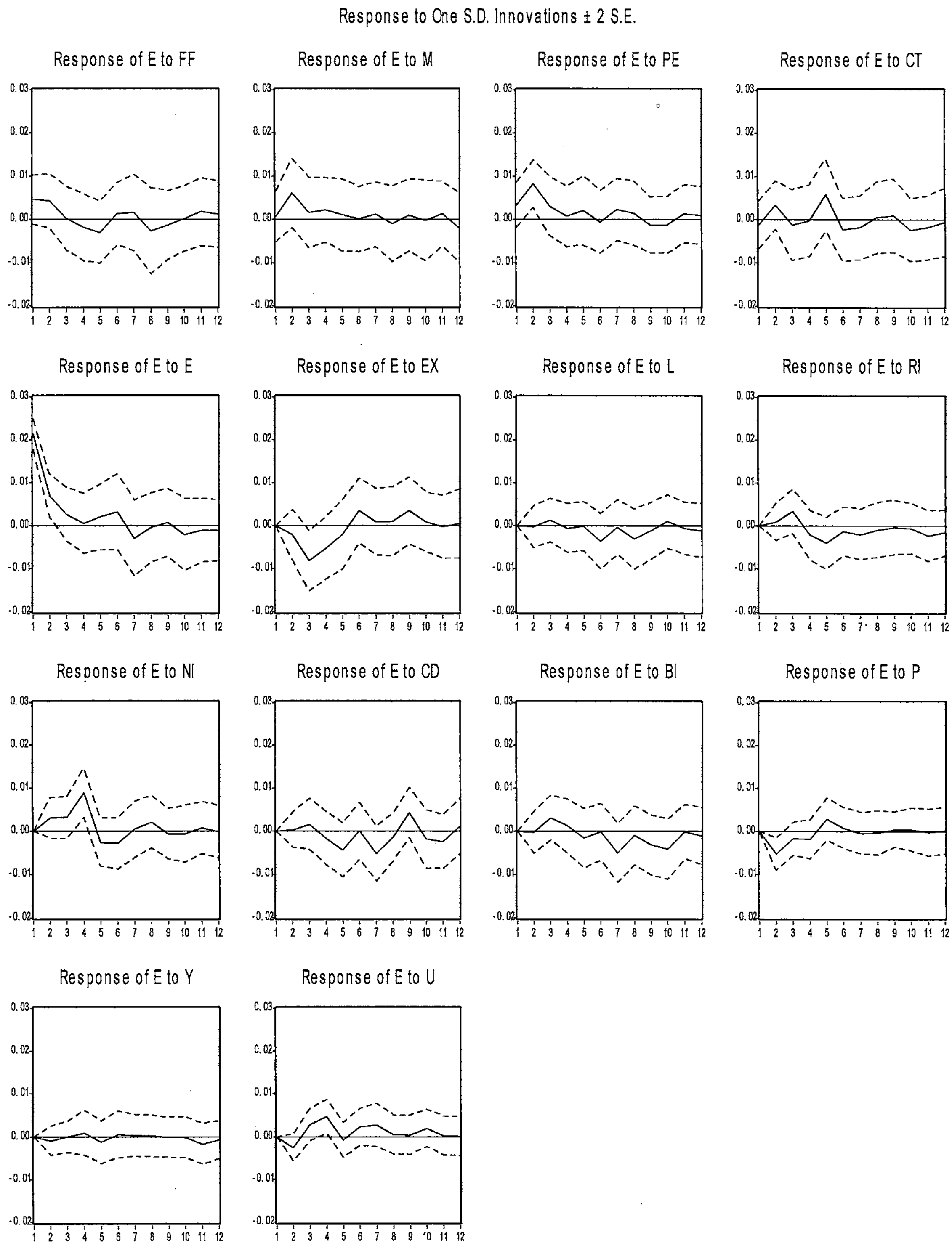

Figure 16. Dollar Exchange Value Impulse Responses

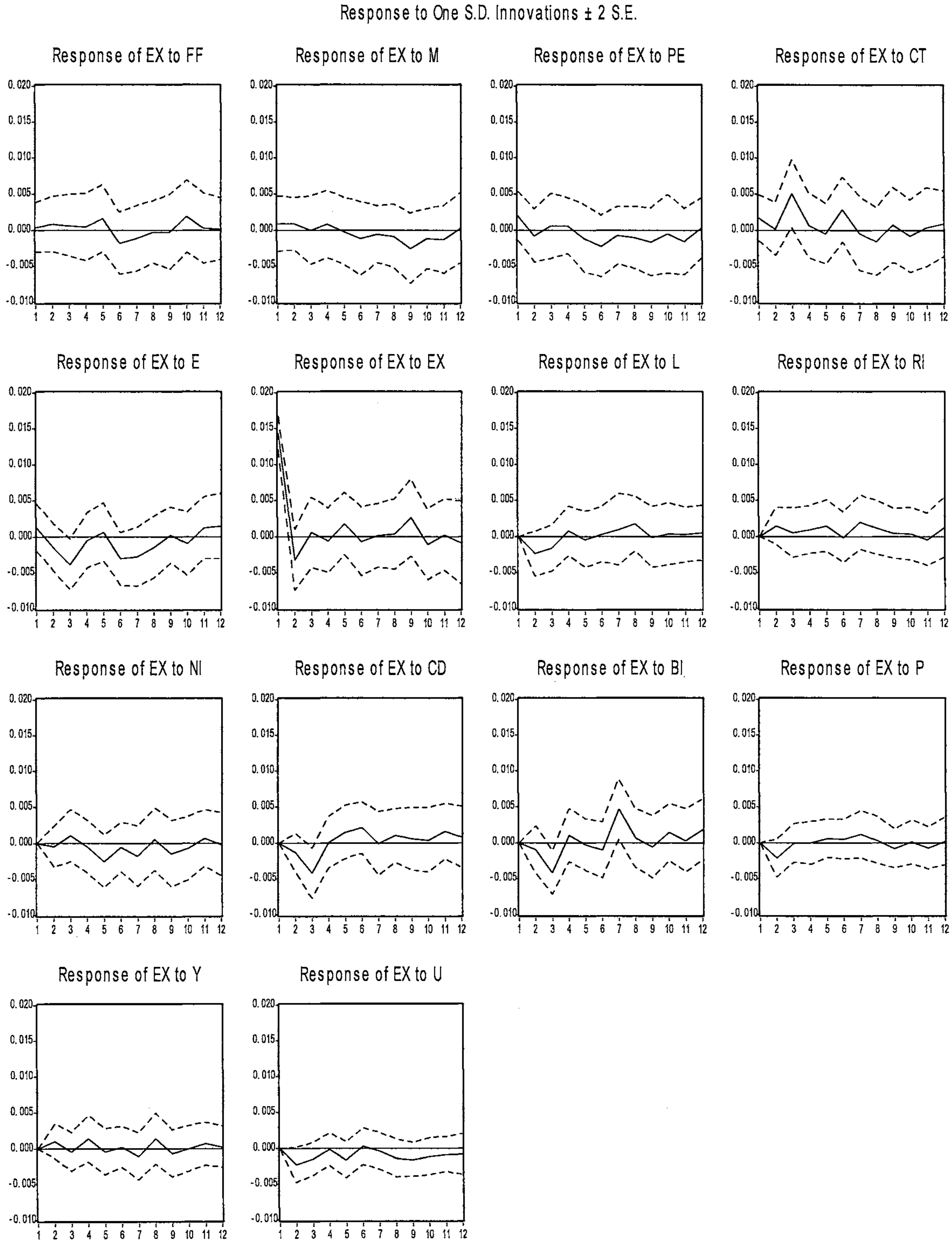

Figure 17. U.S. Exports Impulse Responses

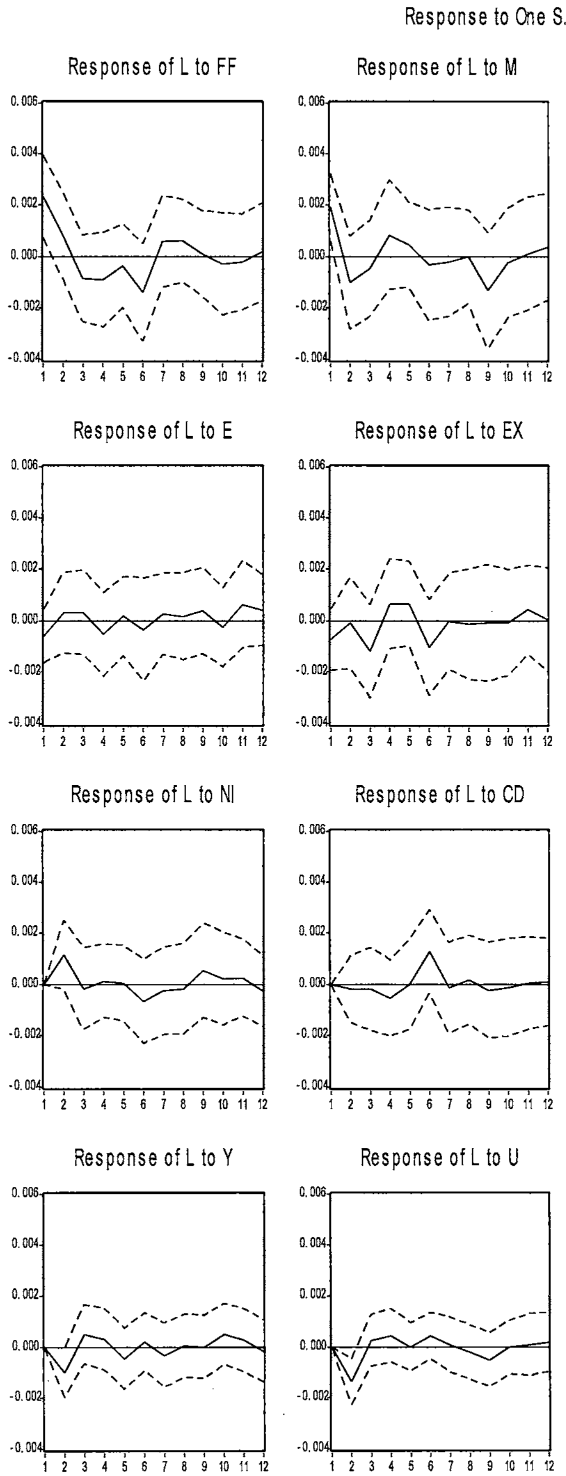

Figure 18. Bank Lending Impulse Responses

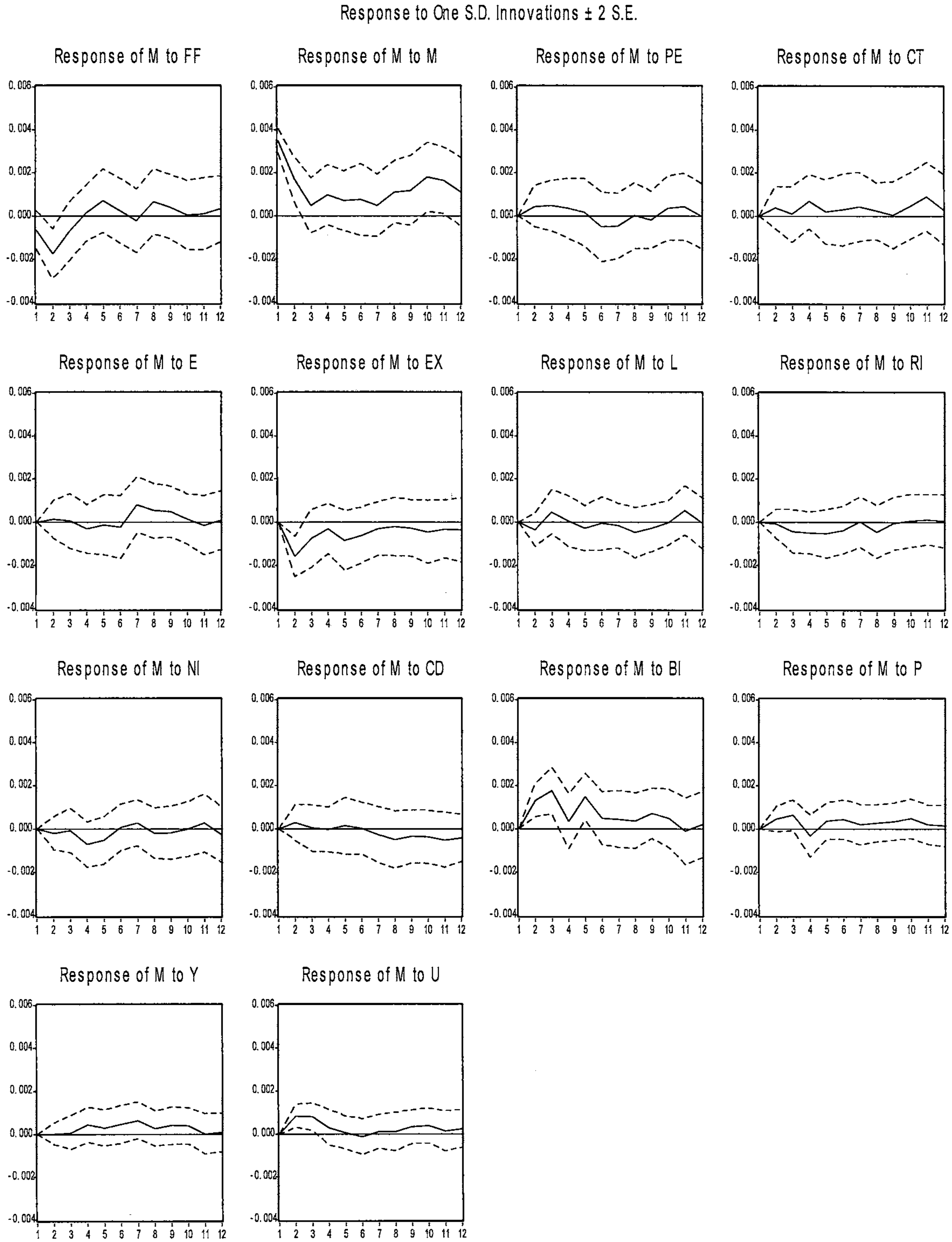

Figure 19. M2 Money Supply Impulse Responses

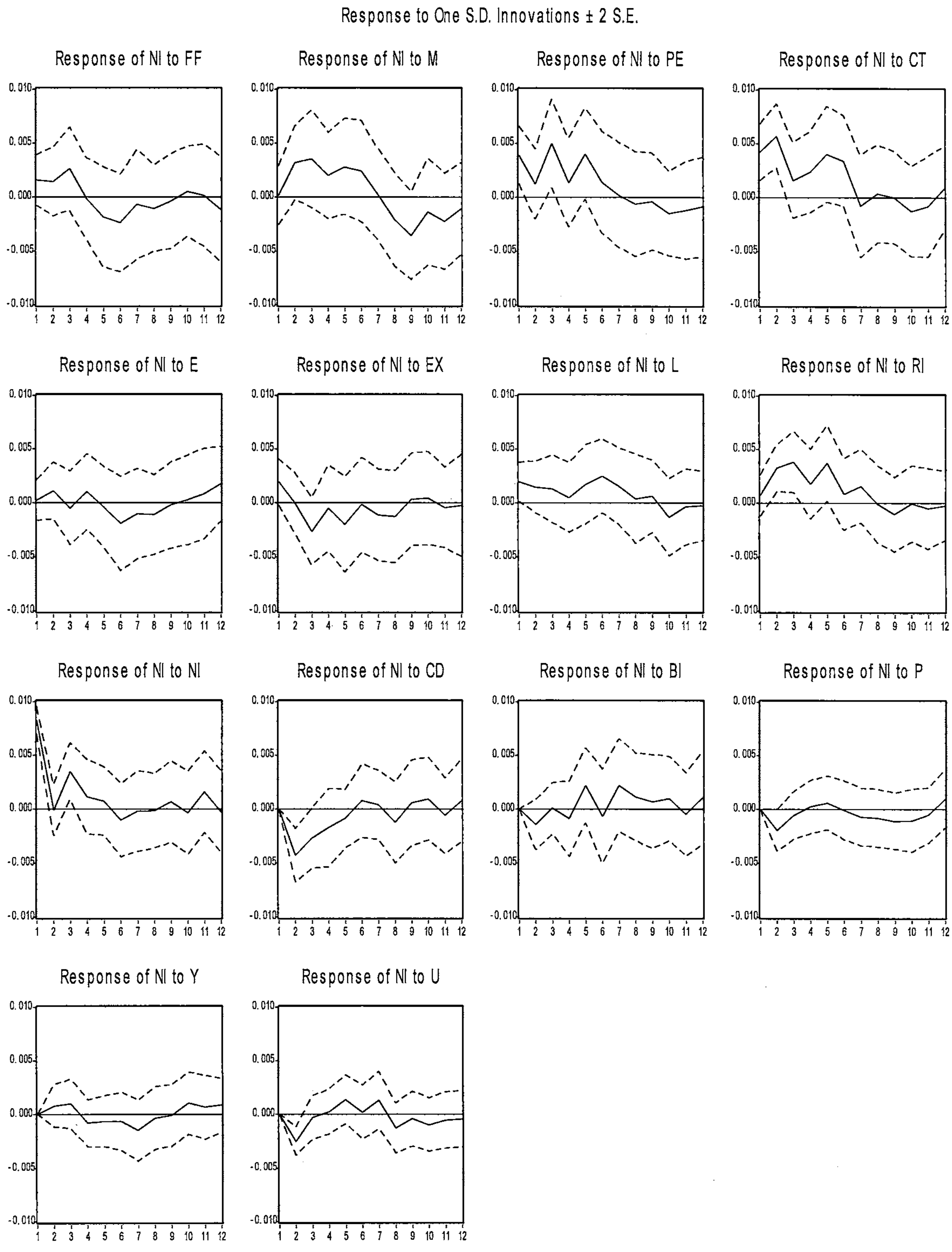

Figure 20. Non-Residential Investment Impulse Responses

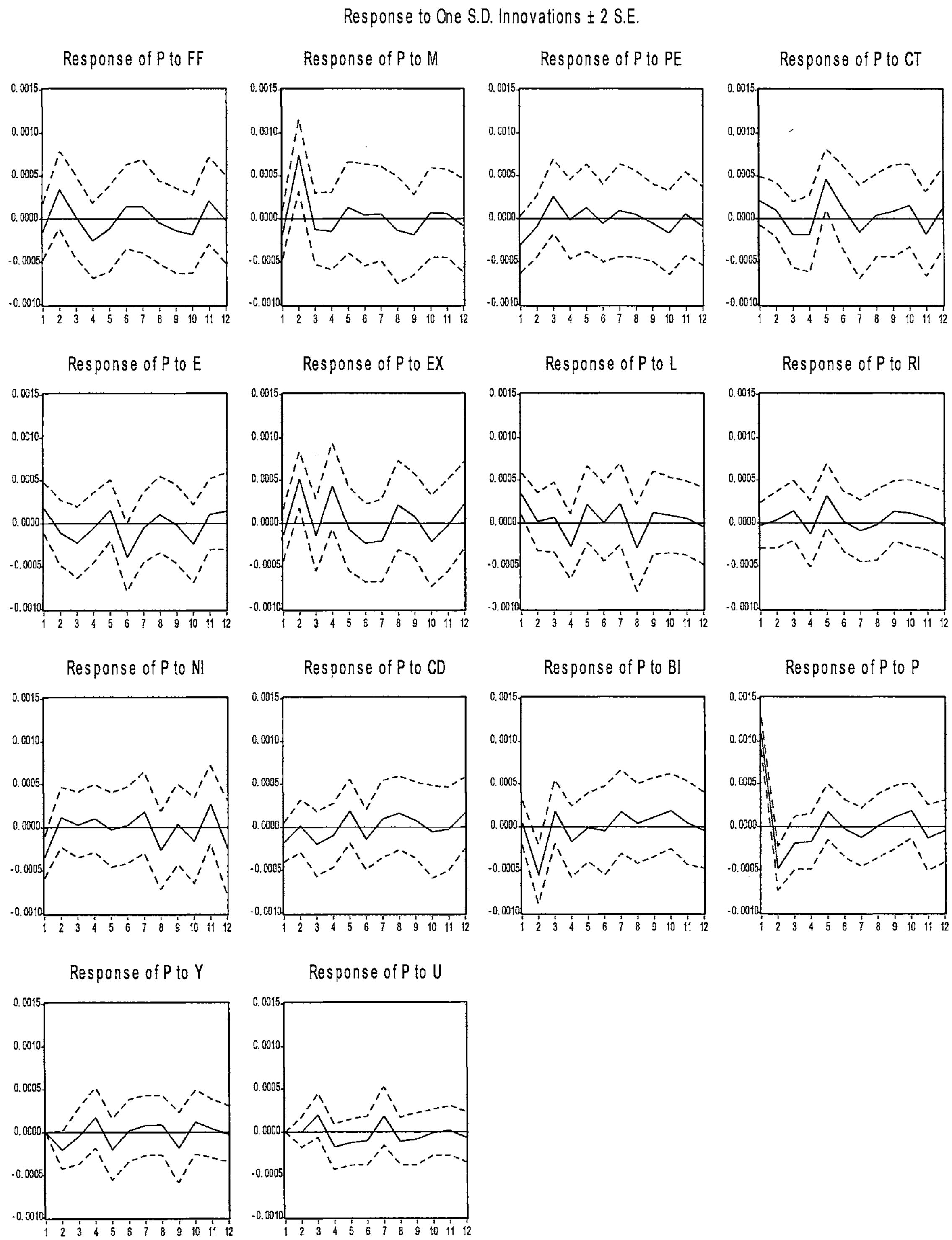

Figure 21. Price Level Impulse Responses

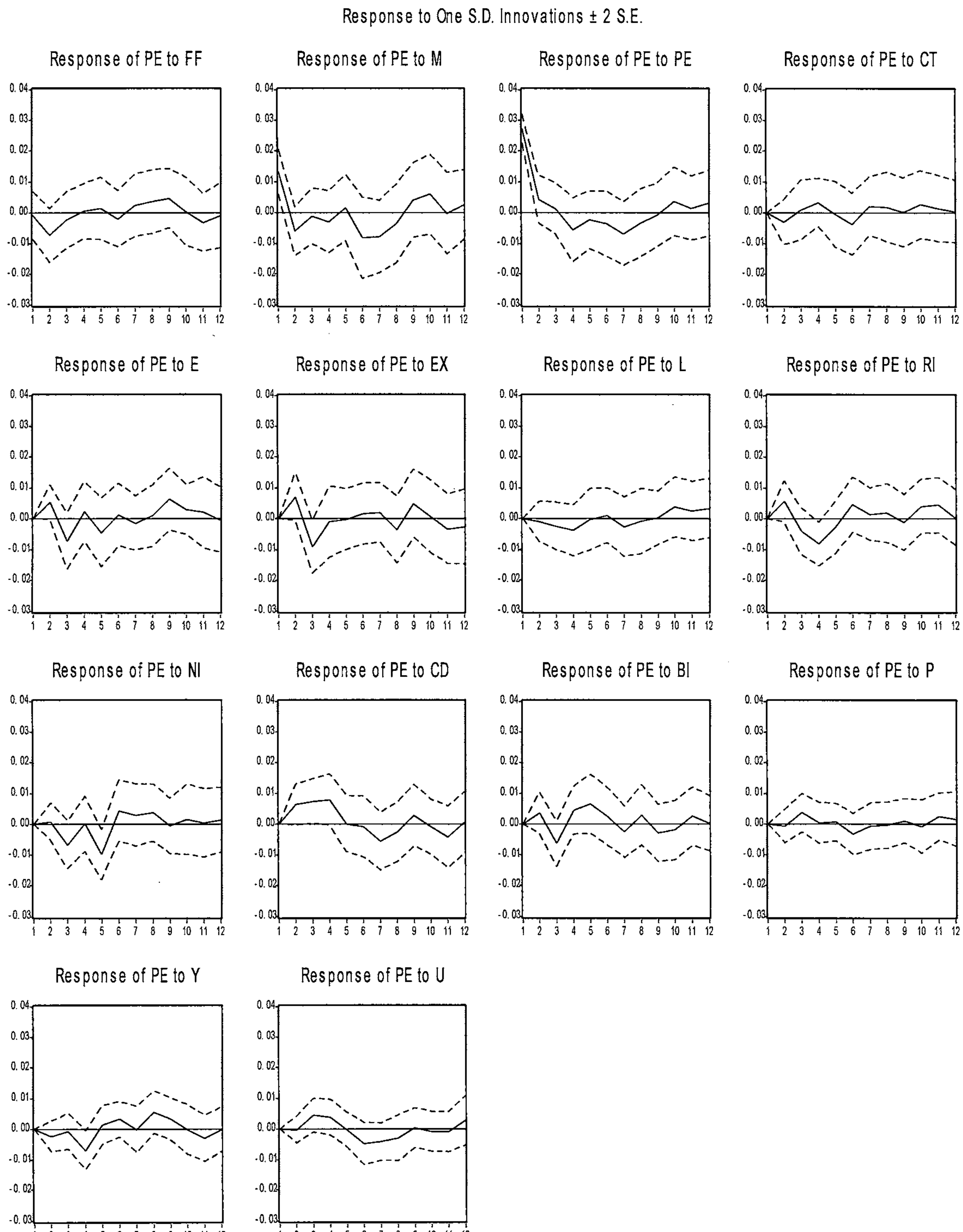

Figure 22. Equity Price Impulse Responses

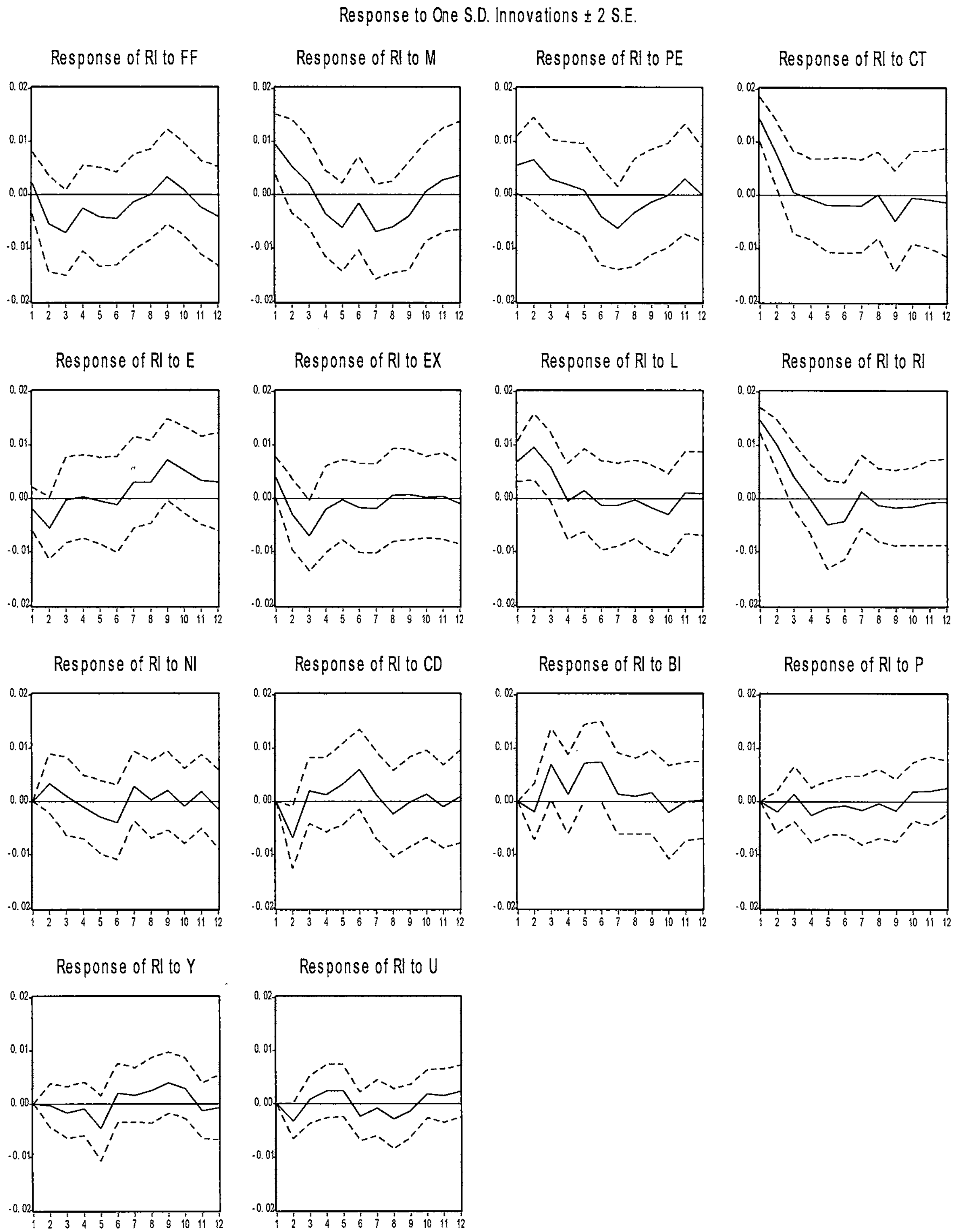

Figure 23. Residential Investment Impulse Responses

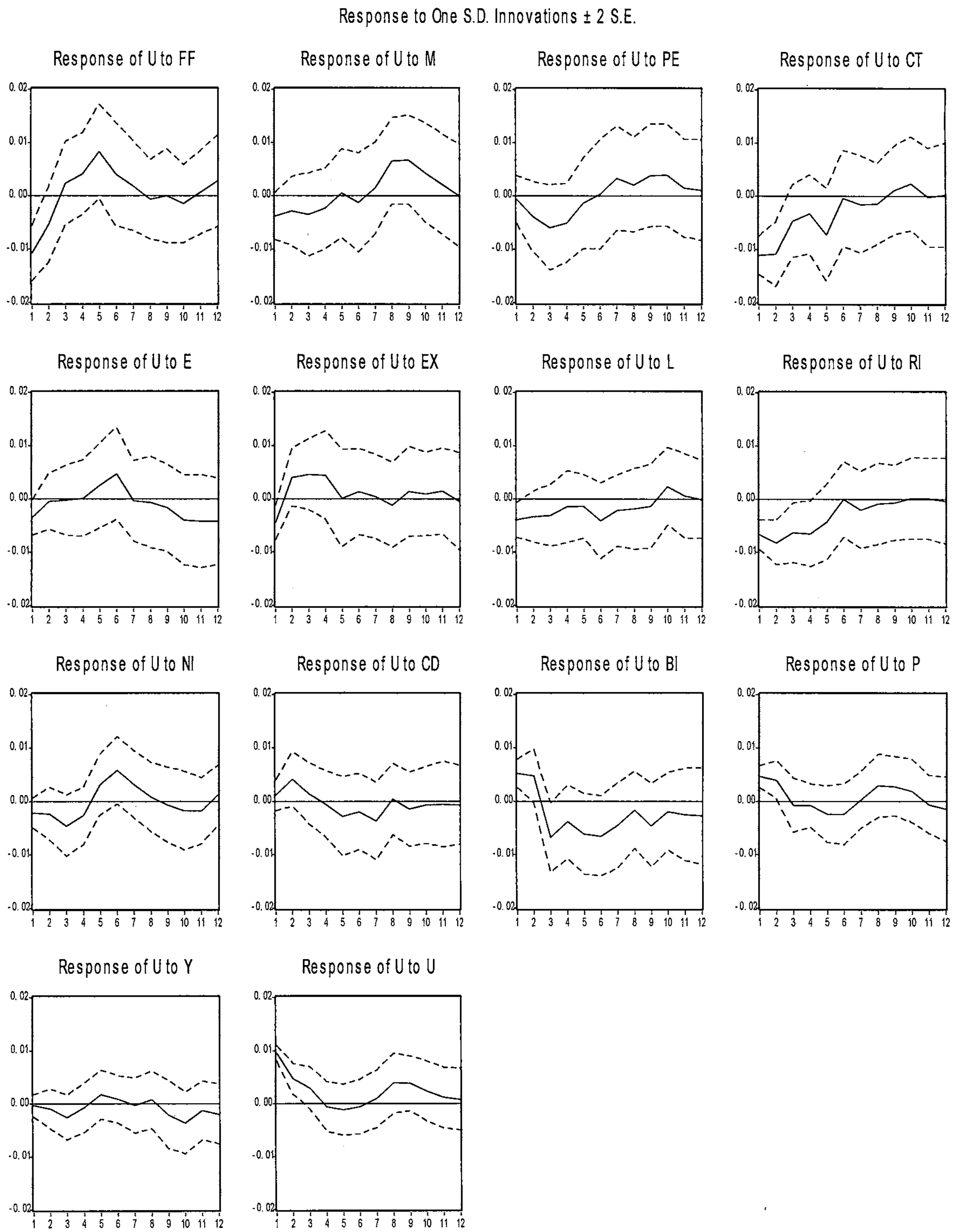

Figure 24. Unemployment Impulse Responses

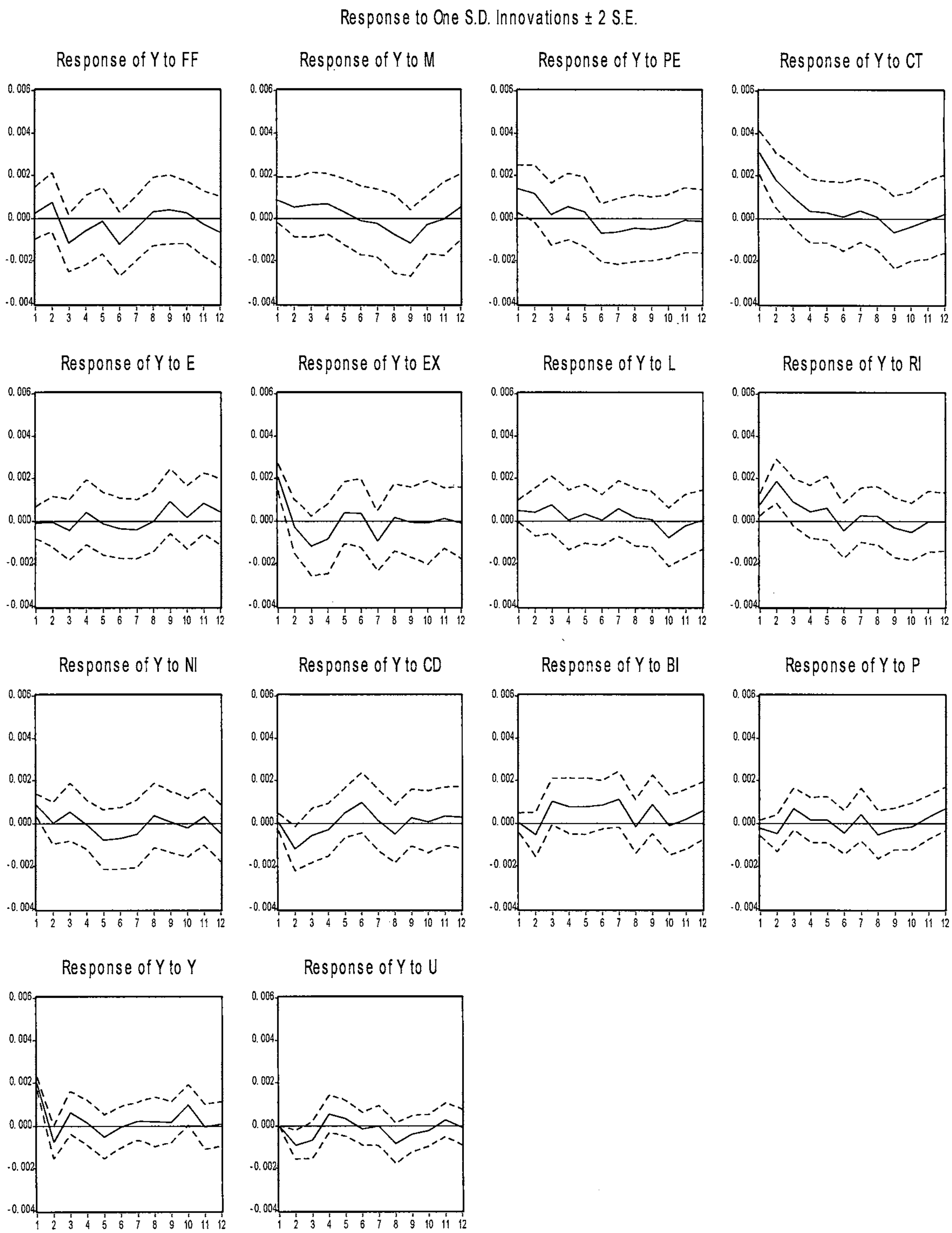

Figure 25. Output Impulse Responses

APPENDIX D

VARIANCE DECOMPOSITIONS

TABLE 12
VARIANCE DECOMPOSITION OF BI

Period	BI	CD	CT	E	EX	FF	L
1	43.71	1.17	28.99	0.85	7.99	5.96	3.03
2	28.22	5.68	21.54	1.22	5.80	4.22	4.91
3	26.12	4.65	20.05	5.17	5.39	5.25	4.60
4	22.96	4.83	17.81	5.19	6.19	8.66	4.22
5	19.40	3.89	14.34	8.60	4.56	11.76	5.49
6	15.55	3.08	14.05	12.99	4.50	12.35	5.96
7	13.72	2.71	16.59	11.51	4.30	11.33	5.45
8	12.49	2.86	15.07	10.41	4.74	10.44	4.93
9	11.25	3.41	14.71	11.11	4.40	9.37	4.67
10	9.57	4.49	12.60	16.69	4.28	8.89	4.23
11	8.73	4.05	11.29	17.65	6.04	10.61	3.89
12	8.15	4.22	10.47	20.36	6.02	10.23	3.60
Average	***18.32***	***3.75***	***16.46***	***10.15***	***5.35***	***9.09***	***4.58***

Period	M	NI	P	PE	RI	U	Y
1	1.97	1.32	0.00	3.66	1.36	0.00	0.00
2	4.85	0.90	1.71	3.07	15.79	1.97	0.12
3	6.15	1.53	2.31	2.51	13.91	1.77	0.60
4	5.37	1.88	2.37	2.19	12.25	5.41	0.67
5	3.91	2.96	2.04	4.58	9.44	5.81	3.22
6	3.55	3.20	1.63	3.89	10.88	4.80	3.58
7	5.52	3.10	1.56	5.48	10.73	4.79	3.19
8	10.49	3.01	1.42	5.32	11.36	4.33	3.14
9	11.92	3.30	3.16	4.82	10.17	4.31	3.41
10	11.03	3.19	2.74	4.01	8.49	3.59	6.19
11	10.04	4.40	2.46	4.16	7.75	3.34	5.58
12	9.39	5.01	2.33	3.87	8.07	3.11	5.17
Average	***7.01***	***2.82***	***1.98***	***3.96***	***10.02***	***3.60***	***2.90***

Ordering: FF M PE CT E EX L RI NI CD BI P Y U

TABLE 13
VARIANCE DECOMPOSITION OF CD

Period	BI	CD	CT	E	EX	FF	L
1	0.00	20.49	68.17	4.77	0.07	0.17	0.16
2	4.32	33.25	35.66	4.63	0.44	0.09	7.05
3	5.63	28.39	28.74	3.98	0.56	6.02	6.01
4	4.87	24.67	24.78	3.94	2.10	5.74	5.24
5	5.08	23.09	21.42	5.20	1.72	8.06	4.51
6	4.51	20.58	20.25	5.81	2.24	8.31	4.97
7	5.16	19.55	19.95	5.58	2.52	7.91	5.28
8	4.84	19.58	18.54	5.62	2.63	7.35	5.22
9	4.51	19.22	16.72	7.15	2.39	6.53	4.97
10	4.10	17.50	15.54	9.59	2.28	7.08	4.60
11	3.82	16.32	14.76	11.87	2.90	7.01	5.01
12	3.69	15.94	14.65	13.19	2.97	7.10	4.85
Average	***4.21***	***21.55***	***24.93***	***6.78***	***1.90***	***5.95***	***4.82***

Period	M	NI	P	PE	RI	U	Y
1	4.36	0.23	0.00	1.49	0.08	0.00	0.00
2	2.36	0.17	0.05	1.92	8.36	1.48	0.23
3	6.73	0.16	0.05	1.53	9.79	1.38	1.04
4	9.63	0.69	2.35	1.82	9.83	3.32	1.00
5	8.62	4.73	2.29	1.67	8.36	4.39	0.87
6	7.81	4.46	2.07	1.84	11.88	3.93	1.35
7	8.70	4.37	2.22	1.90	11.73	3.77	1.35
8	11.19	4.44	2.10	1.87	10.83	3.97	1.81
9	10.82	7.27	3.11	1.76	9.62	3.92	2.01
10	9.84	6.64	2.83	2.43	8.76	3.84	4.97
11	9.25	6.84	2.80	2.37	8.87	3.58	4.63
12	8.95	6.63	3.24	2.29	8.57	3.45	4.47
Average	***8.19***	***3.89***	***1.93***	***1.91***	***8.89***	***3.09***	***1.98***

Ordering: FF M PE CT E EX L RI NI CD BI P Y U

TABLE 14
VARIANCE DECOMPOSITION OF CT

Period	BI	CD	CT	E	EX	FF	L
1	0.00	0.00	81.04	0.00	0.00	0.02	0.00
2	6.56	16.30	42.05	3.36	0.07	1.88	4.19
3	8.28	15.45	31.50	2.51	0.08	9.51	4.18
4	7.23	13.98	30.64	2.31	0.40	8.94	4.66
5	9.38	11.13	25.82	5.34	0.33	11.64	4.67
6	8.64	9.75	26.51	5.53	2.01	12.27	4.35
7	8.25	9.21	25.72	5.45	2.06	11.58	4.73
8	7.79	8.89	24.24	5.62	2.58	11.33	4.60
9	6.81	10.45	22.04	8.39	2.21	9.72	4.07
10	6.04	9.21	19.46	12.12	2.47	10.42	3.93
11	5.49	8.39	17.86	14.26	3.68	10.47	5.33
12	5.26	8.37	17.20	16.08	3.84	10.18	5.07
Average	***6.64***	***10.10***	***30.34***	***6.75***	***1.64***	***9.00***	***4.15***

Period	M	NI	P	PE	RI	U	Y
1	9.06	0.00	0.00	9.88	0.00	0.00	0.00
2	6.22	0.19	0.03	5.46	10.34	3.35	0.00
3	9.27	0.49	1.02	4.84	9.49	2.47	0.89
4	9.17	0.51	2.92	4.60	8.94	4.79	0.91
5	7.33	5.44	2.53	4.53	6.87	4.19	0.80
6	6.54	5.17	2.16	3.88	8.81	3.56	0.83
7	8.02	5.26	2.06	3.88	9.29	3.67	0.82
8	10.87	5.29	1.97	3.68	8.81	3.50	0.84
9	10.71	6.44	3.02	3.27	8.58	3.28	1.03
10	9.52	5.68	2.73	3.41	7.81	2.99	4.21
11	8.87	5.55	2.61	3.27	7.63	2.78	3.83
12	8.44	6.21	2.54	3.16	7.25	2.66	3.74
Average	***8.67***	***3.85***	***1.97***	***4.49***	***7.82***	***3.10***	***1.49***

Ordering: FF M PE CT E EX L RI NI CD BI P Y U

TABLE 15
VARIANCE DECOMPOSITION OF E

Period	BI	CD	CT	E	EX	FF	L
1	0.00	0.00	0.32	92.90	0.00	4.26	0.00
2	0.05	1.08	3.04	58.61	0.84	11.04	0.89
3	0.06	0.97	2.91	50.12	5.00	10.52	1.37
4	0.09	0.78	2.71	39.13	9.33	8.33	1.29
5	0.08	2.56	10.66	32.22	9.57	6.97	2.12
6	1.10	2.53	10.42	29.60	10.04	7.12	2.17
7	1.14	3.18	9.91	27.92	9.83	7.79	2.06
8	1.03	4.11	9.01	27.97	9.07	9.55	2.68
9	1.21	4.07	9.47	25.56	11.13	10.13	2.47
10	2.33	4.33	9.26	24.53	11.19	9.66	3.26
11	2.22	4.28	9.26	23.43	10.72	10.13	3.18
12	2.53	3.97	8.67	21.31	10.04	9.87	3.84
Average	***0.99***	***2.66***	***7.14***	***37.78***	***8.06***	***8.78***	***2.11***

Period	M	NI	P	PE	RI	U	Y
1	0.08	0.00	0.00	2.43	0.00	0.00	0.00
2	0.64	0.68	9.57	12.05	0.48	0.99	0.03
3	0.56	0.59	10.32	10.47	5.80	0.95	0.38
4	0.68	13.56	9.30	8.27	4.72	1.49	0.30
5	1.25	11.17	9.85	7.52	3.94	1.77	0.31
6	3.93	10.28	9.05	7.14	3.98	2.24	0.40
7	3.98	10.32	9.67	6.77	4.15	2.91	0.38
8	3.62	9.55	8.85	6.15	4.17	3.36	0.88
9	3.34	10.14	8.22	6.02	3.88	3.16	1.19
10	3.18	9.60	8.47	5.74	4.34	2.99	1.13
11	3.14	9.41	8.90	5.55	4.48	4.01	1.27
12	8.00	8.90	8.32	5.32	4.06	3.82	1.36
Average	***2.70***	***7.85***	***8.38***	***6.95***	***3.67***	***2.31***	***0.64***

Ordering: FF M PE CT E EX L RI NI CD BI P Y U

TABLE 16
VARIANCE DECOMPOSITION OF EX

Period	BI	CD	CT	E	EX	FF	L
1	0.00	0.00	1.36	0.75	95.64	0.07	0.00
2	0.35	1.69	1.16	1.57	76.10	1.37	2.06
3	9.57	6.82	9.00	6.74	49.68	1.81	3.73
4	9.28	5.99	10.90	6.06	43.98	3.34	4.65
5	9.98	5.56	9.93	5.75	39.91	3.87	4.36
6	9.10	6.91	10.11	6.15	36.89	3.54	3.97
7	10.21	5.96	8.55	9.09	30.06	6.49	5.95
8	8.77	4.91	7.93	11.67	25.93	8.23	7.94
9	7.94	4.47	8.48	11.33	27.39	8.71	7.17
10	7.24	4.29	8.93	10.94	25.55	8.56	6.55
11	7.69	4.20	8.37	10.26	23.95	8.05	6.71
12	7.17	4.04	7.69	10.90	22.18	8.45	6.23
Average	***7.27***	***4.57***	***7.70***	***7.60***	***41.44***	***5.21***	***4.94***

Period	M	NI	P	PE	RI	U	Y
1	0.35	0.00	0.00	1.83	0.00	0.00	0.00
2	0.32	0.26	3.02	5.02	3.33	3.75	0.00
3	0.42	0.57	2.15	3.80	2.19	3.52	0.01
4	0.45	0.79	1.93	3.84	4.81	3.49	0.51
5	1.19	1.74	2.01	3.83	5.35	5.46	1.05
6	1.15	1.94	2.58	4.76	6.42	5.03	1.43
7	1.32	1.58	3.92	4.01	6.59	4.72	1.55
8	3.88	1.33	3.69	3.37	5.78	3.90	2.67
9	3.56	2.47	3.63	3.15	5.74	3.52	2.44
10	5.23	3.84	3.41	2.98	6.13	3.70	2.65
11	6.63	3.60	3.60	3.02	7.86	3.53	2.55
12	7.27	3.65	5.32	2.84	7.25	3.84	3.18
Average	***2.65***	***1.81***	***2.94***	***3.54***	***5.12***	***3.70***	***1.50***

Ordering: FF M PE CT E EX L RI NI CD BI P Y U

TABLE 17
VARIANCE DECOMPOSITION OF FF

Period	BI	CD	CT	E	EX	FF	L
1	0.00	0.00	0.00	0.00	0.00	100.00	0.00
2	3.47	2.27	12.40	1.59	0.65	54.02	0.01
3	3.46	2.41	12.21	1.44	1.84	43.18	0.50
4	2.99	2.51	11.29	1.21	3.02	36.45	0.73
5	3.54	2.56	13.56	1.19	2.60	31.27	4.18
6	9.33	2.31	9.74	7.32	1.99	24.66	4.70
7	7.45	1.84	9.96	11.17	5.72	23.35	4.05
8	6.61	2.04	8.75	13.56	5.48	24.19	4.47
9	6.17	1.94	8.42	13.91	5.44	22.78	5.73
10	5.70	1.96	10.23	13.13	5.66	21.44	5.28
11	5.48	2.06	9.51	13.36	5.70	20.38	5.04
12	4.95	2.11	8.56	13.01	7.48	18.59	4.54
Average	***4.93***	***2.00***	***9.55***	***7.57***	***3.80***	***35.03***	***3.27***

Period	M	NI	P	PE	RI	U	Y
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	5.41	0.69	6.67	0.92	5.11	6.42	0.38
3	4.32	0.58	5.53	2.05	11.19	10.12	1.17
4	5.23	3.71	6.94	2.04	14.16	8.53	1.18
5	5.25	3.89	6.97	2.01	13.74	7.38	1.84
6	9.64	4.36	5.59	2.97	9.93	5.55	1.91
7	9.27	4.26	5.09	2.38	7.99	4.73	2.74
8	8.67	3.72	4.59	2.17	7.19	4.59	3.98
9	8.69	4.28	4.18	2.04	8.10	4.25	4.05
10	8.90	3.93	5.79	1.90	7.98	3.93	4.17
11	10.68	3.54	5.64	1.89	7.18	4.05	5.47
12	12.10	5.28	5.15	1.71	7.20	4.20	5.12
Average	***7.35***	***3.19***	***5.18***	***1.84***	***8.31***	***5.31***	***2.67***

Ordering: FF M PE CT E EX L RI NI CD BI P Y U

TABLE 18
VARIANCE DECOMPOSITION OF L

Period	BI	CD	CT	E	EX	FF	L
1	0.00	0.00	10.59	0.97	1.49	15.18	50.01
2	0.54	1.12	8.37	1.13	4.03	10.70	38.47
3	0.48	1.01	7.26	0.99	6.77	9.93	33.47
4	0.65	0.87	8.34	1.77	5.77	9.47	28.76
5	2.55	0.73	8.58	1.92	6.41	9.52	24.77
6	2.70	2.79	7.59	2.27	5.74	10.60	22.03
7	2.63	3.10	7.95	2.63	5.29	9.74	21.34
8	2.56	3.01	7.91	2.54	5.15	9.40	20.60
9	2.75	3.17	7.48	2.70	4.87	8.84	19.35
10	2.84	2.86	9.84	2.88	4.38	7.97	19.46
11	2.74	3.09	8.93	6.53	4.89	7.27	17.00
12	2.81	3.17	9.14	7.20	5.13	8.16	16.28
Average	***1.94***	***2.08***	***8.50***	***2.79***	***4.99***	***9.73***	***25.96***

Period	M	NI	P	PE	RI	U	Y
1	10.28	0.00	0.00	11.48	0.00	0.00	0.00
2	6.92	1.70	7.00	8.17	4.90	5.97	0.98
3	8.72	1.94	6.88	10.86	4.26	5.17	2.27
4	7.92	2.04	7.93	13.82	3.65	7.06	1.95
5	9.93	2.48	6.92	13.51	4.37	6.18	2.14
6	9.43	4.64	6.57	11.98	5.47	6.29	1.89
7	8.76	4.80	6.60	11.45	5.97	7.01	2.72
8	8.50	4.64	7.89	11.09	6.89	6.77	3.04
9	9.76	4.41	7.73	10.58	7.27	7.16	3.93
10	9.53	3.98	7.52	10.30	7.60	6.55	4.29
11	10.23	7.08	6.62	9.00	6.66	5.73	4.24
12	9.76	7.08	6.31	8.97	6.39	5.47	4.13
Average	***9.15***	***3.73***	***6.50***	***10.93***	***5.29***	***5.78***	***2.63***

Ordering: FF M PE CT E EX L RI NI CD BI P Y U

TABLE 19
VARIANCE DECOMPOSITION OF M

Period	BI	CD	CT	E	EX	FF	L
1	0.00	0.00	0.00	0.00	0.00	3.14	0.00
2	7.13	0.00	0.18	0.10	8.39	14.68	1.78
3	16.37	0.00	0.30	2.29	5.21	18.51	1.94
4	13.32	0.32	0.34	5.20	4.32	16.86	1.73
5	16.48	0.42	0.75	5.21	3.56	14.76	2.77
6	14.95	0.52	0.84	4.86	3.46	13.70	5.00
7	13.70	1.06	1.21	6.51	4.60	12.58	4.64
8	12.81	1.02	1.43	9.05	5.49	12.53	5.48
9	11.78	1.06	1.94	13.27	6.01	13.23	5.60
10	11.24	1.13	1.77	14.79	7.13	12.51	6.18
11	10.48	1.37	2.44	14.01	8.24	11.76	5.74
12	10.10	1.41	2.37	13.53	8.41	11.43	5.98
Average	***11.53***	***0.69***	***1.13***	***7.40***	***5.40***	***12.97***	***3.90***

Period	M	NI	P	PE	RI	U	Y
1	96.86	0.00	0.00	0.00	0.00	0.00	0.00
2	61.20	0.13	0.62	2.47	0.32	2.90	0.09
3	39.38	0.24	2.81	4.12	1.94	6.46	0.44
4	35.26	2.02	2.16	4.86	6.19	6.93	0.47
5	29.34	3.93	2.15	4.43	8.79	6.51	0.91
6	26.55	6.08	2.28	4.13	10.55	6.14	0.95
7	25.28	5.70	2.12	3.76	9.98	5.82	3.05
8	22.90	5.20	2.00	3.90	9.20	5.28	3.72
9	19.84	4.55	1.79	3.42	8.09	4.57	4.85
10	19.02	4.37	1.67	3.19	7.48	4.50	5.02
11	19.49	4.47	1.83	4.08	7.00	4.29	4.80
12	20.47	4.44	1.81	3.93	6.74	4.55	4.83
Average	***34.63***	***3.43***	***1.77***	***3.53***	***6.36***	***4.83***	***2.43***

Ordering: FF M PE CT E EX L RI NI CD BI P Y U

TABLE 20
VARIANCE DECOMPOSITION OF NI

Period	BI	CD	CT	E	EX	FF	L
1	0.00	0.00	15.90	0.06	3.38	2.25	3.47
2	0.03	7.37	18.92	0.19	2.25	3.25	5.36
3	0.03	8.35	14.63	1.00	2.32	3.70	3.95
4	0.10	7.70	14.93	1.14	3.13	3.50	3.81
5	1.37	6.20	19.17	1.69	3.29	3.44	4.74
6	1.57	4.93	16.38	5.10	4.45	6.98	5.29
7	2.98	4.31	15.85	6.36	4.03	9.53	5.91
8	3.41	4.36	13.89	9.69	3.58	12.60	5.40
9	3.35	4.00	13.47	9.63	3.76	13.55	5.15
10	3.22	5.31	13.25	9.30	4.00	12.38	4.65
11	2.96	4.87	13.61	10.20	4.33	12.09	4.22
12	2.54	5.19	12.05	14.22	4.56	11.45	3.91
Average	***1.80***	***5.21***	***15.17***	***5.71***	***3.59***	***7.89***	***4.66***

Period	M	NI	P	PE	RI	U	Y
1	0.02	60.57	0.00	13.88	0.46	0.00	0.00
2	7.23	31.10	1.88	7.56	7.75	6.42	0.69
3	10.42	25.21	1.48	8.82	14.58	4.92	0.58
4	12.16	23.29	1.76	8.18	15.24	4.53	0.54
5	11.63	17.91	1.84	10.45	13.09	4.10	1.08
6	13.56	14.99	1.50	8.71	10.35	3.24	2.96
7	11.91	13.27	1.39	7.57	8.97	3.77	4.14
8	10.61	12.45	1.44	6.61	8.83	3.44	3.68
9	11.77	11.42	1.40	6.05	9.39	3.40	3.66
10	13.75	10.12	1.37	5.42	9.97	3.13	4.14
11	14.73	9.24	1.58	5.08	10.04	2.97	4.08
12	15.73	8.77	1.77	4.36	8.60	2.70	4.15
Average	***11.13***	***19.86***	***1.45***	***7.72***	***9.77***	***3.55***	***2.48***

Ordering: FF M PE CT E EX L RI NI CD BI P Y U

TABLE 21
VARIANCE DECOMPOSITION OF P

Period	BI	CD	CT	E	EX	FF	L
1	0.11	1.98	2.46	1.85	1.19	1.37	6.81
2	4.24	1.57	1.14	0.88	10.20	1.79	3.21
3	4.12	3.12	1.12	1.36	8.87	1.56	2.91
4	3.32	2.95	3.74	6.77	10.83	5.49	6.94
5	4.78	3.11	5.62	7.89	9.20	4.79	7.74
6	4.60	2.84	6.63	9.19	8.40	4.94	7.45
7	4.30	2.59	6.34	8.34	8.14	5.76	8.94
8	4.13	2.49	7.60	8.06	7.65	5.52	11.54
9	3.96	2.44	8.42	7.33	8.04	5.16	10.99
10	3.80	2.34	8.12	8.18	7.69	5.98	11.25
11	4.22	2.33	8.13	8.17	8.01	5.79	11.07
12	3.97	2.58	9.16	8.20	7.62	5.48	11.24
Average	***3.80***	***2.53***	***5.71***	***6.35***	***7.99***	***4.47***	***8.34***

Period	M	NI	P	PE	RI	U	Y
1	2.09	7.26	69.32	5.49	0.05	0.00	0.00
2	23.98	5.04	39.33	2.84	0.17	0.06	5.56
3	25.99	5.29	34.56	4.01	1.28	0.15	5.68
4	19.79	4.10	26.86	3.19	1.11	0.58	4.33
5	16.95	3.57	25.02	4.01	2.40	0.74	4.18
6	15.90	5.11	23.73	4.19	2.42	0.71	3.90
7	15.65	6.19	21.77	4.42	2.68	1.33	3.54
8	15.45	5.69	20.00	4.12	2.49	1.24	4.02
9	14.17	5.44	21.76	3.86	2.36	1.12	4.93
10	13.92	5.88	20.78	3.69	2.35	1.32	4.71
11	14.35	5.56	19.70	4.72	2.24	1.29	4.43
12	14.74	6.42	18.52	4.44	2.25	1.21	4.17
Average	***16.08***	***5.46***	***28.44***	***4.08***	***1.82***	***0.81***	***4.12***

Ordering: FF M PE CT E EX L RI NI CD BI P Y U

TABLE 22
VARIANCE DECOMPOSITION OF PE

Period	BI	CD	CT	E	EX	FF	L
1	0.00	0.00	0.00	0.00	0.00	0.08	0.00
2	0.39	1.62	9.79	0.17	12.17	3.23	1.12
3	3.05	4.95	7.51	4.18	12.37	2.80	1.63
4	2.87	4.21	10.11	3.39	11.81	3.55	2.78
5	8.17	4.84	8.86	4.09	10.89	3.13	2.55
6	7.88	6.32	12.28	3.54	9.45	3.84	2.57
7	6.81	5.39	10.81	3.00	8.05	4.33	3.67
8	6.15	5.63	11.55	4.03	7.34	3.99	4.88
9	5.57	5.47	10.42	5.63	8.02	4.78	5.08
10	5.03	4.96	10.74	8.28	7.51	6.18	4.68
11	5.07	5.06	10.24	8.00	7.89	6.00	5.53
12	6.06	4.82	11.50	7.60	8.30	5.72	5.32
Average	***4.75***	***4.44***	***9.48***	***4.33***	***8.65***	***3.97***	***3.32***

Period	M	NI	P	PE	RI	U	Y
1	19.40	0.00	0.00	80.53	0.00	0.00	0.00
2	13.38	0.00	0.77	53.23	4.11	0.00	0.01
3	10.27	3.02	1.77	39.89	4.71	3.53	0.32
4	8.28	2.38	1.38	31.46	9.16	4.55	4.06
5	7.32	4.25	1.87	27.41	8.58	4.46	3.60
6	6.96	3.73	1.65	24.50	7.71	5.70	3.86
7	11.24	5.78	1.88	23.42	7.26	4.93	3.44
8	11.27	6.50	2.34	21.23	6.58	4.83	3.68
9	11.50	5.87	2.46	20.79	6.53	4.37	3.52
10	10.69	6.06	2.42	19.52	6.16	4.57	3.20
11	11.27	5.74	2.31	18.68	6.10	4.34	3.77
12	10.70	6.30	2.30	17.78	5.78	4.16	3.67
Average	***11.02***	***4.14***	***1.76***	***31.54***	***6.06***	***3.79***	***2.76***

Ordering: FF M PE CT E EX L RI NI CD BI P Y U

TABLE 23
VARIANCE DECOMPOSITION OF RI

Period	BI	CD	CT	E	EX	FF	L
1	0.00	0.00	33.37	0.71	2.47	0.79	7.88
2	0.00	6.15	21.00	4.97	1.81	6.17	12.01
3	4.23	5.41	17.84	5.35	1.58	10.38	12.32
4	3.76	4.60	15.82	5.55	2.16	11.55	10.47
5	4.38	4.29	12.31	5.39	1.71	13.76	8.87
6	5.69	4.01	12.69	5.06	1.48	15.19	7.54
7	5.10	3.76	14.69	5.40	1.54	13.86	7.04
8	4.58	3.35	13.04	6.68	2.02	12.49	6.38
9	3.90	3.31	12.33	12.04	1.94	11.52	5.61
10	3.30	3.29	10.41	18.56	2.28	11.85	5.63
11	2.93	2.92	9.27	22.02	3.79	12.29	5.50
12	2.79	2.78	8.83	23.78	3.92	11.88	5.59
Average	***3.39***	***3.65***	***15.13***	***9.63***	***2.23***	***10.98***	***7.90***

Period	M	NI	P	PE	RI	U	Y
1	14.35	0.00	0.00	5.17	35.25	0.00	0.00
2	11.12	1.66	0.32	5.34	27.09	1.62	0.74
3	12.44	1.37	0.86	4.14	21.58	1.29	1.20
4	10.57	2.38	1.35	4.68	21.36	4.53	1.22
5	9.20	3.55	1.09	4.98	21.76	5.44	3.28
6	7.85	5.18	0.92	4.20	22.83	4.57	2.79
7	9.73	5.14	1.53	4.08	21.20	4.22	2.72
8	15.01	4.72	1.49	3.68	19.11	3.76	3.68
9	14.50	5.11	1.99	3.17	16.32	3.23	5.03
10	12.29	4.86	1.86	2.94	13.70	2.70	6.35
11	10.90	4.91	1.65	3.59	12.19	2.39	5.66
12	10.94	4.94	1.59	3.42	11.79	2.29	5.45
Average	***11.58***	***3.65***	***1.22***	***4.12***	***20.35***	***3.00***	***3.18***

Ordering: FF M PE CT E EX L RI NI CD BI P Y U

TABLE 24
VARIANCE DECOMPOSITION OF U

Period	BI	CD	CT	E	EX	FF	L
1	5.44	0.26	24.92	2.38	4.07	23.73	3.17
2	5.29	2.30	30.66	1.13	2.02	15.79	2.33
3	6.34	1.80	26.91	0.89	2.50	12.34	2.51
4	7.16	1.60	24.18	0.79	2.66	11.19	2.24
5	8.67	2.17	22.55	1.87	2.28	14.73	2.94
6	8.48	1.53	16.00	6.54	2.25	18.46	5.51
7	7.72	1.30	14.28	7.36	3.20	20.56	5.20
8	6.80	1.59	12.59	7.33	3.66	19.96	4.58
9	6.26	1.58	12.22	6.76	3.62	19.30	4.24
10	5.62	1.61	11.75	8.45	3.19	17.12	3.90
11	4.69	1.74	9.77	12.19	4.61	16.26	3.45
12	4.08	2.21	8.50	16.66	4.94	15.61	3.05
Average	***6.38***	***1.64***	***17.86***	***6.03***	***3.25***	***17.09***	***3.60***

Period	M	NI	P	PE	RI	U	Y
1	2.93	0.97	4.31	0.09	9.15	18.57	0.02
2	1.44	0.96	5.68	0.27	18.82	12.98	0.32
3	2.87	1.43	4.45	0.22	23.23	13.20	1.30
4	5.51	1.82	5.20	0.87	23.94	11.69	1.15
5	5.04	1.53	6.62	2.26	18.55	9.36	1.43
6	5.50	3.16	6.56	1.74	13.30	7.45	3.52
7	5.13	3.94	5.86	1.62	12.87	7.10	3.86
8	6.78	5.94	5.16	1.43	13.91	6.49	3.78
9	9.83	6.16	5.13	1.65	13.75	5.99	3.51
10	11.92	5.87	5.91	1.64	12.71	5.54	4.75
11	13.38	5.98	5.26	1.44	10.62	4.96	5.66
12	12.46	6.46	4.65	1.31	9.52	4.61	5.95
Average	***6.90***	***3.68***	***5.40***	***1.21***	***15.03***	***9.00***	***2.94***

Ordering: FF M PE CT E EX L RI NI CD BI P Y U

TABLE 25
VARIANCE DECOMPOSITION OF Y

Period	BI	CD	CT	E	EX	FF	L
1	0.00	0.01	43.74	0.03	19.06	0.31	1.01
2	0.09	9.29	32.86	0.15	10.69	0.66	0.94
3	1.64	8.00	28.60	1.14	9.03	2.12	1.02
4	1.63	7.73	26.07	1.18	8.30	2.09	1.03
5	2.87	6.99	23.65	2.21	7.02	3.53	1.23
6	4.20	6.68	18.73	3.18	7.98	11.23	1.28
7	4.77	5.99	17.01	4.48	7.68	12.91	2.37
8	4.84	6.07	16.15	5.06	7.72	12.82	2.24
9	4.68	6.41	16.39	6.28	7.18	11.33	2.00
10	4.25	5.98	16.65	6.63	6.50	10.36	2.82
11	4.22	5.51	14.07	12.28	7.40	10.80	2.61
12	4.22	5.73	12.75	16.08	7.44	10.93	2.40
Average	***3.12***	***6.20***	***22.22***	***4.89***	***8.83***	***7.42***	***1.75***

Period	M	NI	P	PE	RI	U	Y
1	3.33	3.17	0.22	8.57	2.77	0.00	17.78
2	3.92	1.79	0.34	7.27	15.54	4.05	12.40
3	5.67	1.94	1.14	8.26	15.44	5.12	10.89
4	8.55	3.20	2.33	7.90	13.75	6.54	9.70
5	8.25	4.86	2.69	9.65	11.54	6.27	9.22
6	6.54	6.65	2.15	7.95	9.67	4.94	8.82
7	5.87	6.47	2.52	8.18	8.83	5.15	7.78
8	6.30	6.21	2.51	7.91	9.79	4.85	7.53
9	10.12	5.51	2.50	6.98	9.09	4.25	7.29
10	10.48	4.98	2.44	6.26	9.60	3.81	9.24
11	10.64	5.79	2.17	5.36	8.09	3.23	7.84
12	10.10	5.99	2.05	4.89	7.19	2.91	7.32
Average	***7.48***	***4.71***	***1.92***	***7.43***	***10.11***	***4.26***	***9.65***

Ordering: FF M PE CT E EX L RI NI CD BI P Y U

APPENDIX E

OKLAHOMA STATE UNIVERSITY INSTITUTIONAL REVIEW BOARD HUMAN SUBJECTS REVIEW

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
HUMAN SUBJECTS REVIEW

Date: 09-30-97 **IRB#:** BU-98-005

Proposal Title: INTEREST RATE ADJUSTMENT AND THE U.S. ECONOMY: A VECTOR AUTOREGRESSION ANALYSIS OF THE ECONOMIC EFFECTS OF FEDERAL FUNDS RATE POLICY

Principal Investigator(s): Frank Steindl, Steven L. Bovee

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

ALL APPROVALS MAY BE SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING, AS WELL AS ARE SUBJECT TO MONITORING AT ANY TIME DURING THE APPROVAL PERIOD.
APPROVAL STATUS PERIOD VALID FOR DATA COLLECTION FOR A ONE CALENDAR YEAR PERIOD AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL.
ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Disapproval are as follows:
This is exempt due to use of a publicly available extant database. No identifiers are used.

Signature:

Chair of Institutional Review Board

Date: October 3, 1997

cc: Steven L. Bovee

2

VITA

Steven Lawrence Bovee

Candidate for the Degree of

Doctor of Philosophy

Thesis: INTEREST RATE ADJUSTMENT AND THE U.S. ECONOMY: A VECTOR AUTOREGRESSION ANALYSIS OF THE ECONOMIC EFFECTS OF FEDERAL FUNDS RATE POLICY

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