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Dynamic Analysis Of Canadian Monetary Policy Innovations

by

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ABSTRACT

The monetary Vector Autoregression (VAR) models for the U.S. indicate that when monetary policy shocks are identified with innovations in the interest rate, an increase in the interest rate leads to an increase in the price level. This result, being theoretically implausible, is termed the "price puzzle" in the literature. Similarly, when monetary policy shocks are identified with innovations in the money supply, an expansionary policy leads to an increase in the interest rate. This is termed the "liquidity puzzle." This thesis undertakes a comprehensive analysis of monetary policy innovations in Canada using VARs, to examine whether these anomalies exist in the Canadian economy. It first identifies monetary policy innovations, and then examines the dynamic responses of various economic activity measures, as well as other key macro-economic variables, to these innovations. Further, a sectoral analysis is undertaken to investigate the transmission mechanisms of these innovations among sectors in the economy. Finally, the effects of monetary policy shocks on various regions in Canada are examined.

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CHAPTER 1

INTRODUCTION

"Though many macroeconomists would profess little uncertainty about it, the profession as a whole has no clear answers to the question of the size and nature of the effects of monetary policy upon aggregate activity." - Christopher Sims (1992)

The role of money and monetary policy within an economy remains one of the dominant topics in macroeconomics. The effects of monetary policy are presumed to center around the interest rate and the money supply. The common postulation suggests that an expansionary policy reduces the interest rate, thereby reducing the cost of capital. This in turn, spurs investment expenditures which increases output and eventually, prices. Although policy discussions frequently proceed as though these effects were well documented, the empirical evidence is inconclusive. For instance, the Vector Autoregression (VAR) literature dealing with the U.S. economy indicates that when policy shocks are identified by innovations in the money supply (monetary rule), an increase in the money supply results in an *increase* in the interest rate. This has been termed the **"liquidity puzzle."** Similarly, when policy shocks are identified by innovations in the interest rate (interest rate rule), a contractionary policy leads to an *increase* in prices, and has been termed the **"price puzzle."** The discrepancies between theory and empirical findings imply that policy can be counterproductive and thus, has profound ramifications for policy-makers. For instance, suppose the monetary authorities desire a lower interest rate and therefore, expand the money

supply. In the presence of the liquidity puzzle, this initiative would lead to an increase, rather than a decrease, in the interest rate. This thesis seeks to identify monetary policy innovations in Canada, and then examine the dynamic effects of these shocks on the aggregate economy, to determine the consistencies (or lack thereof) between theory and practice. Although several theories on the role of money and monetary policy have been postulated, the empirical evidence either supporting or refuting them is mixed. Milton Friedman and Anna J. Schwartz (1963) were among the first to extensively document the positive relationship in the U.S. between monetary aggregates and economic activity. Christopher Sims (1972) found that the growth rate of money stock helped forecast output. Subsequent authors focused on the distinction between "anticipated" and "unanticipated" money [Robert J. Barro (1977), Robert J. Gordon (1982), Frederic Mishkin (1982)]. Specifically, the debate centered on whether the distinction between "anticipated" and "unanticipated" money was important in the ability of systematic monetary policy to affect output. Despite inconclusive empirical evidence, the debate presumed that the tendency for money to lead output implied a causality.

The discussion on this topic has been fueled, to a large extent, by the advancement in econometric techniques. Sims (1980a) questioned the validity of the numerous identifying restrictions that were placed on the conventional models. Instead, using VAR models, which required significantly less identification restrictions, he demonstrated that although M1 was an important predictor of output, it

lost its predictive power when the commercial paper rate was included in the model (Sims, 1980b). Similar results were later obtained for the Treasury bill rate rather than for the commercial paper rate, by Litterman and Weiss (1985). These results were interpreted as evidence against money causing output, and consequently, against the effectiveness of monetary policy. However, King (1982), McCallum (1983), and Bernanke (1986) among others, argued that the superior predictive power of interest rates does not necessarily imply the ineffectiveness of monetary policy but rather, interest rates may be better indicators of monetary policy than monetary aggregates.

The focus then turned to determine the best interest rate in terms of predicting the economy. Bernanke and Blinder (1992) argued that innovations in the Federal Funds rate were in some respects, a better indicator of monetary policy shocks in the U.S. than were innovations in monetary aggregates. However, Gordon and Leeper (1994) challenged this argument by demonstrating that innovations in either the Federal Funds rate or in monetary aggregates produced some dynamic responses that were theoretically inconsistent. Other authors experimented with interest rate spreads rather than levels. Stock and Watson (1989) found that two interest rate spreads - the difference between the six-month commercial paper rate and the six-month Treasury bill rate, and the difference between the ten-year and one-year Treasury bond rates - outperformed nearly every other variable in forecasting the business cycle. Despite a number of alternative interest rate spreads suggested by various authors, the spread between the commercial paper rate and T-bill rate remains a remarkably good

predictor of the U.S. economy (Bernanke, 1990). Bernanke (1990) suggests that this result may stem from the fact that T-bills and commercial paper are imperfect substitutes. Essentially, monetary policy affects the spread between commercial paper and T-bills by changing the composition of assets available in the economy. Interest rate spreads must then adjust in order to make investors willing to hold the new mix of assets, since commercial paper and T-bills are imperfect substitutes. This hypothesis was first postulated by Cook (1981) who argued that T-bills are valuable to banks and other investors for reasons besides their direct yield. For example, T-bills can be used for posting margin, for collateralizing overnight repurchase agreements, and for satisfying bank adequacy requirements; functions which the commercial paper cannot fulfill. Nevertheless, the evidence that interest rates are better predictors of the U.S. economy than monetary aggregates is a momentous challenge to the conventional postulation that money causes output.

Fung and Gupta (1994) examine the empirical evidence of the liquidity effect in Canada. They identify a Canadian monetary policy innovation using VARs, by focusing on the instruments of monetary policy. In particular, they represent the orthogonalized innovation in excess settlement balances as a monetary policy shock. Their empirical results indicate that an unanticipated expansionary shock causes a decline in the interest rate, an increase in output, and a depreciation in the external value of the Canadian dollar. Although their results accord to theoretical postulations, the use of excess settlement balances is difficult to explain since it does not directly

correlate with other marco variables (Kasumovich, 1996). Cushman and Zha (1995) reconsider the debate on the identification and dynamic effects of monetary policy innovations in Canada using a comprehensive VAR model that treats Canada as a small open economy. They impose block exogeneity restrictions treating foreign variables as exogenous, and examine the transmission mechanisms, the effects, and the relative importance of monetary policy shocks. They also examine the transmission channels for foreign shocks, and the ability of the monetary authorities to react to them. Their results conform to theoretical predictions. Specifically, an unanticipated contractionary monetary policy by the domestic authorities results in an increase in domestic interest rate, an appreciation of the exchange rate, and a decrease in domestic output and the price level.

Armour, Engert, and Fung (1996) demonstrate that the overnight interest rate is as good an indicator of monetary policy stance in Canada as other short term rates, such as the 90-day commercial paper rate. Kasumovich (1996) utilizes this overnight interest rate to analyze the effects of an interest rate shock to the Canadian economy. He also considers the effects of a money supply shock. His central focus rests on identifying the long-run relationships between policy variables and final variables, and therefore, he uses cointegration techniques within the VAR framework for the analysis. An open economy model is not considered since he asserts that the long-run effects of monetary policy innovations depend upon the demand for money rather than on the openness of the economy. His results indicate that under a monetary rule, an

increase in the money supply produces theoretically consistent results. However, when he utilizes an interest rate rule, a contractionary monetary stance results in a temporary increase in the price level ("price puzzle").

The existence of anomalies in the response of key macroeconomic variables to monetary innovations in the U.S. and in Canada forms the basis for re-examining the dynamic effects of monetary policy disturbances. To do this, the thesis first attempts to identify the interest rate and/or the monetary aggregates whose movements can be classified as policy innovations. Following the U.S. literature [Bernanke (1990), Bernanke and Blinder (1992)], three interest rate variables and three monetary aggregates are tested using Granger-causality and variance decomposition measures, to examine their ability to predict seven different measures of real economic activity in Canada. Granger-causality tests are simple *F*-tests that determine whether a particular variable can be excluded from the model. This measure however, is potentially sensitive to the non-orthogonality of the variables. Therefore, the variance decomposition measure is undertaken to examine the robustness of the results. The variance decomposition is constructed from a VAR with orthogonolized residuals, and is the percentage of the variance of the forecasted variable attributable to the alternative right-hand side variables at different time horizons. These results though, are potentially sensitive to the ordering of variables in the VAR due to the identification restrictions[1]. Thus, several orderings are considered to test the

[1] These issues are further discussed in Chapter 2 which deals with the theoretical foundations of VARs.

soundness of the results. The three interest rates used to identifying monetary policy innovations are: the three-month commercial paper rate, the three-month Treasury bill rate, and the long-term government bond rate, while M1, M2 and M2+ are the monetary variables examined. The seven measures of economic activity include: real GDP at factor cost, real industrial production, real retail sales, the unemployment rate, housing starts, building permits, and real net manufacturing orders. To preview these results, the Granger-causality tests and variance decomposition measures were inconclusive. Resorting to existing literature, the commercial paper and M2+ were selected as the interest rate variable and monetary aggregate variable, respectively, whose movements reflected monetary policy innovations. The thesis then uses impulse response functions to examine the dynamic responses of the seven economic activity measures to monetary policy innovations under different identification schemes[2].

Furthermore, there exists considerable intrigue on the transmission mechanism through which monetary policy innovations impact the economy. The standard "sticky-wage/prices" view asserts that a contractionary policy increases the cost of borrowing and decreases economic activity via a decrease in investment. A second hypothesis, the "capital-markets-imperfection" view, alleges that bank finances and non-bank finances are imperfect substitutes for certain sectors of the economy (Bernanke and Blinder, 1988). Specifically, the financial intermediation expertise

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[2] The "monetary rule" and "interest rate rule" are the two identification schemes undertaken throughout in this thesis.

attained by the financial institutions, and their ability to monitor loan performances, enables them to extend credit to customers who find it difficult to borrow in the open market. A contractionary monetary policy, by reducing reserves, will reduce the volume of loans from these financial institutions. This in turn, leads to a decline in the aggregate demand of agents who have a lower ability to substitute bank finances for non-bank finances, usually small borrowers such as individuals and small businesses (Bernanke and Blinder, 1992). Hence, the thesis also undertakes a sectoral analysis to examine the empirical evidence of these postulations. Following Dale and Haldane (1995), the thesis examines the response of the corporate sector, and of the personal sector, to monetary disturbances. It investigates the response of the exchange rate, the stock market, corporate and personal deposits, corporate and personal borrowing, and the price level to these shocks. In addition, Dale and Haldane (1995) demonstrate that for the U.K., using aggregate data conceals vital information regarding differences in sectoral responses to monetary shocks. A similar analysis using aggregate data is performed for the Canadian case.

Furthermore, theoretical propositions assume a uniform response of geographical regions to monetary policy disturbances. However, as Carlino and DeFina (1996) illustrate for the U.S. economy, the responses of regions to such disturbances can vary widely. This differential response can be attributed to regional differences in the mix of interest sensitive industries, and regional differences in the mix of large and small borrowers (Carlino and DeFina, 1996). In particular, due to

heterogeneous resources across regions, it is plausible that certain regions may have a higher concentration of interest sensitive industries, which may result in remarkable discrepancies in regional responses to monetary disturbances. Moreover, regions with a higher concentration of small borrowers may be especially sensitive to monetary innovations, due to the limited ability of these borrowers to substitute sources of credit. Therefore, the thesis also investigates the dynamic responses of the ten provinces in Canada to monetary policy innovations. There are two approaches taken for this regional analysis. The first investigates the response of provinces within a region to monetary shocks. The second allows for feedback effects among regions.

While there are several methodologies that facilitate dynamic analysis, this thesis will use unrestricted Vector Autoregression (VAR) models for its objectives. Other methodologies, such as Transfer Function Analysis and Intervention Analysis, require distinguishing between the "endogenous" variable and "exogenous" variables. However, many economic systems exhibit feedback effects, and therefore, it is usually difficult to establish that the time path of the "exogenous" variable is unaffected by the time path of the "endogenous" variable. Vector Autoregression models circumvent this issue by treating all variables symmetrically. These models capture feedback effects and hence, their appeal. However, the VARs in their primitive form are underidentified. Overcoming this shortcoming requires postulating certain assumptions about the error terms of the model, which in turn imply a certain "ordering" of the contemporaneous effects of variables on each other. Throughout this

thesis, the Choleski Decomposition is used for identification purposes (Enders, 1995). This is discussed further in Chapter 2, which establishes the theoretical framework underlying VAR models. Chapter 3 attempts to identify monetary policy innovations in Canada, and then examines the response of the aggregate economy to these shocks. Chapters 4 and 5 undertake a sectoral and regional analysis, respectively, while Chapter 6 provides a summary and conclusion.

CHAPTER 2

THEORETICAL FOUNDATION OF VECTOR AUTOREGRESSION (VAR) MODELS

2.1 Introduction

Although single equation time series methodologies are often used to analyze dynamic relationships in economics, a significant amount of additional information can be captured using multi-equation dynamic models. Despite a variety of such models, this thesis uses unrestricted Vector Autoregression (VAR) models for its objectives. Other multi-equation dynamic models such as Intervention Analysis and Transfer Function Analysis generalize the univariate approach by allowing the time path of the "exogenous" variables to determine the time path of the "endogenous" variable. These techniques are appropriate if it is known *a priori*, that the system does not exhibit feedback effects. In practice, economic systems do contain feedback effects and therefore, it is often difficult to determine whether the time paths of the designated "exogenous" variables remain unaffected by the "endogenous" variable. Vector Autoregression models circumvent this issue by treating all variables symmetrically, hence their appeal.

This chapter outlines the theoretical underpinnings of unrestricted VAR models. Section 2.2 describes the theoretical foundation for the VAR model and discusses a variety of measure that are used for analyzing the dynamic effects of

shocks, such as impulse response functions, variance decomposition and Granger causality tests. Section 2.3 provides a conclusion.

2.2 Theoretical Foundations of VARs[3]

2.2.1 The VAR Model

When variables cannot be classified as either endogenous or exogenous, a natural extension is to treat each one symmetrically. Consider a simple bivariate system:

$$y_t = b_{10} - b_{12} z_t + \gamma_{11} y_{t-1} + \gamma_{12} z_{t-1} + \varepsilon_{yt} \tag{2.1}$$

$$z_t = b_{20} - b_{21} y_t + \gamma_{21} y_{t-1} + \gamma_{22} z_{t-1} + \varepsilon_{zt} \tag{2.2}$$

where, by assumption,

- both y_t and z_t are stationary;
- ε_{yt} and ε_{zt} are white-noise disturbances with standard deviation of σ_y and σ_z respectively;
- ε_{yt} and ε_{zt} are uncorrelated.

Equations (2.1) and (2.2), which constitute a first-order VAR[4] will be used to illustrate the theoretical foundations of VARs. These can be extended to multivariate, higher-order systems.

The VAR system described above incorporates feedback effects since y_t and z_t affect each other. For instance, $-b_{12}$ is the contemporaneous effect of a one unit

[3] This closely follows Enders (1995).
[4] This is a first-order VAR since the longest lag is unity.

change in z_t on y_t. Similarly, γ_{21} is the contemporaneous effect of a one unit change in y_{t-1} on z_t. Although ε_{yt} and ε_{zt} are pure innovations (shocks) in y_t and z_t respectively, if b_{12} is not equal to zero, ε_{zt} has an indirect contemporaneous effect on y_t. Due to this inherent feedbacks in the system, the VAR described by (2.1) and (2.2) is not in its reduced form, and is referred to as a **structural** VAR, alternatively called the **primitive** system. For practical purposes, it is desirable to transform the system of equations into a reduced form. Using matrix algebra, the system can be written in a compact manner:

$$\begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix}\begin{bmatrix} y_t \\ z_t \end{bmatrix}=\begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix}+\begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{bmatrix}\begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix}+\begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix}$$

or

$$Bx_t=\Gamma_0+\Gamma_1 x_{t-1}+\varepsilon_t$$

where

$$B=\begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix} \qquad x_t=\begin{bmatrix} y_t \\ z_t \end{bmatrix} \qquad \Gamma_0=\begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix}$$

$$\Gamma_1=\begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{bmatrix} \qquad \varepsilon_t=\begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix}$$

To obtain the VAR in reduced form, the above equation is premultiplied by B^{-1} which gives:

$$x_t=A_0+A_1 x_{t-1}+e_t \tag{2.3}$$

where

$$A_0 = B^{-1}\Gamma_0 \qquad A_1 = B^{-1}\Gamma_1 \qquad e_t = B^{-1}\varepsilon_t$$

Defining a_{i0} as element i of the vector A_0, a_{ij} as the element in row i and column j of matrix A_1, and e_{it} as element i of the vector e_t, equation (3.3) can be rewritten as:

$$y_t = a_{10} + a_{11}y_{t-1} + a_{12}z_{t-1} + e_{1t} \tag{2.4a}$$

$$z_t = a_{20} + a_{21}y_{t-1} + a_{22}z_{t-1} + e_{2t} \tag{2.4b}$$

The system above is a VAR in reduced form, alternatively referred to as a **standard** system. It is critical to note that the error terms, e_{1t} and e_{2t} are composites of the two shocks ε_{yt} and ε_{zt}. To illustrate, since $e_t = B^{-1}\varepsilon_t$, e_{1t} and e_{2t} are computed as:

$$e_{1t} = \frac{(\varepsilon_{yt} - b_{12}\varepsilon_{zt})}{(1 - b_{12}b_{21})} \tag{2.5}$$

$$e_{2t} = \frac{(\varepsilon_{zt} - b_{21}\varepsilon_{yt})}{(1 - b_{12}b_{21})} \tag{2.6}$$

Both e_{1t} and e_{2t} have zero means, constant variances, and are individually serially uncorrelated because ε_{yt} and ε_{zt} are white-noise processes. However, e_{1t} and e_{2t} are correlated and the covariance of the two terms is given by:

$$Ee_{1t}e_{2t} = E\left[\frac{(\varepsilon_{yt} - b_{12}\varepsilon_{zt})(\varepsilon_{zt} - b_{21}\varepsilon_{yt})}{(1 - b_{12}b_{21})^2}\right]$$

which can be rewritten as:

$$Ee_{1t}e_{2t} = -\frac{(b_{21}\sigma_y^2 + b_{12}\sigma_z^2)}{(1 - b_{12}b_{21})} \tag{2.7}$$

Generally, (2.7) will not be equal to zero, implying that the two shocks are correlated. The variance/covariance matrix of the e_{1t} and e_{2t} shocks can be defined as:

$$\Sigma = \begin{bmatrix} \text{var}(e_{1t}) & \text{cov}(e_{1t}, e_{2t}) \\ \text{cov}(e_{1t}, e_{2t}) & \text{var}(e_{2t}) \end{bmatrix}$$

Since all the elements of Σ are time-independent, the matrix can be written as:

$$\Sigma = \begin{bmatrix} \sigma_1^2 & \sigma_{12} \\ \sigma_{21} & \sigma_2^2 \end{bmatrix}$$

where

$$\text{var}(e_{it}) = \sigma_i^2 \text{ and } \text{cov}(e_{1t}, e_{2t}) = \sigma_{12} = \sigma_{21}$$

2.2.2 Identification

Since z_t is correlated with ε_{yt} and y_t with ε_{zt}, the structural VAR is unidentifiable unless certain restrictions are placed on the system. This identification problem does not arise in the standard system. To illustrate, the primitive system requires 10 parameter estimates while the standard system only requires 9[5]. One parameter in the structural system has to be restricted in order to exactly identify the system (Enders, 1995). Enders (1995) suggests the **recursive** system proposed by Sims (1980a). For instance, if one is willing to assume that b_{21} is zero, then the structural system described by (2.1) and (2.2) now becomes:

$$y_t = b_{10} - b_{12} z_t + \gamma_{11} y_{t-1} + \gamma_{12} z_{t-1} + \varepsilon_{yt} \tag{2.8}$$

$$z_t = b_{20} + \gamma_{21} y_{t-1} + \gamma_{22} z_{t-1} + \varepsilon_{zt} \tag{2.9}$$

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[5] Enders (1995) undertakes a comprehensive discussion of this issue.

which yields a new B^{-1} matrix:

$$B^{-1}=\begin{bmatrix}1 & -b_{12}\\ 0 & 1\end{bmatrix}$$

Premultiplying (2.8) and (2.9) by B^{-1} gives:

$$\begin{bmatrix}y_t\\ z_t\end{bmatrix}=\begin{bmatrix}b_{10}-b_{12}b_{20}\\ b_{20}\end{bmatrix}+\begin{bmatrix}\gamma_{11}-b_{12}\gamma_{21} & \gamma_{12}-b_{12}\gamma_{22}\\ \gamma_{21} & \gamma_{22}\end{bmatrix}\begin{bmatrix}y_{t-1}\\ z_{t-1}\end{bmatrix}+\begin{bmatrix}\varepsilon_{yt}-b_{12}\varepsilon_{zt}\\ \varepsilon_{zt}\end{bmatrix} \qquad (2.10)$$

which in turn, results in the following theoretical parameter estimates:

$$\begin{aligned}
a_{10}&=b_{10}-b_{12}b_{20}\\
a_{11}&=\gamma_{11}-b_{12}\gamma_{21}\\
a_{12}&=\gamma_{12}-b_{12}\gamma_{22}\\
a_{20}&=b_{20}\\
a_{21}&=\gamma_{21}\\
a_{22}&=\gamma_{22}\\
e_{1t}&=\varepsilon_{yt}-b_{12}\varepsilon_{zt}\\
e_{2t}&=\varepsilon_{zt}
\end{aligned}$$

and the system is exactly identified. Given the solutions of the error terms e_{1t} and e_{2t}, the variances and covariances can be identified as:

$$\text{Var}\,(e_1)=\sigma_y^2+b_{12}^2\sigma_z^2 \qquad \text{Var}\,(e_2)=\sigma_z^2 \qquad \text{Cov}\,(e_1,e_2)=-b_{12}\sigma_z^2$$

The restriction $b_{21}=0$ implies that z_t has a contemporaneous effect on y_t but y_t affects z_t with a one period lag. This arises from the error structure of the structural system in that both ε_{yt} and ε_{zt} shocks affect the contemporaneous value of y_t, but only ε_{zt} shocks affect the contemporaneous value of z_t, under the restriction.

Decomposing the residuals in this triangular manner is termed the **Choleski Decomposition** (Enders, 1995).

The critical issue is that the Choleski Decomposition introduces a potentially important asymmetry on the system, and implies an **"ordering"** of the variables. Specifically, since the assumption $b_{21}=0$ implies that the ε_{zt} shock directly affects e_{1t} and e_{2t} but an ε_{yt} shock does not affect e_{2t}, z_t is said to occur "prior" to y_t. The importance of the ordering depends on the magnitude of the correlation coefficients between e_{1t} and e_{2t}. As a rule of thumb, if this correlation is greater than 0.2 in absolute values, the ordering is deemed important to the model, and the analysis should be undertaken under various orderings (Enders, 1995).

2.2.3 Impulse Response Functions

Plotting the impulse response functions is a practical method to visually represent the behavior of y_t and z_t in response to the various innovations. To derive these functions, it is useful to represent the VAR as a Vector Moving Average (VMA). Reconsider equation (2.3):

$$x_t = A_0 + A_1 x_{t-1} + e_t \qquad (2.3)$$

Iterating backwards, one obtains:

$$x_t = A_0 + A_1(A_0 + A_1 x_{t-2} + e_{t-1}) + e_t$$

which can be written as:

$$x_t = (I + A_1)A_0 + A_1^2 x_{t-2} + A_1 e_{t-1} + e_t$$

where $I=2\times2$ identity matrix.

After n iterations,

$$x_t=(I+A_1+.....+A_1^n)A_0+\sum_{i=0}^{n}A_1^i e_{t-i}+A_1^{n+1}x_{t-n-1}$$

which can be simplified to

$$x_t=\mu+\sum_{i=0}^{\infty}A_1^i e_{t-i} \tag{2.11}$$

where

$$\mu=\begin{bmatrix}\bar{y} & \bar{z}\end{bmatrix}'$$

Equation (2.11) is the VMA of (2.3) because the variables y_t and z_t are expressed in terms of the current and past values of the two of shocks e_{1t} and e_{2t}. The VMA enables one to trace out the time path of the various shocks on the variable contained in the VAR (Enders, 1995). For illustrative purposes, (2.4a) and (2.4b) can be summarized in matrix form as:

$$\begin{bmatrix}y_t\\z_t\end{bmatrix}=\begin{bmatrix}a_{10}\\a_{20}\end{bmatrix}+\begin{bmatrix}a_{11} & a_{12}\\a_{21} & a_{22}\end{bmatrix}\begin{bmatrix}y_{t-1}\\z_{t-1}\end{bmatrix}+\begin{bmatrix}e_{1t}\\e_{2t}\end{bmatrix} \tag{2.12}$$

or using (2.11) to obtain

$$\begin{bmatrix}y_t\\z_t\end{bmatrix}=\begin{bmatrix}\bar{y}\\\bar{z}\end{bmatrix}+\sum_{i=0}^{\infty}\begin{bmatrix}a_{11} & a_{12}\\a_{21} & a_{22}\end{bmatrix}^i\begin{bmatrix}e_{1t-i}\\e_{2t-i}\end{bmatrix} \tag{2.13}$$

Equation (2.13) expresses y_t and z_t in terms of e_{1t} and e_{2t}. Rewriting this in terms of ε_{yt} and ε_{zt} using (2.5) and (2.6), the vector of errors can be represented as:

$$\begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} = \begin{bmatrix} 1 \\ 1-b_{12}b_{21} \end{bmatrix} \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix} \tag{2.14}$$

Equations (2.13) and (2.14) can be combined to obtain:

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} \bar{y} \\ \bar{z} \end{bmatrix} + \begin{bmatrix} 1 \\ 1-b_{12}b_{21} \end{bmatrix} \sum_{i=0}^{\infty} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}^i \begin{bmatrix} 1 & -b_{12} \\ -b_{21} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix}$$

In order to simplify the notation, define the 2×2 matrixϕ_i with elements $\phi_{jk}(i)$:

$$\phi_i = \begin{bmatrix} A_1^i \\ 1-b_{12}b_{21} \end{bmatrix} \begin{bmatrix} 1 & -b_{12} \\ -b_{21} & 1 \end{bmatrix}$$

Using this simplification, the moving average representation of (2.13) and (2.14) can be written in terms of the ε_{yt} and ε_{zt} as:

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} \bar{y}_t \\ \bar{z}_t \end{bmatrix} + \sum_{i=0}^{\infty} \begin{bmatrix} \phi_{11}(i) & \phi_{12}(i) \\ \phi_{21}(i) & \phi_{22}(i) \end{bmatrix} \begin{bmatrix} \varepsilon_{yt-i} \\ \varepsilon_{zt-i} \end{bmatrix}$$

or more conveniently, as:

$$x_t = \mu + \sum_{i=0}^{\infty} \phi_i \varepsilon_{t-i} \tag{2.15}$$

The moving average representation gives significant insight to the interaction between y_t and z_t. The coefficients of ϕ_i can be used to produce the effects of the ε_{yt} and ε_{zt} shocks on the time paths of y_t and z_t. The four elements of $\phi_{jk}(0)$ are **impact multipliers** (Enders, 1995). For example, the coefficient $\phi_{12}(0)$ is the instantaneous impact of a one-unit change in ε_{zt} on y_t. Similarly, $\phi_{11}(1)$ and $\phi_{12}(1)$ are the one period responses of unit changes in ε_{yt-1} and ε_{zt-1}, respectively. Updating

by one period, $\phi_{11}(1)$ and $\phi_{12}(1)$ also represent the effects of unit changes in ε_{yt} and ε_{zt} on y_{t+1} (Enders, 1995).

The accumulated effects of unit impulses in ε_{yt} and ε_{zt} are obtained by the appropriate summation of the coefficients of the impulse response functions (Enders, 1995). For instance, after n periods, the effect of ε_{zt} on the value of y_{t+n} is $\phi_{12}(n)$. Thus, the cumulated sum of the effects of ε_{zt} on y_t is:

$$\sum_{i=0}^{n}\phi_{12}(i)$$

Permitting n to approach infinity yields the **long-run multiplier**. Since by assumption, y_t and the z_t are stationary, it must be the case that for all j and k

$$\sum_{i=0}^{\infty}\phi_{jk}^{2}(i)$$

is finite.

The four sets of coefficients $\phi_{11}(i)$, $\phi_{12}(i)$, $\phi_{21}(i)$ and $\phi_{22}(i)$ are the **impulse response functions** (Enders, 1995). Graphically, the impulse response functions are obtained by plotting the coefficients of $\phi_{jk}(i)$ against i. It is possible, in principle, to know all the parameters of the primitive system (2.1) and (2.2). This knowledge will allow one to trace out the time paths of the effects of the pure ε_{yt} or ε_{zt} shocks However, in practice, this is rarely possible due to the identification problem discussed earlier.

2.2.4 Variance Decomposition

Understanding the properties of the forecast errors is extremely valuable in uncovering the interrelationships among the variables in the VAR. The **forecast error variance decomposition** indicates the proportion of the movements in a sequence attributable to its "own" shocks versus shocks to the other variable (Enders, 1995). To derive this, suppose that the coefficients of A_0 and A_1 were known and that one wanted to forecast the various values of x_{t+i} conditional on the observed values of x_t. Updating (2.3) by one period and taking the conditional expectation of x_{t+1} yields:

$$E_t x_{t+1} = A_0 + A_1 x_t$$

The one-step ahead forecast error is $x_{t+1} - E_t x_{t+1} = e_{t+1}$. Similarly, updating for two periods gives:

$$x_{t+2} = A_0 + A_1 x_{t+1} + e_{t+2}$$

or

$$x_{t+2} = A_0 + A_1 (A_0 + A_1 x_t + e_{t+1}) + e_{t+2}$$

Taking conditional expectations, the two-step ahead forecast of x_{t+2} is:

$$E_t x_{t+2} = (I + A_1) A_0 + A_1^2 x_t$$

and the associated two-step ahead forecast error is given by:

$$e_{t+2} + A_1 e_{t+1}.$$

In general the *n*-step forecast can be written as:

$$E_t x_{t+n} = (I + A_1 + A_1^2 + \ldots\ldots + A_1^{n-1}) A_0 + A_1^n x_t$$

and the associated forecast error is:

$$e_{t+n} + A_1 e_{t+n-1} + A_1^2 e_{t+n-2} + \ldots\ldots + A_1^{n-1} e_{t+1} \qquad (2.16)$$

These forecast errors can be considered in terms of the VMA. To illustrate, using (2.16) to conditionally forecast x_{t+1}, the one step ahead forecast error is $\phi_0 \varepsilon_{t+1}$. In general,

$$x_{t+n} = \mu + \sum_{i=0}^{\infty} \phi_i \varepsilon_{t+n-1}$$

and the associated *n*-period forecast error $x_{t+n} - E_t x_{t+n}$ is:

$$x_{t+n} - E_t x_{t+n} = \sum_{i=0}^{\infty} \phi_i \varepsilon_{t+n-i}$$

Focusing solely on the y_t sequence, the *n*-step ahead forecast error is represented as:

$$\begin{aligned} y_{t+n} - E_t y_{t+n} = {} & \phi_{11}(0)\varepsilon_{yt+n} + \phi_{11}(1)\varepsilon_{yt+n-1} + \ldots\ldots + \phi_{11}(n-1)\varepsilon_{yt+1} \\ & + \phi_{12}(0)\varepsilon_{zt+n} + \phi_{12}(1)\varepsilon_{zt+n-1} + \ldots\ldots + \phi_{12}(n-1)\varepsilon_{zt+1} \end{aligned}$$

Denote the *n*-step ahead forecast error variance of y_{t+n} as $\sigma_y(n)^2$. Then,

$$\begin{aligned} \sigma_y(n)^2 = {} & \sigma_y^2[\phi_{11}(0)^2 + \phi_{11}(1)^2 + \ldots\ldots + \phi_{11}(n-1)^2] \\ & + \sigma_z^2[\phi_{12}(0)^2 + \phi_{12}(1)^2 + \ldots\ldots + \phi_{12}(n-1)^2] \end{aligned}$$

Since all values of $\phi_{jk}(i)^2$ are necessarily non-negative, the variance of the forecast error increases as the forecast horizon *n* increases. It is possible to decompose the *n*-step ahead forecast error variance due to each one of the shocks. Specifically, the proportions of $\sigma_y(n)^2$ due to the shocks in the ε_{yt} and ε_{zt} sequences are:

$$\frac{\sigma_y^2[\phi_{11}(0)^2 + \phi_{11}(1)^2 + \ldots\ldots + \phi_{11}(n-1)^2]}{\sigma_y(n)^2}$$

and,

$$\frac{\sigma_z^2[\phi_{12}(0)^2+\phi_{12}(1)^2+.....+\phi_{12}(n-1)^2]}{\sigma_y(n)^2}$$

This indicates the proportion of the movements in a sequence due to its "own" shocks versus shocks to the other variable. If the ε_z shock does not explain any of the forecast error variance of y_t , then y_t is exogenous. The y_t sequence then evolves independently of the ε_z shock and the z_t sequence. By contrast, ε_z shock may explain all the forecast variance in the y_t sequence at all forecast horizons. Therefore y_t is entirely endogenous. In applied research, it is typical for a variable to explain almost all its forecast error variance at short horizons and smaller proportions at longer horizons (Enders, 1995). This is expected if the ε_z shock had little contemporaneous effect, but a much greater lagged effect, on y_t.

2.2.5 Hypothesis Testing - Granger Causality

Consider the following multivariate generalization of (2.3):

$$x_t = A_0 + A_1 x_{t-1} + A_2 x_{t-2} + ... + A_p x_{t-p} + e_t \qquad (2.17)$$

where

$x_t =$ an $(n \times 1)$ vector containing each of the n variables included in the VAR;

$A_0 =$ an $(n \times 1)$ vector of intercept terms;

$A_i = (n \times n)$ matrices of coefficients;

$e_t =$ an $(n \times 1)$ vector of error terms.

Sims' (1980a) methodology of estimating a VARs involves little more than determining the appropriate variables to include in the model, and the appropriate lag length. Variables are generally selected according to the relevant economic theory, while lag-length tests select the appropriate lag length. There is no explicit attempt to "pare down" the number of parameter estimates. For instance, the matrix A_0 contains n intercept terms and each matrix A_i contains n^2 coefficients; hence $n+pn^2$ terms need to be estimated. The VAR may be **overparameterized** if many of these variables can be properly excluded from the model. On the other hand, the aim is to determine the important interrelationships among the variables and not make short-term forecasts (Enders, 1995). Improperly imposing zero restrictions may waste important information. To obtain a parsimonious model, measures other than the standard t-tests are required since the regressors are likely to be highly collinear.

In addition to a careful examination of the relevant theoretical model in order to determine the appropriate variables to include in the model, a test of causality can be undertaken to determine whether the lags of one variable enter into the equation for another variable. In the two equation model with p lags, y_t does not **Granger cause** z_t if and only if all the coefficients of $A_{21}(L)$ are statistically insignificant Thus, if y_t does not improve the forecasting performance of z_t, then y_t does not Granger cause z_t. Standard F-tests are the simplest method to determine Granger causality. This method tests the restriction:

$$a_{21}(1)=a_{21}(2)=a_{21}(3)=.....=a_{21}(p)=0$$

In the n variable case in which $A_{ij}(L)$ represents the coefficients of lagged values of variable j on variable i, variable j does not Granger cause variable i if all coefficients of the polynomial $A_{ij}(L)$ are statistically insignificant.

The issue of whether the variables in a VAR model need to be stationary exists. Sims (1980a) recommends against differencing even if the variables contain a unit root. He asserts that the objective of VAR analysis is to examine the interrelationships among the variables, not to determine the parameter estimates. Information concerning the co-movements in the data is lost once differencing is undertaken. In addition, the form of the variables in the VAR should imitate the true data-generating process (Enders, 1995). Hence, the issue of stationarity is not addressed in this thesis

2.3 Conclusion

In several economic analysis, there are feedback effects exhibited among variables, which makes it difficult to determine the "exogenous" and the "endogenous" variables. Vector Autoregression models circumvent this debate by treating each variable symmetrically. Each variable depends upon its current and past realizations, as well as the current and past realizations of all the other variables in the system. However, due to this inherent feedback effects, identification of the primitive system becomes problematic. Hence, the sequence of error terms has to be restricted in order to identify the systems. One possibility to implement such restrictions is to utilize the Choleski Decomposition of the error terms. This, however, introduces a

potential asymmetry and implies a certain "ordering" of the variables in the system. Nevertheless, this minimum identification restriction is essential to conducting dynamic analysis using VARs, and to circumvent the asymmetry introduced by these restrictions, several orderings of the VARs should be considered.

CHAPTER 3

DYNAMIC EFFECTS OF CANADIAN MONETARY POLICY INNOVATIONS

3.1 Introduction

There has been renewed interest in the identification, as well as the impacts, of monetary policy disturbances. This search has been undertaken extensively for the U.S. economy, and has centered around interest rates and monetary aggregates. Milton Friedman and Anna J. Schwartz (1963) were among the pioneers to document a positive relationship between monetary aggregates and economic activity. Later, Christopher Sims (1972) demonstrated that the growth rate of money stock helped forecast output in a bivariate system.

Subsequent debates questioned whether the distinction between "anticipated" and "unanticipated" money was important in the ability of *systematic* monetary policy to influence output [Robert J. Barro (1977), Robert J. Gordon (1982), Frederic Mishkin (1982)]. Although the empirical evidence was inconclusive, the premises of the debate presumed that the tendency for money to lead output implied a causality. Authors then began to question this supposition. In particular, Sims (1980b), and Litterman and Weiss (1985) demonstrated that interest rates tended to absorb the predictive power of monetary aggregates when included in the model. These results were then interpreted as evidence against money causing output and by extension, against the effectiveness of monetary policy. However, other authors argued that the

superior predictive power of interest rates may not necessarily imply the ineffectiveness of monetary policy but rather, interest rates may be better indicators of monetary policy stance than monetary aggregates [King (1982), McCallum (1983), Bernanke (1986)].

Attention then turned to determining the best interest rate that predicted the economy. Bernanke and Blinder (1992) presented empirical evidence suggesting that the Federal Funds rate was a better indicator of monetary policy in the U.S. than monetary aggregates. Nevertheless, Gordon and Leeper (1994) challenged this argument by demonstrating that innovations in either the Federal Funds rate or monetary aggregates produces some dynamic responses that were theoretically implausible. Others, such as Stock and Watson (1989), and Bernanke (1990) experimented with interest rate spreads. While a number of alternative spreads have been suggested, the spread between the six-month commercial paper rate and the six-month Treasury bill rate seems to be a remarkably good predictor of the U.S. economy (Bernanke, 1990). Regardless, the fact that money has a far less predictive power for output than does the interest rate in the U.S. is a significant challenge to the traditional argument that money leads income.

Literature on monetary disturbances in Canada is extremely sparse, and relatively recent. Fung and Gupta (1994) represent the orthogonolized innovations in excess settlement balances as monetary policy shocks in Canada, while Armour,

Engert, and Fung (1996) found empirical evidence that the overnight interest rate is a good indicator of monetary policy stance in Canada.

This chapter reconsiders this debate for the Canadian economy. The history of the Bank of Canada's operating procedures is taken into account to provide a benchmark for determining the appropriate policy variables to be examined. The empirical analysis undertaken here first attempts to identify the policy variable that is a good predictor of the Canadian economy, using Granger-causality and variance decomposition tests. Then, the response of various economic activity measures to innovations in the policy variable is examined. The methodology used here for identifying the policy variable closely follows that used by Bernanke and Blinder (1992). Section 3.2 discusses the history of Canadian monetary policy practices while Section 3.3 describes the data used in the analysis. Section 3.4 discusses the results for the Granger-causality and variance decomposition tests. Section 3.5 examines the dynamic responses of a variety of economic activities to monetary policy innovations. Section 3.6 provides a conclusion to this chapter.

3.2 Bank of Canada's Operating Procedures

Between 1962 and 1970, Canada was on the gold standard that fixed the exchange rate of the Canadian dollar at U.S. 92.5 cents. The Bank of Canada then targeted short-term interest rates to maintain that external value of the dollar. (Parkin and Bade, 1995). Essentially, the money supply was endogenously determined. This however, was destabilizing to the Canadian economy. The empirical evidence

suggested that during this era, money was procyclical as well as inflationary. This led the Bank to abandon the gold standard in 1970 for a flexible exchange regime. Since then, Canadian monetary policy can be categorized into four distinct periods that alternated between interest rate targeting and monetary targeting. These periods are (Parkin and Bade, 1995):

- 1971-1974: Accommodating Inflation - Interest Rate Targeting
- 1975-1981: Monetary Targeting
- 1982-1988: Exchange Rate Targeting - Interest Rate Targeting.
- 1989-Present: Zero Inflation - Monetary Targeting.

1971-1974: Accommodating Inflation - Interest Rate Targeting

Although Canada switched to a flexible exchange rate regime in 1971, the Bank of Canada continued to adjust short-term interest rates to keep the foreign exchange market and the domestic bond market functioning smoothly, and paid no attention to the money supply. This resulted into "double-digit" inflation. To illustrate, the inflation rate in 1971 was 3 percent while it reached 11 percent in 1974 and 1975. Alarmed by this, the monetary authorities subsequently targeted the growth rate of money supply (Parkin and Bade, 1995).

1975-1981: Monetary Targeting

The high inflation rate caused the Bank to target the growth rate of M1. The target path of the growth of M1 was announced a year in advance, and the Bank adjusted policy in the course of the year to make the actual money supply growth rate

fall within the pre-announced target range (Parkin and Bade, 1995). The Bank targeted M1 because it satisfied two principal requirements. The first was that, according to the Bank's empirical research, the relationship between the real demand for M1 and the variations in real income and short term interest rates was stable. Secondly, since the assets included in M1 were mainly non-interest bearing, the demand for M1 was highly sensitive to interest rate changes. The Bank hoped that this would enable it to control the annual growth rate of M1 without generating large movements in short term interest rates and thereby, preventing instability and uncertainty in the financial and foreign exchange markets (Binhammer, 1993).

Announcing the monetary policy targets ahead of time was intended to influence the expectations of key financial and labour market decision makers with the hopes that this would help reduce actual inflation faster than would otherwise occur. Although the Bank managed to control the growth of M1 within the target ranges, double digit inflation persisted throughout this period (Parkin and Bade, 1995). One explanation for this is that new developments in banking practices occurred at a rapid pace during this period and new kinds of bank deposits were being offered[6]. As a result, people substituted from demand deposits which represented part of M1, into these new deposits that constituted part of M2. Consequently, M2 grew at an

[6] These developments included the introduction of daily interest chequing and savings accounts, and the development of cash management techniques for corporate accounts which reduced the amount of M1 that had to be held for daily transactions purposes. These developments, coupled with the use of new computer technology, induced the public to switch out of non-interest bearing accounts which constituted part of M1, thereby reducing its demand (Binhammer, 1993).

explosive rate while the growth in M1 was declining. Unable to control inflation, the Bank abandoned M1 targeting in 1982 (Parkin and Bade, 1995).

1982-1988: Exchange Rate Targeting - Interest Rate Targeting

The sharp increase and greater volatility in interest rates that occurred in the U.S. beginning in 1980 forced the Bank of Canada to choose between allowing the Canadian rates to follow the U.S., and allowing the Canadian dollar to depreciate to accommodate the differential in interest rates between the two countries. Under the first alternative, the Bank would lose control over the money supply, while the second alternative implied that the Bank would lose control over the external value of the dollar but retain control of the money supply. The Bank chose to resist the depreciation of the exchange rate, fearing that this would worsen the inflation problem in Canada. It indirectly targeted exchange rates by targeting interest rates. Ironically, this resulted in even higher inflation rates for this period (Binhammer, 1993). In addition, the persistent federal deficits led to higher interest rates, and the Bank found it extremely difficult to control the interest rate. In 1989, the Bank to abandon interest rate and exchange rate targeting, and returned to monetary targeting (Parkin and Bade, 1995).

1989-Present: Zero Inflation - Monetary Targeting

Since 1989, the Bank has focused on curbing inflation. Initially, the policy took the form of a return to the high interest rate policies of the 1980s. The Bank aimed at lowering aggregate demand by appreciating the exchange rate and increasing

the interest rate with the hopes of subsequently reducing inflation. This strategy was broadened in 1991 to include fiscal policy and public sector wage cost targets that were consistent with the zero inflation goal. Moreover, a formal declaration of the path of inflation was announced. This set out the path for inflation, taking it down in stages, to a 2 percent annual rate by the end of 1995. The Bank once again targeted M1 to achieve its goal. By 1992 however, inflation was well below 2 percent, and well below the band set by the Bank of Canada (Parkin and Bade, 1995). Finally, inflation was under control.

3.3 Data

In attempting to identify the monetary policy variables that best predict the Canadian economy utilizing the Vector Autoregression (VAR) methodology, seven measures of real economic activity, three interest rates and three monetary aggregates are used. The real economic activity measures include: real GDP at factor cost, real industrial production, real retail sales, the unemployment rate, housing starts, building permits, and real net manufacturing orders. The three-month commercial paper rate, the three-month Treasury bill rate, and the long-term government bond rate are the interest rate variables, while M1, M2, and M2+ are the monetary aggregates examined in this analysis. The price level is included for comparability with existing literature. Each series comprises of seasonally adjusted monthly data from 1969:01 to 1996:02[7] .

[7] A moving average ration was used to adjust the data that were not already seasonally adjusted. This methodology was chosen to maintain consistency with the practices of Statistics Canada. See the Data Appendix for details on the sources of the data.

Monthly data is used in hopes of attaining more precise measures of the dynamic interactions among the variables, and to be consistent with recent studies. Throughout this thesis, the lag length in the VAR is set equal to one year plus one period - the thirteenth month is added because it can sometimes capture seasonal effects not removed by seasonal adjustments of the data. This practice follows Sims (1992) paper. Trends are not included since these are unreliable, at least for inferences about low-frequency phenomena (Dueker and Serletis, 1996). All the data except the interest rate variables are logged.

3.4 The Predictive Power of Monetary Policy Variables

The attempt to identify the monetary policy variables that best predict the economy begins with a series of Granger-causality tests whose results are discussed in sub-section 3.4.1. However, caution should be used in interpreting the Granger-causality results of the reduced form VAR. Bernanke and Blinder (1992) explain that Granger-causality tests are sensitive to the non-orthogonality among the right-hand-side variables. A stylized example will illustrate the potential problem. Suppose that an interest rate variable, say the Treasury bill rate, was truly an exogenous variable which moved a monetary aggregate, say M1, which in turn moved the economy. Consequently, the Treasury bill rate might be insignificant in a regression that included M1 even though it is the genuine driving force of the economy. They assert that this potential problem led Sims (1980b), and Litterman and Weiss (1985), to focus on the variance decomposition measures.

3.4.1 Granger-Causality Tests

Table 3.1 reports marginal significance levels of Granger-causality *F*-tests. Each row of the table represents an equation that forecasts a measure of economic activity by thirteen lags of itself, the price level, the monetary aggregates and the interest rate variables. In particular, the table shows the marginal significance levels for the null hypothesis that all the lags of a particular right-hand-side variable, indicated by the column heading, can be excluded from one of the system's equations, indicated by the row heading[8].

The focus in this series of tests is on the predictive power of the monetary aggregates and interest rates. Overall, the monetary aggregates dominate the interest rates in four of the seven systems. For instance, the probability of excluding M2+ from the GDP and industrial production equations is less than 1 percent. The M1 aggregate shows similar performance in the case of manufacturing orders, while M2 is the best predictor of the unemployment rate. Interest rates dominate monetary aggregates in predicting retail sales, housing starts, and building permits. The T-bill rate is significant at the 1 percent level in predicting housing starts, while the long-term government bond rate is significant at the 13 percent level and the 23 percent level in predicting retail sales and building permits, respectively. Nevertheless, despite the dominance of monetary aggregates, there is a lack of strong domination by any one of the monetary aggregates in predicting the various measures of economic

[8] The table does not contain a column for the marginal significance of the lags of the left-hand-side variable since such a column would have 0.0000 everywhere.

activity in Canada. This, in addition to the sensitivity of Granger-causality tests to the non-orthogonality of the right-hand side variables, warrants additional tests.

3.4.2 Variance Decomposition

The variance decomposition is constructed from a VAR with orthogonolized residuals. It is the percentage of the variance of the forecasted variable attributable to the alternative right-hand-side variables at different time horizons. This measure however, also has its drawbacks. Specifically, if the absolute value of the residual correlation coefficients are greater than 0.2, then the variance decomposition is sensitive to the ordering of the explanatory variables (Enders, 1995). This arises due to the identification assumptions under the Choleski Decompositions[9]. Tables 3.2 through 3.8 report the residual correlation coefficients for each model considered in the Granger-causality tests. Due to the symmetric nature of these matrices, only the lower triangular elements are reported. The results indicate that the variance decomposition measures are potentially sensitive to the orderings since a significant number of these correlation coefficients are greater than 0.2, in absolute values. To circumvent this problem, different orderings of the VAR are considered.

There are two identification schemes that will be used throughout this thesis. The **interest rate rule (R-rule)** identifies monetary policy shocks through innovations in the interest rate. Thus, the interest rate variables are placed prior to monetary aggregates in the VAR. By contrast, the **monetary rule (M-rule)** identifies policy

[9] See Chapter 2 for a detailed discussion on this issue.

shocks by innovations in monetary aggregates. Hence, monetary aggregates are placed prior to interest rate variables in the VAR.

The variance decomposition tests begin with an M-Rule ordering {Y, P, M1, M2, M2+, commercial paper rate, T-bill rate, long-term government bond rate} where Y represents the various measures of economic activity[10]. Five different time horizons are analyzed. In particular, the variance decomposition at the 12, 24, 36, 48 and 60 month time intervals are examined. Table 3.9 reports the results for this ordering. The focus for these tests is on the monetary policy variables (interest rates and monetary aggregates). Over the 12-month horizon, M1 and the commercial paper rate each dominate in three instances, while M2 is the best predictor of retail sales. This scenario alters significantly over the remaining four time horizons as the commercial paper rate dominates the other variables in explaining the variance in the various economic activities. In fact in several instances, the commercial paper rate has more explanatory power than even the lags of the economic activity measure.

The sensitivity of the variance decomposition to the orderings is evident when the positions of the T-bill rate and commercial paper rate in the VAR are switched. A second M-rule ordering {Y, P, M1, M2, M2+, T-bill rate, commercial paper rate, long-term government bond rate} is considered. These results are summarized in Table 3.10. At the 12-month horizon, the T-bill rate dominates in four of the seven instances, while M1 is the best explanatory variable in two cases. Once again M2 is

[10] See the Data Appendix for abbreviations of variables.

the best policy variable in explaining retail sales. Nevertheless, over the remaining time horizons, the T-bill rate dominates in all instances and rivals the performance of the commercial paper rate under the previous ordering.

Two other M-rule orderings are undertaken to analyze the sensitivity of the orderings. Both of these have the long-term government bond rate placed prior to the commercial paper rate and the T-bill rate. The first of these orderings takes the form {Y, P, M1, M2, M2+, long-term government bond rate, commercial paper rate , T-bill rate} and the results are summarized in Table 3.11. This set of ordering fails to produce a dominant monetary policy variable as both long-term government bond rate and the commercial paper rate perform equally well in explaining the different measures of economic activity.

The last set of the M-rule ordering places the T-bill rate after the long-term bond rate but prior to the commercial paper rate as follows: {Y, P, M1, M2, M2+, long-term government bond rate, T-bill rate, commercial paper rate}. Once again, as summarized in Tables 3.12, this ordering does not produce a dominant monetary policy variable as both the long-term bond rate and the T-bill rate perform equally well.

The above results indicate that the interest rate variables are better predictors of the Canadian economy than monetary aggregates. This is further reinforced by the fact that the interest variables were placed at maximum "disadvantage" in the

orderings relative to the monetary aggregates[11]. Hence, undertaking R-rule orderings will not significantly alter the results. Nevertheless, four different R-rule orderings are considered, and their results summarized in Tables 3.13 to 3.16. These results are qualitatively identical to the M-rule ordering in that the interest rates dominate the monetary aggregates in explaining the variances in the economic activities. Furthermore, different interest rates dominate in different orderings, similar to the previous case. Thus, all these orderings fail to produce a single dominant policy variable.

3.5 Dynamic Response of the Economy to Monetary Policy Innovations

Plotting impulse response functions is a practical method to visually represent the behaviour of the response of the economy to monetary innovations. The subsequent impulse response analysis uses the commercial paper rate as the interest rate variable, and M2+ as the monetary aggregate variable. Bernanke (1990) demonstrated that the commercial paper rate was an exceptionally good predictor of the U.S. economy even when the Federal Funds rate was included in the regression. The commercial paper rate tended to rise sharply during Fed-induced "credit crunches", such as the episodes of disintermediation (Bernanke, 1990). In addition, the commercial paper rate contains information on the cost of borrowing to the private sector, which in turn determines investment levels and hence, real economic activity[12].

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[11] See Chapter 2 for a discussion on this issue.

[12] All the subsequent analysis was re-done using the T-bill rate instead of the commercial paper rate and the results were qualitatively identical to the commercial paper rate case.

M2+ is selected as the monetary aggregate variable because Serletis and King (1993) have shown that this is the best simple sum monetary aggregate in predicting movements in the Canadian economy. Both an R-rule and an M-rule ordering are considered in generating the impulse response functions. The responses, based on orthogonolized innovations, cover a 60-month horizon. Dashed lines denote plus and minus two standard deviation bands computed using the Monte Carlo methodology with 500 draws from the posterior distribution (Dueker and Serletis, 1996). The lag length is set at thirteen[13].

Sims' (1980) Model

The examination of the dynamic effects of monetary policy disturbances begins with Sims' (1980b) four-variable VAR specification. The R-rule responses are ordered {R, M, P, Y} while the M-rule responses are ordered {M, R, P, Y}. This set of orderings implicitly assume that monetary policy innovations have a contemporaneous affect on economic activity[14].

The R-rule impulse response functions are summarized in Figures 3.1 through 3.7. An increase in the interest rate, interpreted as a contractionary monetary policy, leads to a significant decline in all of the economic activities, which is consistent with economic theory. However, the shock causes an increase, albeit a statistically insignificant one, in the price level. This phenomenon, being inconsistent with theory, is termed the "**price puzzle**" in the literature.

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[13] Follows Sims (1992).

[14] See the discussion on Choleski Decomposition in Chapter 2.

The M-rule responses are summarized in Figures 3.8 through 3.14. A positive innovation in the money supply causes a significant increase in all of the economic activities, and an increase in the price level. However, this innovation leads to an increase in interest rates, which is contrary to theoretical predictions. This has been termed the "**liquidity puzzle**" in the literature dealing with the U.S. economy. Interestingly, interest rates are a lagging indicator of the various economic activities as they decline only after the positive affects of the shock on activity have declined.

Sims' (1992) Model[15]

Sims' solution to the price puzzle that was evident in the U.S. economy was to extend his R-rate formulation to include an index of sensitive commodity prices to capture information on future inflationary pressures over and above that already embodied within the consumer price index (Dueker and Serletis, 1996). Consistent with this approach, an R-rule ordering of {Y, P, Commodity Prices, R, M} and an M-rule ordering of {Y, P, Commodity Prices, M, R} are considered. These orderings implicitly assume that monetary innovations have a lagged effect on economic activities[16]. This analysis covers the period from 1972:1 to 1996:2 since data on commodity prices was unavailable for the preceding years. The new R-rule impulse response functions are summarized in Figure 3.15 through 3.21, and are qualitatively identical to the model without commodity prices. Specifically, the fourth rows of Figures 3.15 to 3.21 illustrate the response of economy activities to a contractionary

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[15] This follows Dueker and Serletis (1996).
[16] See the discussion on Choleski Decomposition in chapter 2.

monetary policy stance. This innovation causes a decline in economic activity, which persists in varying degrees in different incidences, from 20 months in the case of building permits to over 60 months in the case of retail sales. In most cases, the decline persists for over 40 months. The "price puzzle" is still present in this model, although it is statistically insignificant as it was in the previous R-rule models.

The new M-rule response functions are illustrated in Figures 3.22 through 3.28. Examining the fourth row of Figure 3.22, a positive monetary innovation produces a temporary increase in GDP, a statistically insignificant increase in both the price level and the commodity price index, and a temporary but insignificant increase in the interest rate. This pattern is repeated for the various economic activity measures. Thus, the inclusion of the commodity price index does not solve the "liquidity puzzle". Moreover, the price level response is statistically insignificant.

3.6 Conclusion

In recent years, there has been renewed interest in identifying monetary policy disturbances. This search has concentrated on interest rates and monetary aggregates. This chapter attempts to identify the policy variable that best predicted the various economic activities in Canada by undertaking Granger-causality and variance decomposition tests. Due to the inconclusiveness of these tests, the commercial paper rate and the M2+ monetary aggregate were selected, through reference to previous literature, to represent the variables whose movements could be identified as changes in policy stance. The dynamic responses of the various economic activities to

innovations in these policy variables is then analyzed, using impulse response functions. A contractionary innovation under an R-Rule ordering causes a decline in output and an increase in the price level. The latter response, being inconsistent with theoretical predictions, is termed the "price puzzle" in the literature. An expansionary innovation under an M-rule ordering causes an increase in the various economic activities, the price level, and the interest rate. The interest rate response is termed the "liquidity puzzle" in the literature due to its inconsistency with theoretical postulations. The inclusion of commodity prices, which resolved the "price puzzle" in the U.S. economy, does not qualitatively alter the results obtained for the Canadian economy.

Table 3.1: Granger Causality Tests

Forecast Variable	Price	M1	M2	M2+	Comm Paper	T-Bill	L-T. Gvt Bond
GDP	0.1584	0.0333	0.0394	**0.0076**	0.4985	0.7106	0.2315
Industrial Production	0.1209	0.0759	0.0184	**0.0018**	0.3660	0.2333	0.0713
Retail Sales	0.7972	0.1523	0.3141	0.1690	0.4766	0.4822	**0.1387**
Unemployment Rate	0.1572	0.5140	**0.1120**	0.3929	0.9178	0.9735	0.5675
Housing Starts	0.0679	0.2927	0.6892	0.5479	0.0345	**0.0018**	0.4836
Building Permits	0.2116	0.5078	0.9806	0.8749	0.5331	0.6109	**0.2362**
Manufacturing Orders	0.0475	**0.0275**	0.1963	0.3341	0.0969	0.1359	0.0347

Table 3.2: Residual Correlation Matrices For Innovations In {GDP, Price, M1, M2, M2+, Commercial Paper Rate, T-Bill Rate, Long-Term Government Bond Rate} Model

	GDP	Price	M1	M2	M2+	Comm. Paper	T-Bill	L-T Gvt Bond
GDP	1.000							
Price	-0.704	1.000						
M1	-0.519	0.672	1.000					
M2	0.783	-0.769	-0.554	1.000				
M2+	-0.072	0.030	-0.079	-0.008	1.000			
Comm. Paper	0.060	-0.104	-0.154	0.083	0.592	1.000		
T-Bill	-0.085	0.204	-0.034	-0.066	0.079	-0.041	1.000	
L-T Gvt. Bond	-0.847	0.840	0.616	-0.939	0.048	-0.092	0.112	1.000

Table 3.3: Residual Correlation Matrices For Innovations In {Industrial Production, Price, M1, M2, M2+, Commercial Paper Rate, T-Bill Rate, Long-Term Government Bond Rate} Model

	Indust. Prod.	Price	M1	M2	M2+	Comm. Paper	T-Bill	L-T Gvt Bond
Industrial Production	1.000							
Price	-0.153	1.000						
M1	-0.046	0.678	1.000					
M2	0.100	-0.756	-0.537	1.000				
M2+	-0.075	0.050	-0.052	-0.022	1.000			
Comm. Paper	0.008	-0.094	-0.132	0.075	0.575	1.000		
T-Bill	-0.012	0.228	0.036	-0.079	0.063	-0.044	1.000	
L-T Gvt. Bond	-0.169	0.827	0.581	-0.938	0.068	-0.077	0.141	1.000

Table 3.4: Residual Correlation Matrices For Innovations In {Retail, Price, M1, M2, M2+, Commercial Paper Rate, T-Bill Rate, Long-Term Government Bond Rate} Model

	Retail	Price	M1	M2	M2+	Comm. Paper	T-Bill	L-T Gvt Bond
Retail	1.000							
Price	-0.063	1.000						
M1	-0.025	0.678	1.000					
M2	-0.031	0.766	-0.546	1.000				
M2+	0.060	0.034	-0.073	-0.025	1.000			
Comm. Paper	0.067	-0.116	-0.144	0.068	0.565	1.000		
T-Bill	-0.141	0.240	0.061	-0.049	0.037	-0.042	1.000	
L-T Gvt. Bond	-0.011	0.842	0.594	-0.934	0.070	-0.078	0.140	1.000

Table 3.5: Residual Correlation Matrices For Innovations In {Unemployment, Price, M1, M2, M2+, Commercial Paper Rate, T-Bill Rate, Long-Term Government Bond Rate} Model

	Unemp.	Price	M1	M2	M2+	Comm. Paper	T-Bill	L-T Gvt Bond
Unemployment	1.000							
Price	-0.012	1.000						
M1	0.022	0.671	1.000					
M2	0.034	-0.760	-0.543	1.000				
M2+	0.099	0.034	-0.067	-0.022	1.000			
Comm. Paper	0.045	-0.098	-0.122	0.063	0.578	1.000		
T-Bill	-0.060	0.212	0.036	-0.032	0.023	-0.044	1.000	
L-T Gvt. Bond	-0.027	0.830	0.581	-0.931	0.058	-0.081	0.129	1.000

Table 3.6: Residual Correlation Matrices For Innovations In {Housing, Price, M1, M2, M2+, Commercial Paper Rate, T-Bill Rate, Long-Term Government Bond Rate} Model

	Housing	Price	M1	M2	M2+	Comm. Paper	T-Bill	L-T Gvt Bond
Housing	1.000							
Price	-0.153	1.000						
M1	-0.046	0.678	1.000					
M2	0.100	-0.756	-0.537	1.000				
M2+	-0.075	0.050	-0.052	-0.022	1.000			
Comm. Paper	0.008	-0.094	-0.132	0.075	0.575	1.000		
T-Bill	-0.012	0.228	0.036	-0.079	0.063	-0.044	1.000	
L-T Gvt. Bond	-0.169	0.827	0.581	-0.938	0.068	-0.077	0.141	1.000

Table 3.7: Residual Correlation Matrices For Innovations In {Building Permits, Price, M1, M2, M2+, Commercial Paper Rate, T-Bill Rate, Long-Term Government Bond Rate} Model

	Permits	Price	M1	M2	M2+	Comm. Paper	T-Bill	L-T Gvt Bond
Permits	1.000							
Price	-0.564	1.000						
M1	-0.445	0.698	1.000					
M2	0.624	-0.754	-0.545	1.000				
M2+	-0.106	0.037	-0.016	-0.025	1.000			
Comm. Paper	0.017	-0.118	-0.034	0.061	0.555	1.000		
T-Bill	-0.242	0.248	0.087	-0.068	0.030	-0.080	1.000	
L-T Gvt. Bond	-0.664	0.815	0.585	-0.921	0.072	-0.078	0.158	1.000

Table 3.8: Residual Correlation Matrices For Innovations In {Manufacturing Orders, Price, M1, M2, M2+, Commercial Paper Rate, T-Bill Rate, Long-Term Government Bond Rate} Model

	Manufacturing	Price	M1	M2	M2+	Comm. Paper	T-Bill	L-T Gvt Bond
Manufacturing	1.000							
Price	0.504	1.000						
M1	0.394	0.689	1.000					
M2	-0.549	-0.755	-0.545	1.000				
M2+	-0.029	0.054	-0.027	-0.026	1.000			
Comm. Paper	-0.022	-0.099	-0.058	0.069	0.577	1.000		
T-Bill	-0.010	0.284	0.126	-0.103	0.053	-0.046	1.000	
L-T Gvt. Bond	0.555	0.817	0.590	-0.923	0.083	-0.072	0.182	1.000

Table 3.9: Variance Decomposition For {Own, Price, M1, M2, M2+, Commercial Paper Rate, T-Bill Rate, Long-Term Government Bond Rate} Model

Forecast Variable	Own	Price	M1	M2	M2+	Comm. Paper	T-Bill	L-T Gvt Bond
			Table A: 12-Month Horizon					
GDP	55.60	3.37	**14.08**	8.19	3.08	9.51	4.36	1.82
Industrial Production	49.04	5.66	9.77	5.02	6.46	**11.92**	9.68	2.45
Retail Sales	65.91	1.44	1.43	**12.84**	0.98	7.76	3.00	6.64
Unemployment Rate	62.00	2.35	**15.52**	7.76	4.68	6.68	0.77	0.23
Housing Starts	54.89	3.97	2.72	10.02	1.35	**18.86**	4.26	3.94
Building Permits	59.63	3.05	0.47	8.69	1.59	**14.91**	2.82	8.84
Manufacturing Orders	58.03	9.13	**9.95**	2.01	1.49	7.15	7.40	4.85
			Table B: 24-Month Horizon					
GDP	31.59	2.45	8.87	6.85	3.00	**42.49**	2.65	2.10
Industrial Production	28.12	3.69	5.87	4.17	3.96	**46.46**	6.30	1.43
Retail Sales	46.55	2.48	2.71	11.96	1.44	**16.67**	10.38	8.22
Unemployment Rate	37.54	3.45	11.66	7.43	4.40	**31.15**	3.50	0.87
Housing Starts	44.98	4.31	8.25	8.98	1.70	**23.09**	4.33	4.35
Building Permits	46.14	3.94	4.53	7.09	2.02	**21.61**	6.28	8.40
Manufacturing Orders	30.89	6.40	5.82	5.21	1.00	**39.59**	5.44	5.66
			Table C: 36-Month Horizon					
GDP	23.15	1.66	6.34	5.42	2.48	**56.45**	3.07	1.44
Industrial Production	27.24	2.96	4.28	5.01	5.68	**46.51**	6.06	2.27
Retail Sales	32.16	3.49	2.085	13.09	4.56	**24.96**	13.72	5.94
Unemployment Rate	33.42	2.59	11.93	7.13	5.02	**31.86**	5.93	2.22
Housing Starts	43.39	5.52	7.91	9.98	1.90	**21.69**	5.11	4.50
Building Permits	42.66	4.16	4.87	7.56	3.49	**21.27**	7.96	8.05
Manufacturing Orders	21.76	4.33	3.80	10.11	0.69	**50.25**	4.06	5.03
			Table D: 48-Month Horizon					
GDP	21.07	1.43	5.48	4.68	4.02	**57.49**	4.61	1.21
Industrial Production	26.26	3.33	3.79	4.81	9.90	**40.86**	8.30	2.75
Retail Sales	26.44	4.62	1.94	12.90	8.20	**25.29**	15.89	4.73
Unemployment Rate	33.10	3.16	11.32	8.78	10.89	**22.68**	5.86	4.13
Housing Starts	42.54	6.64	7.59	10.03	2.66	**20.60**	5.35	4.59
Building Permits	39.86	4.34	5.12	7.04	6.55	**20.59**	8.31	8.18
Manufacturing Orders	21.11	3.75	3.26	12.58	0.59	**50.17**	3.54	5.01
			Table E: 60-Month Horizon					
GDP	20.12	1.37	5.34	4.49	5.05	**55.34**	7.03	1.26
Industrial Production	25.03	4.00	3.59	4.62	11.24	**39.75**	9.16	2.61
Retail Sales	25.17	5.21	2.01	12.91	9.68	**23.38**	17.27	4.38
Unemployment Rate	29.99	4.11	9.95	10.57	16.02	**18.65**	5.65	5.06
Housing Starts	40.35	9.78	7.56	*9.76*	2.93	**19.82**	5.18	4.62
Building Permits	38.19	4.87	5.41	6.74	7.78	**20.67**	8.25	8.11
Manufacturing Orders	21.53	3.77	3.18	12.89	0.71	**49.03**	3.53	5.37

Table 3.10: Variance Decomposition For {Own, Price, M1, M2, M2+, T-Bill Rate, Commercial Paper Rate, Long-Term Government Bond Rate} Model

Forecast Variable	Own	Price	M1	M2	M2+	T-Bill	Comm. Paper	L-T Gvt Bond
			Table A: 12-Month Horizon					
GDP	55.60	3.37	**14.09**	8.18	3.08	11.56	2.31	1.82
Industrial Production	49.04	5.66	9.77	5.02	5.47	**17.98**	3.61	2.45
Retail Sales	65.91	1.44	1.43	**12.84**	0.98	10.11	0.65	6.64
Unemployment Rate	62.00	2.35	**15.52**	7.76	4.68	7.20	0.25	0.23
Housing Starts	54.89	3.97	2.72	10.02	1.35	**19.30**	3.82	3.94
Building Permits	59.63	3.05	0.47	8.69	1.59	**17.34**	0.39	8.84
Manufacturing Orders	58.03	9.13	9.95	2.01	1.49	**11.07**	3.48	4.85
			Table B: 24-Month Horizon					
GDP	31.58	2.45	8.87	6.84	3.00	**40.97**	4.17	2.10
Industrial Production	28.12	3.69	5.87	4.18	3.97	**48.83**	3.92	1.43
Retail Sales	46.55	2.48	2.71	11.96	1.44	**24.15**	2.20	8.52
Unemployment Rate	37.54	3.46	11.66	7.43	4.40	**34.26**	0.38	0.87
Housing Starts	44.98	4.31	8.25	8.98	1.70	**22.56**	4.86	4.35
Building Permits	46.14	3.94	4.53	7.09	2.01	**26.31**	1.58	8.40
Manufacturing Orders	30.89	6.40	5.82	5.21	1.00	**41.57**	3.45	5.66
			Table C: 36-Month Horizon					
GDP	23.15	1.66	6.34	5.41	2.48	**56.00**	3.52	1.44
Industrial Production	27.25	2.96	4.28	5.01	5.68	**49.62**	2.93	2.27
Retail Sales	32.16	3.49	2.08	13.09	4.56	**35.99**	2.67	5.94
Unemployment Rate	33.42	2.59	11.93	7.13	5.02	**37.10**	0.59	2.22
Housing Starts	43.39	5.52	7.91	9.98	1.90	**21.40**	5.40	4.50
Building Permits	42.65	4.16	4.87	7.56	3.48	**26.84**	2.39	8.05
Manufacturing Orders	21.76	4.33	3.80	10.11	0.67	**50.69**	3.62	5.03
			Table D: 48-Month Horizon					
GDP	21.07	1.43	5.48	4.68	4.02	**59.09**	3.02	1.21
Industrial Production	26.27	3.34	3.79	4.81	9.90	**44.92**	4.22	2.75
Retail Sales	26.44	4.62	1.94	12.90	8.20	**37.48**	3.70	4.73
Unemployment Rate	33.18	3.16	11.32	8.79	10.89	**27.11**	1.42	4.13
Housing Starts	42.54	6.64	7.59	10.03	2.66	**20.04**	5.91	4.59
Building Permits	39.86	4.34	5.12	7.04	6.55	**25.29**	3.62	8.18
Manufacturing Orders	21.11	3.75	3.26	12.57	0.59	**50.01**	3.69	5.01
			Table E: 60-Month Horizon					
GDP	20.11	1.37	5.35	4.49	5.04	**58.20**	4.18	1.26
Industrial Production	25.03	4.01	3.59	4.62	11.25	**42.80**	6.09	2.61
Retail Sales	25.17	5.21	2.01	12.91	9.68	**35.17**	5.47	4.38
Unemployment Rate	29.99	4.11	9.95	10.57	16.02	**21.36**	2.94	5.06
Housing Starts	40.35	9.77	7.56	9.76	2.93	**18.91**	6.10	4.62
Building Permits	38.19	4.87	5.40	6.74	7.77	**24.61**	4.31	8.11
Manufacturing Orders	21.51	3.77	3.18	12.89	0.71	**48.84**	3.72	5.37

Table 3.11: Variance Decomposition For {Own, Price, M1, M2, M2+, Long-Term Government Bond Rate, Commercial Paper Rate, T-Bill Rate} Model

Forecast Variable	Own	Price	M1	M2	M2+	L-T Gvt. Bond	Comm. Paper	T-Bill
			Table A: 12-Month Horizon					
GDP	55.60	3.37	**14.09**	8.18	3.08	0.44	10.15	5.09
Industrial Production	49.04	5.66	9.77	5.02	6.46	1.52	**11.52**	11.01
Retail Sales	65.91	1.44	1.43	12.84	0.98	**13.13**	2.38	1.88
Unemployment Rate	62.00	2.35	**15.52**	7.76	4.68	2.27	4.76	0.66
Housing Starts	54.89	3.97	2.72	10.01	1.35	**13.20**	9.95	3.92
Building Permits	59.63	3.05	0.47	8.69	1.59	**19.98**	5.22	1.36
Manufacturing Orders	58.03	9.13	9.95	2.01	1.49	**3.51**	7.45	8.44
			Table B: 24-Month Horizon					
GDP	31.58	2.45	8.87	6.84	3.00	4.46	**39.50**	3.28
Industrial Production	28.12	3.69	5.87	4.17	3.96	8.64	**38.44**	7.11
Retail Sales	46.55	2.47	2.71	11.96	1.44	**20.53**	6.97	7.37
Unemployment Rate	37.54	3.46	11.66	7.43	4.40	11.44	**21.22**	2.85
Housing Starts	44.98	4.31	8.25	8.98	1.70	**14.88**	12.70	4.19
Building Permits	46.14	3.94	4.53	7.09	2.02	**21.25**	10.10	4.98
Manufacturing Orders	30.89	6.40	5.82	5.21	1.00	3.52	**40.64**	6.52
			Table C: 36-Month Horizon					
GDP	23.15	1.66	6.34	5.41	2.48	10.08	**47.50**	3.39
Industrial Production	27.24	2.96	4.28	5.01	5.68	14.72	**34.20**	5.92
Retail Sales	32.16	3.49	2.08	13.09	4.56	**17.64**	6.97	7.37
Unemployment Rate	33.42	2.59	11.93	7.13	5.02	15.22	**20.23**	4.47
Housing Starts	43.39	5.52	7.91	9.98	1.90	**14.52**	12.08	4.71
Building Permits	42.66	4.16	4.87	7.56	3.48	**19.75**	10.68	6.84
Manufacturing Orders	21.76	4.33	3.80	10.11	0.67	4.10	**50.25**	5.00
			Table D: 48-Month Horizon					
GDP	21.07	1.43	5.48	4.68	4.02	10.97	**47.47**	4.89
Industrial Production	26.26	3.33	3.79	4.81	9.90	15.07	**29.32**	7.52
Retail Sales	26.44	4.61	1.94	12.90	8.20	**15.81**	15.78	14.32
Unemployment Rate	33.18	3.16	11.32	8.78	10.89	**14.45**	**14.15**	4.07
Housing Starts	42.54	6.64	7.59	10.03	2.66	**13.85**	11.51	5.18
Building Permits	39.86	4.34	5.12	7.04	6.55	**19.02**	10.49	7.57
Manufacturing Orders	21.11	3.75	3.26	12.57	0.59	3.87	**50.46**	4.39
			Table E: 60-Month Horizon					
GDP	20.11	1.37	5.35	4.49	5.05	10.62	**45.62**	7.39
Industrial Production	25.03	4.00	3.59	4.62	11.24	14.37	**28.78**	8.37
Retail Sales	25.17	5.21	2.01	12.90	9.68	14.60	14.58	**15.84**
Unemployment Rate	29.99	4.11	9.94	10.57	**16.02**	12.22	13.41	3.72
Housing Starts	40.35	9.78	7.56	9.76	2.93	**13.45**	11.04	5.15
Building Permits	38.19	4.87	5.40	6.74	7.77	**18.81**	10.56	7.65
Manufacturing Orders	21.53	3.77	3.18	12.89	0.71	4.09	**49.52**	4.31

Table 3.12: Variance Decomposition For {Own, Price, M1, M2, M2+, Long-Term Government Bond Rate, T-Bill Rate, Commercial Paper Rate} Model

Forecast Variable	Own	Price	M1	M2	M2+	L-T Gvt. Bond	T-Bill	Comm Paper
			Table A: 12-Month Horizon					
GDP	55.60	3.36	14.09	8.18	3.08	0.44	**12.93**	2.32
Industrial Production	49.04	5.66	9.77	5.02	6.46	1.52	**18.98**	3.56
Retail Sales	65.91	1.44	1.43	12.84	0.98	**13.13**	3.61	0.66
Unemployment Rate	62.00	2.35	**15.52**	7.76	4.68	2.27	5.17	0.25
Housing Starts	55.89	3.97	2.72	10.01	1.34	**13.20**	9.90	3.97
Building Permits	59.63	3.05	0.47	8.69	1.59	**19.98**	6.19	0.39
Manufacturing Orders	58.03	9.13	9.95	2.01	1.49	3.51	**12.78**	3.11
			Table B: 24-Month Horizon					
GDP	31.58	2.45	8.87	6.85	3.00	4.46	**38.63**	4.15
Industrial Production	28.12	3.69	5.87	4.17	3.96	8.64	**41.65**	3.90
Retail Sales	46.55	2.48	2.71	11.96	1.44	**20.53**	12.11	2.23
Unemployment Rate	37.54	3.45	11.66	7.43	4.40	11.44	**23.69**	0.39
Housing Starts	44.98	4.31	8.25	8.98	1.70	**14.88**	11.83	5.06
Building Permits	42.66	4.16	4.87	7.56	3.48	**19.75**	15.14	2.39
Manufacturing Orders	30.89	6.40	5.82	5.21	1.00	3.52	**43.65**	3.52
			Table C: 36-Month Horizon					
GDP	23.15	1.66	6.34	5.41	2.48	10.07	**47.38**	3.51
Industrial Production	27.24	2.96	4.28	5.01	5.68	14.72	**37.20**	2.92
Retail Sales	32.16	3.49	2.08	13.09	4.56	17.64	**24.28**	2.69
Unemployment Rate	33.42	2.59	11.93	7.13	5.02	15.22	**24.11**	0.59
Housing Starts	43.39	5.52	7.91	9.98	1.90	**14.52**	11.23	5.55
Building Permits	42.66	4.16	4.87	7.56	3.48	**19.75**	15.14	2.39
Manufacturing Orders	21.76	4.33	3.80	10.11	0.67	4.10	**51.42**	3.82
			Table D: 48-Month Horizon					
GDP	21.07	1.43	5.48	4.68	4.02	10.97	**49.34**	3.01
Industrial Production	26.26	3.33	3.79	4.81	9.90	15.07	**32.61**	4.23
Retail Sales	26.44	4.62	1.94	12.90	8.20	15.80	**26.39**	3.71
Unemployment Rate	3.18	3.16	11.32	8.78	10.89	14.45	**16.83**	1.38
Housing Starts	42.54	6.63	7.59	10.03	2.66	**13.85**	10.60	6.09
Building Permits	39.86	4.34	5.12	7.04	6.55	**19.02**	14.44	3.62
Manufacturing Orders	21.11	3.75	3.26	12.58	0.59	3.87	**50.90**	3.95
			Table E: 60-Month Horizon					
GDP	20.11	1.37	5.35	4.49	5.05	10.62	**48.84**	4.18
Industrial Production	25.02	4.00	3.59	4.62	11.24	14.37	**31.04**	6.11
Retail Sales	25.17	5.21	2.01	12.90	9.68	14.60	**24.94**	5.48
Unemployment Rate	29.99	4.11	9.94	10.57	16.02	12.22	**14.27**	2.86
Housing Starts	40.35	9.78	7.56	9.76	2.93	**13.45**	9.89	6.30
Building Permits	38.19	4.87	5.40	6.74	7.77	**18.81**	13.90	4.31
Manufacturing Orders	21.53	3.77	3.18	12.89	0.71	4.09	**49.84**	4.00

Table 3.13: Variance Decomposition For {Own, Price, Commercial Paper Rate, T-Bill Rate, Long-Term Government Bond Rate, M1, M2, M2+} Model

Forecast Variable	Own	Price	Comm. Paper	T-Bill	L-T Gvt. Bond	M1	M2	M2+
			Table A: 12-Month Horizon					
GDP	55.60	3.37	9.46	2.13	2.30	**15.25**	8.22	3.67
Industrial Production	49.04	5.66	11.70	4.39	2.12	**12.02**	6.01	9.06
Retail Sales	65.91	1.44	7.84	1.42	6.39	2.15	**13.86**	0.99
Unemployment Rate	62.00	2.35	7.28	0.44	0.24	**16.55**	6.75	4.38
Housing Starts	54.89	3.97	**20.55**	3.53	6.10	2.98	9.20	0.79
Building Permits	59.63	3.05	**16.18**	1.68	9.54	0.38	8.26	1.29
Manufacturing Orders	58.03	9.13	6.93	5.36	5.22	**10.87**	2.30	2.15
			Table B: 24-Month Horizon					
GDP	31.58	2.45	**42.63**	1.35	2.44	9.92	6.61	3.01
Industrial Production	28.12	3.69	**46.28**	3.49	1.24	6.92	4.77	5.51
Retail Sales	46.55	2.47	**17.00**	9.85	8.43	2.20	12.39	1.09
Unemployment Rate	37.54	3.45	**32.95**	2.99	1.12	11.70	6.36	3.90
Housing Starts	44.98	4.31	**25.74**	3.94	4.61	7.30	8.08	1.04
Building Permits	46.14	3.94	**23.19**	5.34	7.12	3.55	6.72	2.00
Manufacturing Orders	30.89	6.40	**38.25**	5.06	5.87	6.48	5.70	1.35
			Table C: 36-Month Horizon					
GDP	23.15	1.66	**55.12**	2.58	1.64	7.76	5.48	2.61
Industrial Production	27.24	2.96	**45.59**	6.30	1.78	4.40	5.04	6.67
Retail Sales	32.16	3.49	**24.63**	17.16	5.90	1.60	12.10	2.96
Unemployment Rate	33.42	2.59	**32.78**	7.79	2.21	10.36	6.23	4.61
Housing Starts	43.39	5.52	**24.17**	4.50	4.78	7.05	9.34	1.25
Building Permits	42.66	4.16	**22.62**	7.15	8.87	4.20	7.37	2.97
Manufacturing Orders	21.76	4.33	**48.14**	4.63	5.15	4.29	10.76	0.95
			Table D: 48-Month Horizon					
GDP	21.07	1.43	**55.37**	4.99	1.47	7.05	4.72	3.89
Industrial Production	26.26	3.33	**39.85**	10.61	2.05	3.75	4.55	9.60
Retail Sales	26.44	4.62	**24.72**	21.52	4.69	1.33	11.28	5.41
Unemployment Rate	33.18	3.16	**23.06**	10.51	3.41	8.99	7.41	10.28
Housing Starts	42.54	6.64	**22.96**	4.79	4.96	6.83	9.61	1.66
Building Permits	39.86	4.34	**22.00**	8.15	9.25	4.59	6.86	4.94
Manufacturing Orders	21.11	3.75	**47.90**	4.31	5.07	3.66	13.34	0.86
			Table E: 60-Month Horizon					
GDP	20.11	1.37	**53.13**	7.85	1.60	6.92	4.54	4.42
Industrial Production	25.03	4.01	**38.92**	11.93	1.94	3.54	4.43	10.20
Retail Sales	25.17	5.21	**22.84**	23.88	4.37	1.30	11.02	6.23
Unemployment Rate	29.99	4.11	**19.48**	11.57	3.85	7.68	8.45	14.85
Housing Starts	40.35	9.78	**22.10**	4.61	5.04	6.83	9.52	1.76
Building Permits	38.19	4.87	**22.16**	8.28	9.26	4.93	6.62	5.69
Manufacturing Orders	21.53	3.77	**46.79**	4.28	5.36	3.59	13.73	0.96

3.14: Variance Decomposition For {Own, Price, T-Bill Rate, Commercial Paper Rate, Long-Term Government Bond Rate, M1, M2, M2+} Model

Forecast Variable	Own	Price	T-Bill	Comm. Paper	L-T Gvt. Bond	M1	M2	M2+
			Table A: 12-Month Horizon					
GDP	55.59	3.37	9.78	1.80	2.30	**15.25**	8.22	3.67
Industrial Production	49.04	5.66	**14.77**	1.32	2.12	12.02	6.01	9.06
Retail Sales	65.91	1.44	8.72	0.63	8.43	2.20	**13.86**	0.99
Unemployment Rate	62.00	2.35	5.44	2.29	0.24	**16.55**	6.75	4.38
Housing Starts	54.89	3.97	**19.29**	4.79	4.10	2.98	9.20	0.79
Building Permits	59.63	3.05	**17.42**	0.43	9.54	0.38	8.26	1.29
Manufacturing Orders	58.03	9.13	**10.01**	2.29	5.22	**10.87**	2.30	2.15
			Table B: 24-Month Horizon					
GDP	31.58	2.45	**39.22**	4.77	2.44	9.92	8.22	3.67
Industrial Production	28.12	3.69	**47.20**	2.57	1.24	6.92	4.76	5.51
Retail Sales	46.55	2.47	**24.23**	2.63	8.43	2.20	12.39	1.09
Unemployment Rate	37.54	3.45	**33.71**	2.23	1.12	11.70	6.36	3.90
Housing Starts	44.98	4.31	**23.92**	5.76	4.61	7.30	8.08	1.04
Building Permits	46.14	3.94	**26.96**	1.57	9.12	3.55	6.72	2.00
Manufacturing Orders	30.89	6.40	**41.12**	2.19	5.87	6.48	5.70	1.35
			Table C: 36-Month Horizon					
GDP	23.14	1.66	**54.00**	3.70	1.64	7.76	5.48	2.61
Industrial Production	27.24	2.96	**49.65**	2.25	1.78	4.40	5.04	6.67
Retail Sales	32.16	3.49	**37.50**	4.29	5.90	1.60	12.10	2.96
Unemployment Rate	33.42	2.59	**37.74**	2.82	2.21	10.36	6.23	4.61
Housing Starts	43.39	5.52	**22.66**	6.01	4.78	7.05	9.34	1.25
Building Permits	42.66	4.16	**27.40**	2.36	8.87	4.20	7.37	2.97
Manufacturing Orders	21.76	4.33	**50.74**	2.03	5.15	4.29	10.76	0.95
			Table D: 48-Month Horizon					
GDP	21.07	1.43	**57.03**	3.33	1.47	7.05	4.72	3.89
Industrial Production	26.26	3.33	**45.24**	5.22	2.05	3.75	4.54	9.59
Retail Sales	26.44	4.61	**39.70**	6.54	4.69	1.33	11.28	5.40
Unemployment Rate	33.18	3.16	**28.02**	5.56	3.41	8.99	7.41	10.28
Housing Starts	42.54	6.64	**21.24**	6.52	4.96	6.83	9.61	1.66
Building Permits	39.86	4.34	**25.82**	4.34	9.25	4.59	6.86	4.94
Manufacturing Orders	21.11	3.75	**50.27**	1.93	5.07	3.66	13.34	0.86
			Table E: 60-Month Horizon					
GDP	20.11	1.37	**56.14**	4.84	1.60	6.97	4.54	4.42
Industrial Production	25.03	4.00	**43.08**	7.78	1.94	3.54	4.43	10.20
Retail Sales	25.17	5.21	**37.45**	9.27	4.37	1.30	11.01	6.22
Unemployment Rate	29.99	4.11	**21.98**	9.08	3.85	7.68	8.45	14.85
Housing Starts	40.35	9.78	**20.10**	6.61	5.04	6.83	9.52	1.76
Building Permits	38.19	4.87	**25.11**	5.33	9.26	4.93	6.23	5.69
Manufacturing Orders	21.53	3.77	**49.11**	1.96	5.36	3.59	13.73	0.96

Table 3.15: Variance Decomposition For {Own, Price, Long-Term Government Bond Rate, Commercial Paper Rate, T-Bill Rate} Model

Forecast Variable	Own	Price	L-T Gvt. Bond	Comm. Paper	T-Bill	M1	M2	M2+
			Table A: 12-Month Horizon					
GDP	55.60	3.37	0.29	10.90	2.70	**15.25**	8.22	3.67
Industrial Production	49.04	5.66	1.45	11.53	5.23	**12.02**	6.01	9.06
Retail Sales	65.91	1.44	12.15	2.59	0.92	2.15	**13.86**	0.99
Unemployment Rate	62.00	2.35	1.94	5.56	0.47	**16.55**	6.75	4.38
Housing Starts	54.89	3.97	**13.47**	11.08	3.63	2.98	9.20	0.79
Building Permits	59.63	3.05	**20.99**	5.71	0.70	0.38	8.26	1.29
Manufacturing Orders	58.03	9.13	3.57	7.67	6.28	**10.88**	2.30	2.15
			Table B: 24-Month Horizon					
GDP	31.58	2.45	4.37	**40.28**	1.78	9.92	6.61	3.01
Industrial Production	28.12	3.69	8.66	**38.34**	4.01	6.92	4.76	5.51
Retail Sales	46.55	2.47	**20.22**	7.10	7.96	2.20	12.39	1.09
Unemployment Rate	37.54	3.45	12.29	**22.24**	2.52	11.70	6.36	3.90
Housing Starts	44.98	4.31	**15.95**	14.23	4.10	7.30	8.08	1.04
Building Permits	46.14	3.94	**22.75**	10.58	4.32	3.55	6.72	2.00
Manufacturing Orders	30.89	6.40	3.58	**39.40**	6.21	6.48	5.70	1.35
			Table C: 36-Month Horizon					
GDP	23.14	1.66	9.28	**47.25**	2.82	7.76	5.47	2.61
Industrial Production	27.24	2.96	14.13	**33.70**	5.85	4.40	5.04	6.67
Retail Sales	32.16	3.49	**17.43**	14.56	15.69	1.60	12.10	2.96
Unemployment Rate	33.42	2.59	15.92	**20.58**	6.27	10.36	6.23	4.61
Housing Starts	43.39	5.52	**15.27**	13.49	4.45	7.05	9.34	1.25
Building Permits	42.66	4.16	**21.09**	11.13	6.42	4.20	7.38	2.97
Manufacturing Orders	21.76	4.33	4.21	**48.00**	5.70	4.29	10.76	0.95
			Table D: 48-Month Horizon					
GDP	21.07	1.43	9.75	**46.77**	5.31	7.05	4.72	3.89
Industrial Production	26.26	3.33	14.11	**28.84**	9.56	3.75	4.55	9.60
Retail Sales	26.44	4.61	15.59	15.17	**20.17**	1.33	11.28	5.41
Unemployment Rate	33.18	3.16	14.37	**14.47**	8.15	8.99	7.41	10.28
Housing Starts	42.54	6.64	**14.91**	12.83	4.97	6.83	9.61	1.66
Building Permits	39.86	4.34	**20.57**	10.93	7.90	4.59	6.86	4.94
Manufacturing Orders	21.11	3.75	3.99	**47.94**	5.34	3.66	13.34	0.86
			Table E: 60-Month Horizon					
GDP	20.11	1.37	9.36	**44.88**	8.34	6.97	4.54	4.42
Industrial Production	25.03	4.00	13.52	**28.37**	10.91	3.54	4.43	10.20
Retail Sales	25.17	5.21	14.40	14.01	**22.67**	1.30	11.01	6.22
Unemployment Rate	29.99	4.11	11.80	14.23	8.88	7.68	8.46	**14.85**
Housing Starts	40.35	9.77	**14.60**	12.26	4.90	6.83	9.52	1.76
Building Permits	38.19	4.87	**20.49**	11.00	8.20	4.93	6.23	5.69
Manufacturing Orders	21.53	3.77	4.14	**47.03**	5.25	3.59	13.73	0.96

Table 3.16: Variance Decomposition For {Own, Price, Long-Term Government Bond Rate, T-Bill Rate, Commercial Paper Rate} Model

Forecast Variable	Own	Price	L-T Gvt. Bond	T-Bill	Comm. Paper	M1	M2	M2+
			Table A: 12-Month Horizon					
GDP	55.60	3.37	0.29	11.79	1.80	**15.25**	8.22	3.67
Industrial Production	49.04	5.66	1.45	**15.51**	1.25	12.02	6.01	9.06
Retail Sales	65.91	1.44	12.15	2.99	0.52	2.15	**13.86**	0.99
Unemployment Rate	62.00	2.35	1.94	3.74	2.29	**16.55**	6.75	4.38
Housing Starts	54.89	3.97	**13.47**	9.77	4.93	2.98	9.20	0.79
Building Permits	59.63	3.05	**20.99**	6.01	0.39	0.38	8.26	1.29
Manufacturing Orders	58.03	9.13	3.57	**11.99**	1.96	10.87	2.30	2.15
			Table B: 24-Month Horizon					
GDP	31.58	2.45	4.37	**37.27**	4.79	9.92	8.22	3.67
Industrial Production	28.12	3.69	8.66	**39.79**	2.56	6.92	6.77	5.51
Retail Sales	46.55	2.47	**20.22**	12.40	2.66	2.20	12.39	1.09
Unemployment Rate	37.54	3.45	**12.30**	22.54	2.22	11.69	6.36	3.90
Housing Starts	44.98	4.31	**15.95**	12.41	5.93	7.30	8.08	1.04
Building Permits	46.14	3.94	**22.75**	13.37	1.53	3.55	6.72	2.00
Manufacturing Orders	30.89	6.40	3.58	**43.35**	2.26	5.48	5.70	1.35
			Table C: 36-Month Horizon					
GDP	23.14	1.66	9.28	**46.35**	3.72	7.76	5.48	2.61
Industrial Production	27.24	2.96	14.13	**37.27**	2.28	4.40	5.04	6.67
Retail Sales	32.16	3.49	17.43	**25.95**	4.30	1.60	12.10	2.96
Unemployment Rate	33.42	2.59	15.92	**24.03**	2.83	10.36	6.23	4.61
Housing Starts	43.39	5.52	**15.53**	11.78	6.15	7.05	9.34	1.25
Building Permits	42.66	4.16	**21.09**	15.24	2.31	4.20	7.37	2.97
Manufacturing Orders	21.76	4.33	4.21	**51.51**	2.20	4.29	10.76	0.95
			Table D: 48-Month Horizon					
GDP	21.07	1.43	9.75	**48.73**	3.34	7.05	4.72	3.89
Industrial Production	26.26	3.33	14.11	**33.07**	5.32	3.75	4.55	9.60
Retail Sales	26.44	4.61	15.59	**28.80**	6.55	1.33	11.28	5.41
Unemployment Rate	33.18	3.16	14.37	**17.03**	5.59	8.99	7.41	10.28
Housing Starts	42.54	6.64	**14.91**	11.13	6.67	6.83	9.61	1.66
Building Permits	39.86	4.34	**20.57**	14.59	4.24	4.59	6.86	4.94
Manufacturing Orders	21.11	3.75	3.99	**51.16**	2.13	3.66	13.34	0.86
			Table E: 60-Month Horizon					
GDP	20.11	1.37	9.36	**48.38**	4.84	6.97	4.54	4.42
Industrial Production	25.03	4.00	13.52	**31.42**	7.86	3.54	4.43	10.20
Retail Sales	25.17	5.21	14.40	**27.41**	9.27	1.30	11.01	6.22
Unemployment Rate	29.99	4.11	11.80	13.98	9.13	7.68	8.45	**14.85**
Housing Starts	40.35	9.78	**14.60**	10.38	6.78	6.83	9.52	1.76
Building Permits	38.19	4.87	**20.49**	13.99	5.22	4.93	6.62	5.69
Manufacturing Orders	21.53	3.77	4.14	**50.10**	2.19	3.59	13.73	0.96

Figure 3.1: Interest Rate Rule Impulse Response Functions For {Interest Rate, Money, Prices, GDP} Model
Response Of

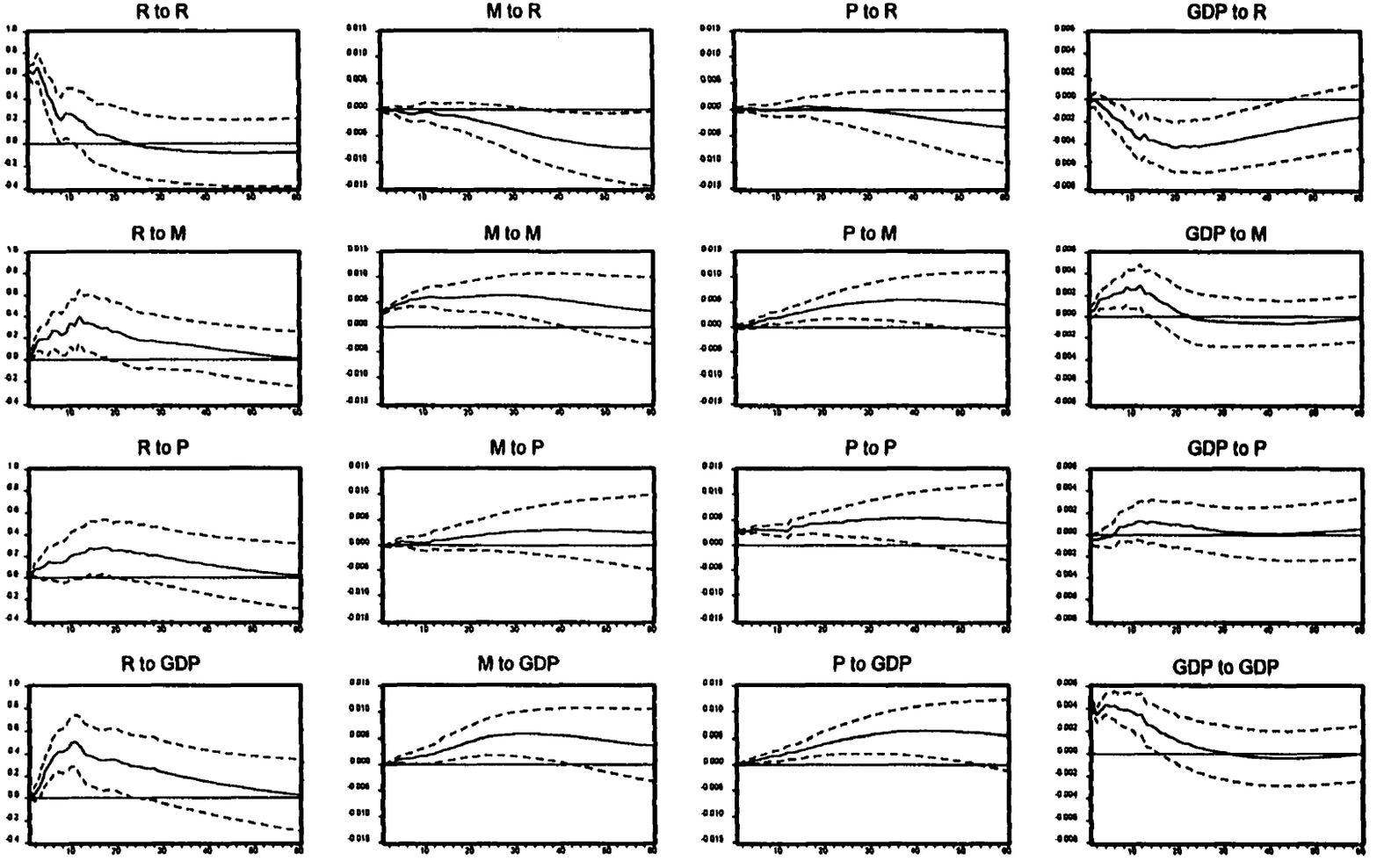


Figure 3.2: Interest Rate Rule Impulse Response Functions For {Interest Rate, Money, Prices, Industrial Production} Model

Response Of

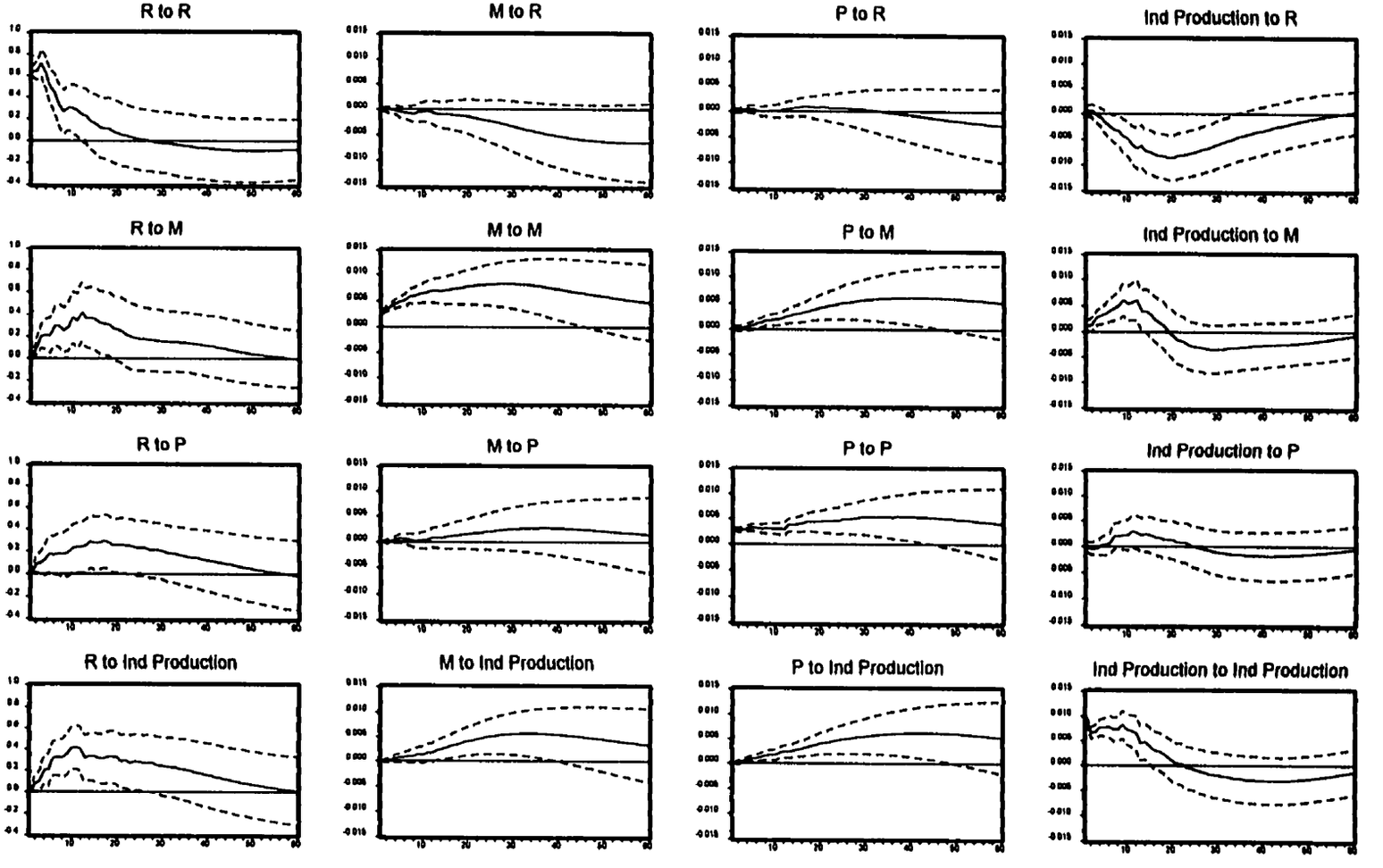


Figure 3.3: Interest Rate Rule Impulse Response Functions For {Interest Rate, Money, Prices, Retail Sales} Model

Response Of

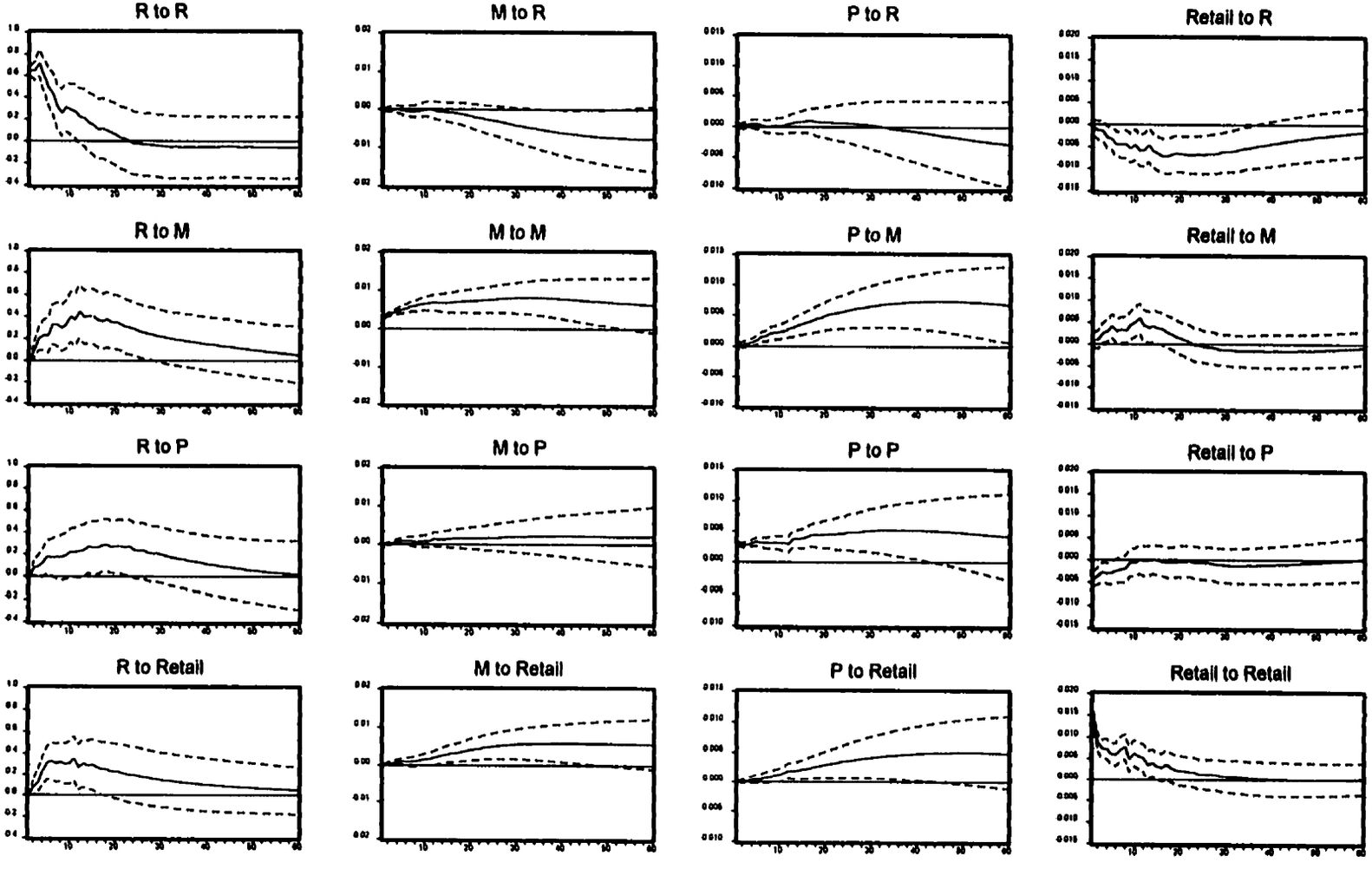


Figure 3.4: Interest Rate Rule Impulse Response Functions For {Interest Rate, Money, Prices, Unemployment Rate} Model

Response Of

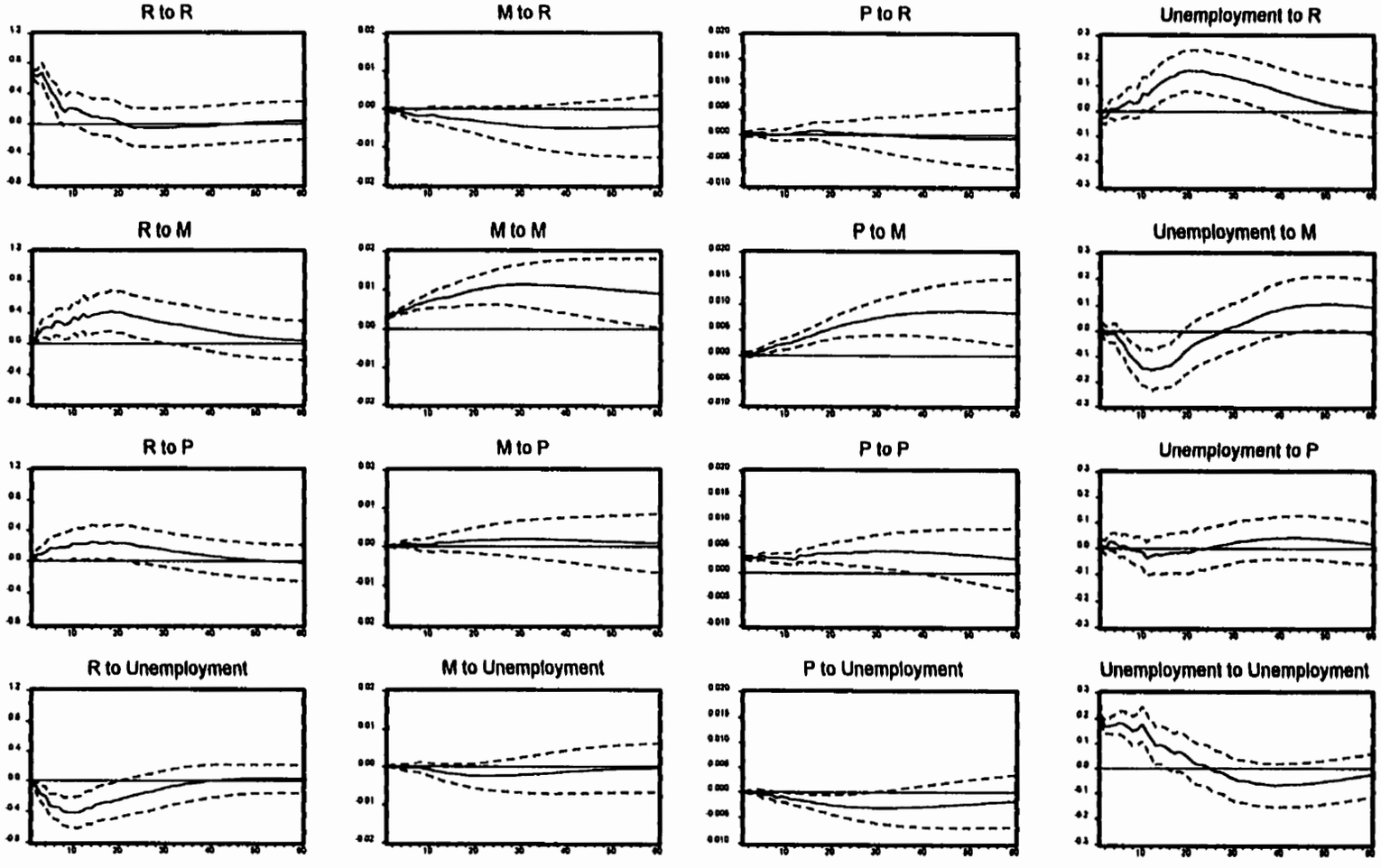


Figure 3.5: Interest Rate Impulse Response Functions For {Interest Rate, Money, Prices, Housing Starts} Model

Response Of

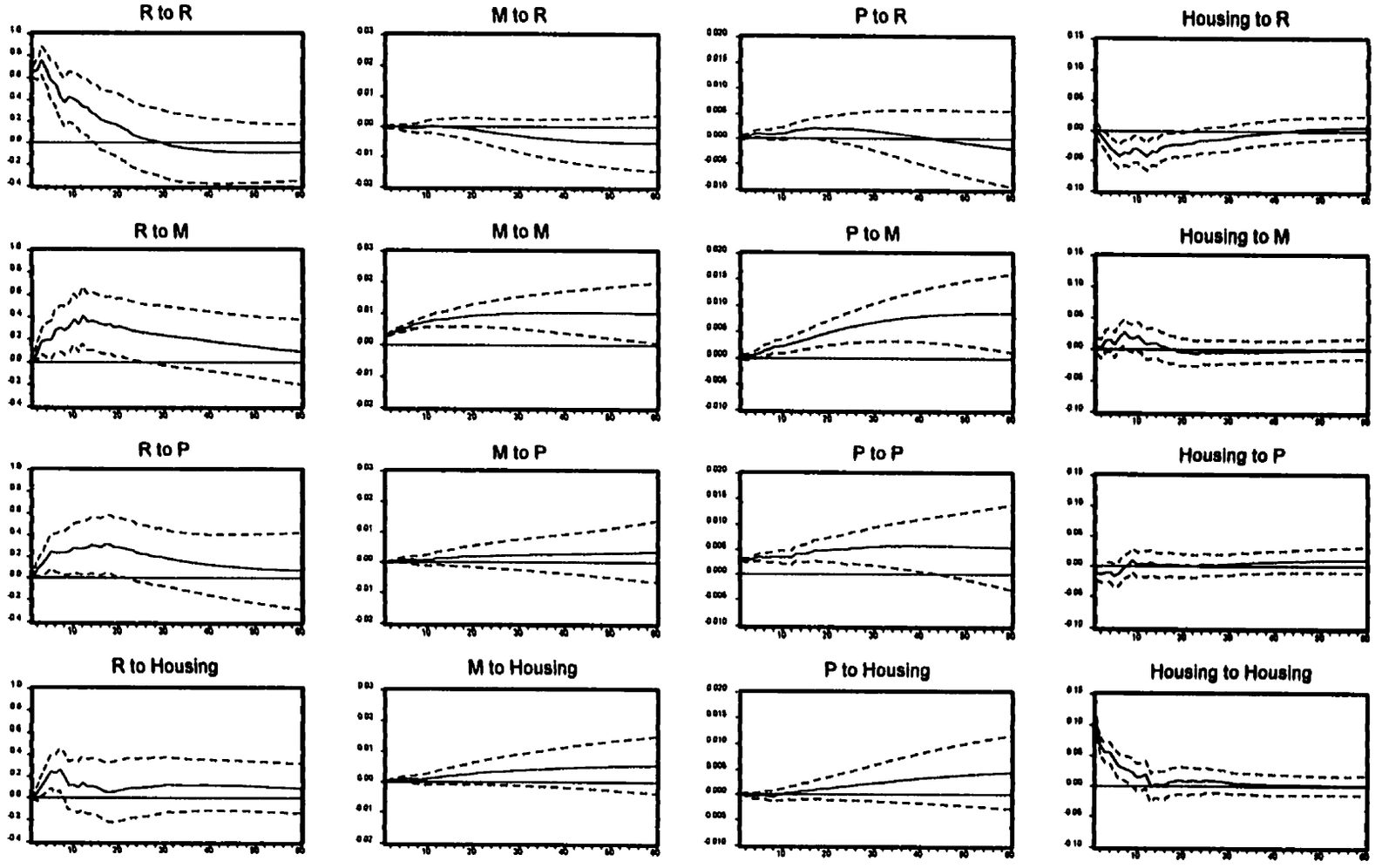


Figure 3.6: Interest Rate Rule Impulse Response Functions For {Interest Rate, Money, Prices, Building Permits} Model
Response Of

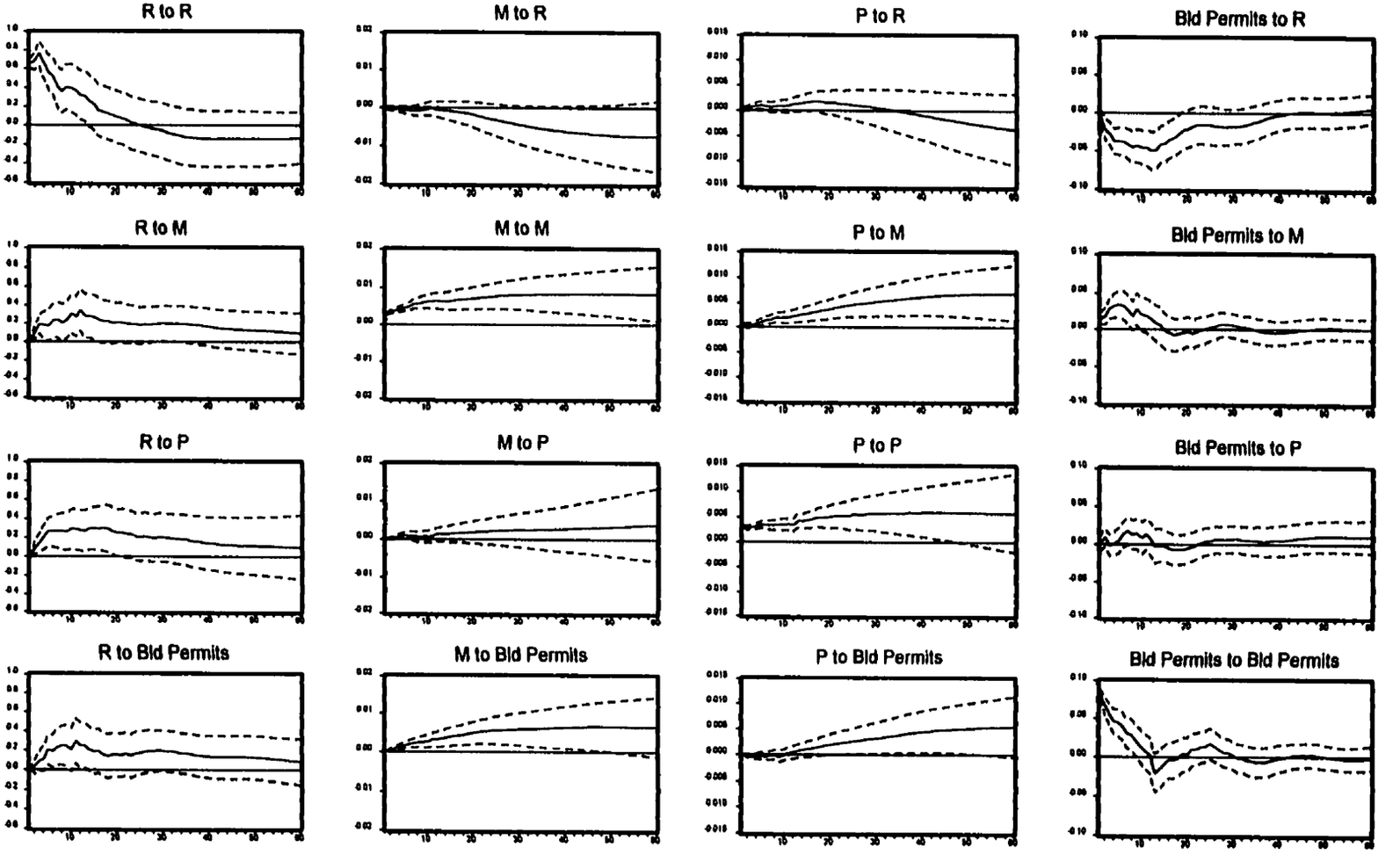


Figure 3.7: Interest Rate Rule Impulse Response Functions For {Interest Rate, Money, Prices, Manufacturing Orders} Model

Response Of

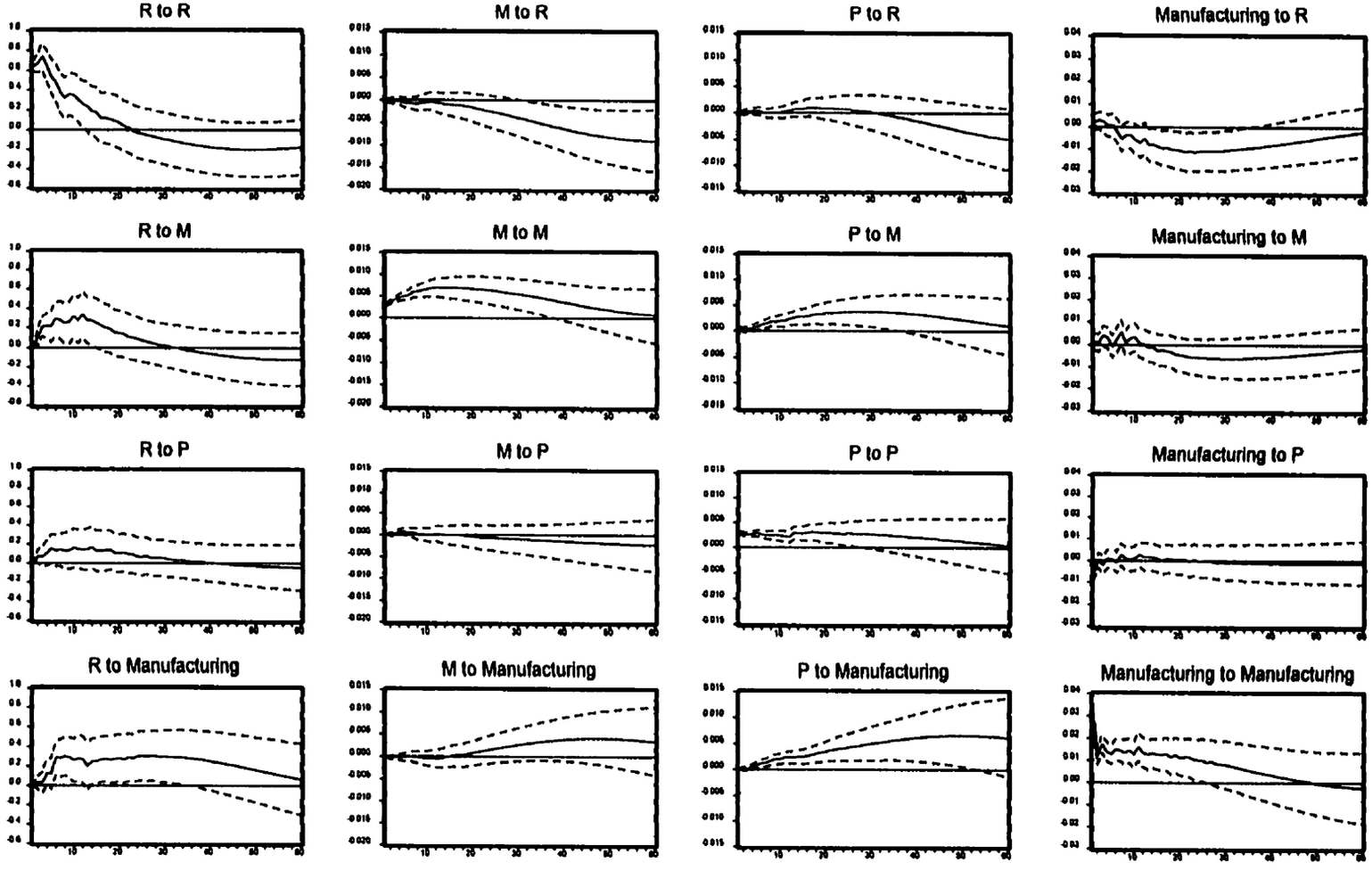


Figure 3.8: Monetary Rule Impulse Response Functions For {Money, Interest Rate, Prices, GDP} Model

Response Of

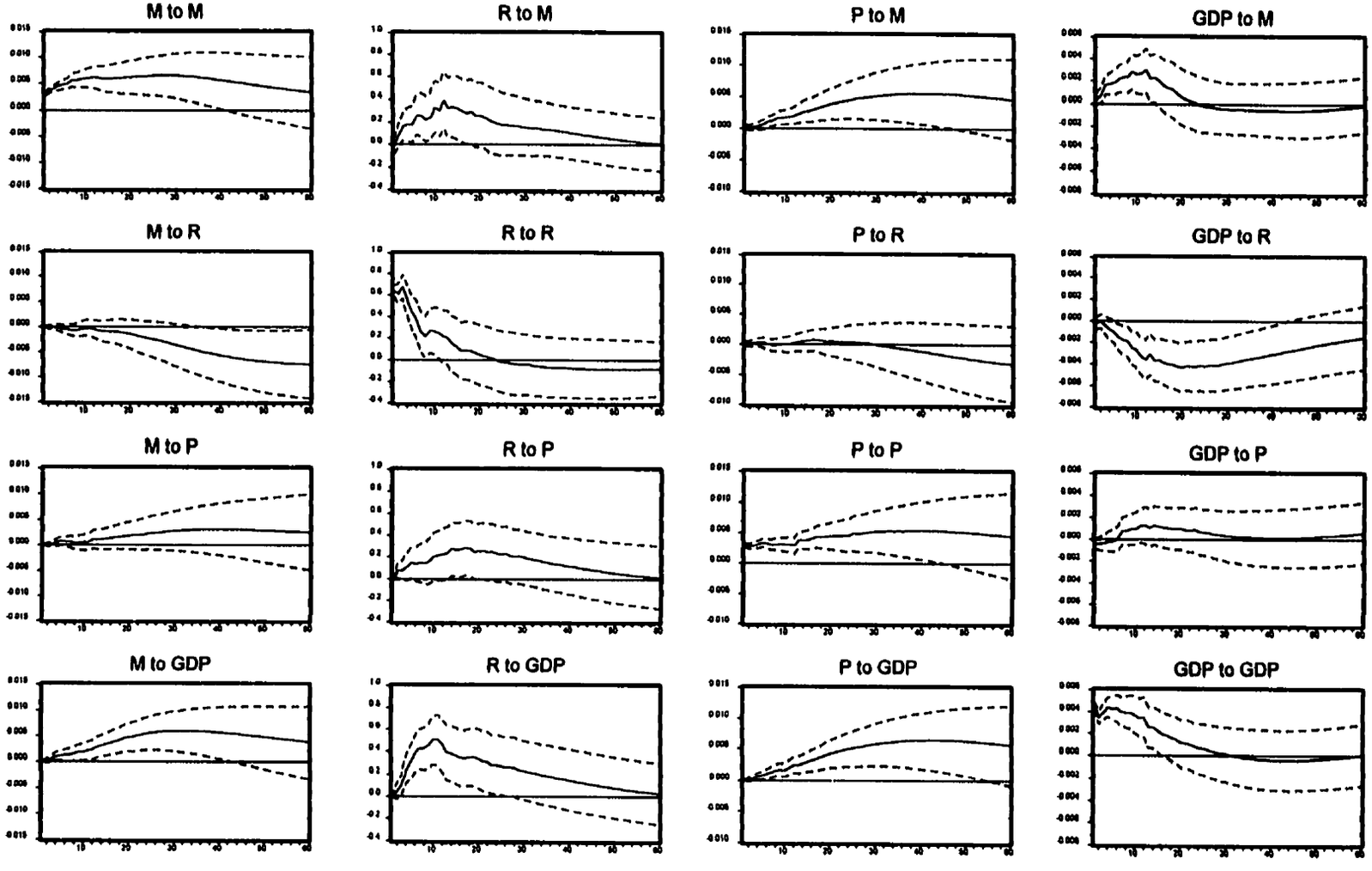


Figure 3.9: Monetary Rule Impulse Response Functions For {Money, Interest Rate, Prices, Industrial Production} Model

Response Of

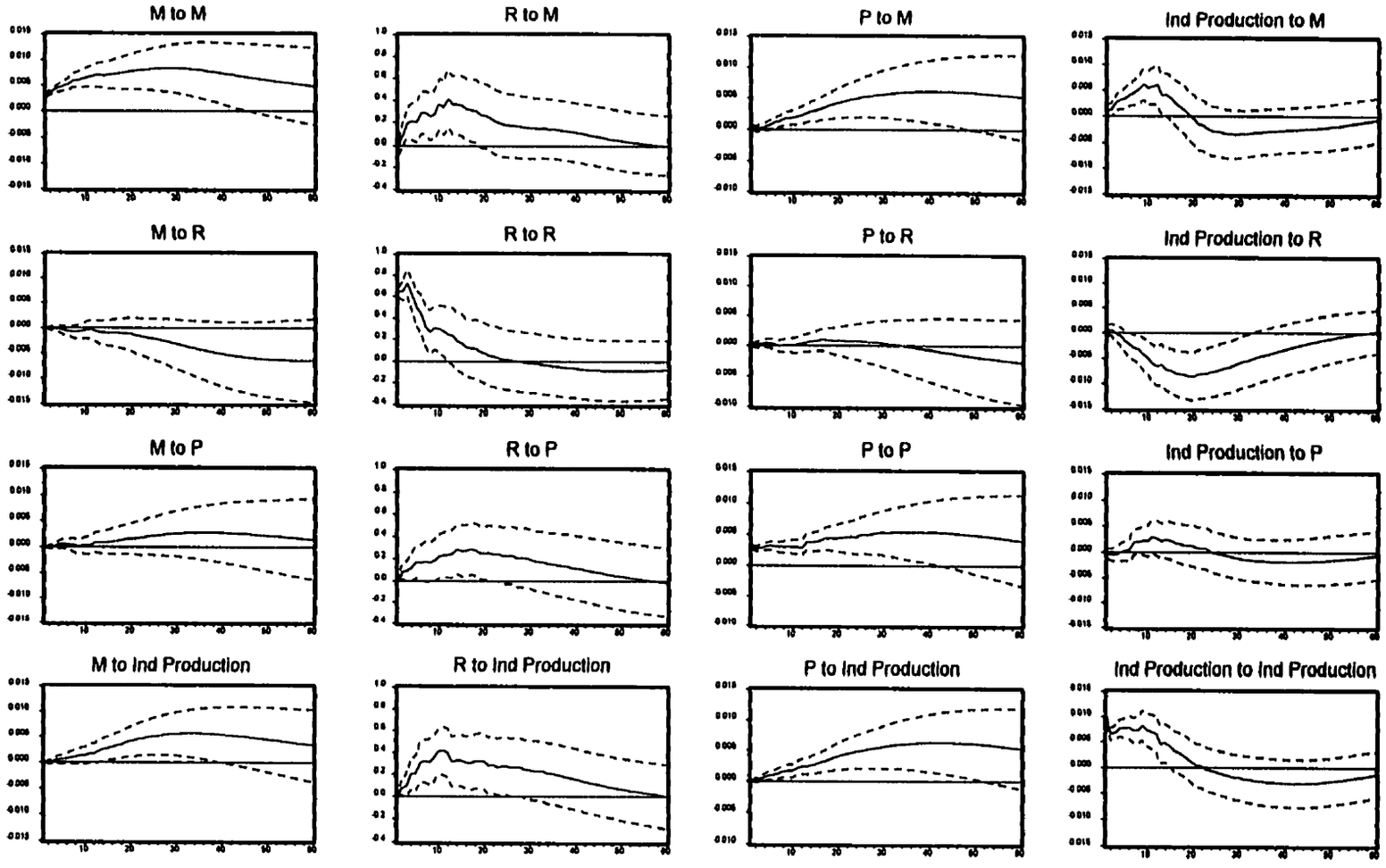


Figure 3.10: Monetary Rule Impulse Response Functions For {Money, Interest Rate, Prices, Retail Sales} Model

Response Of

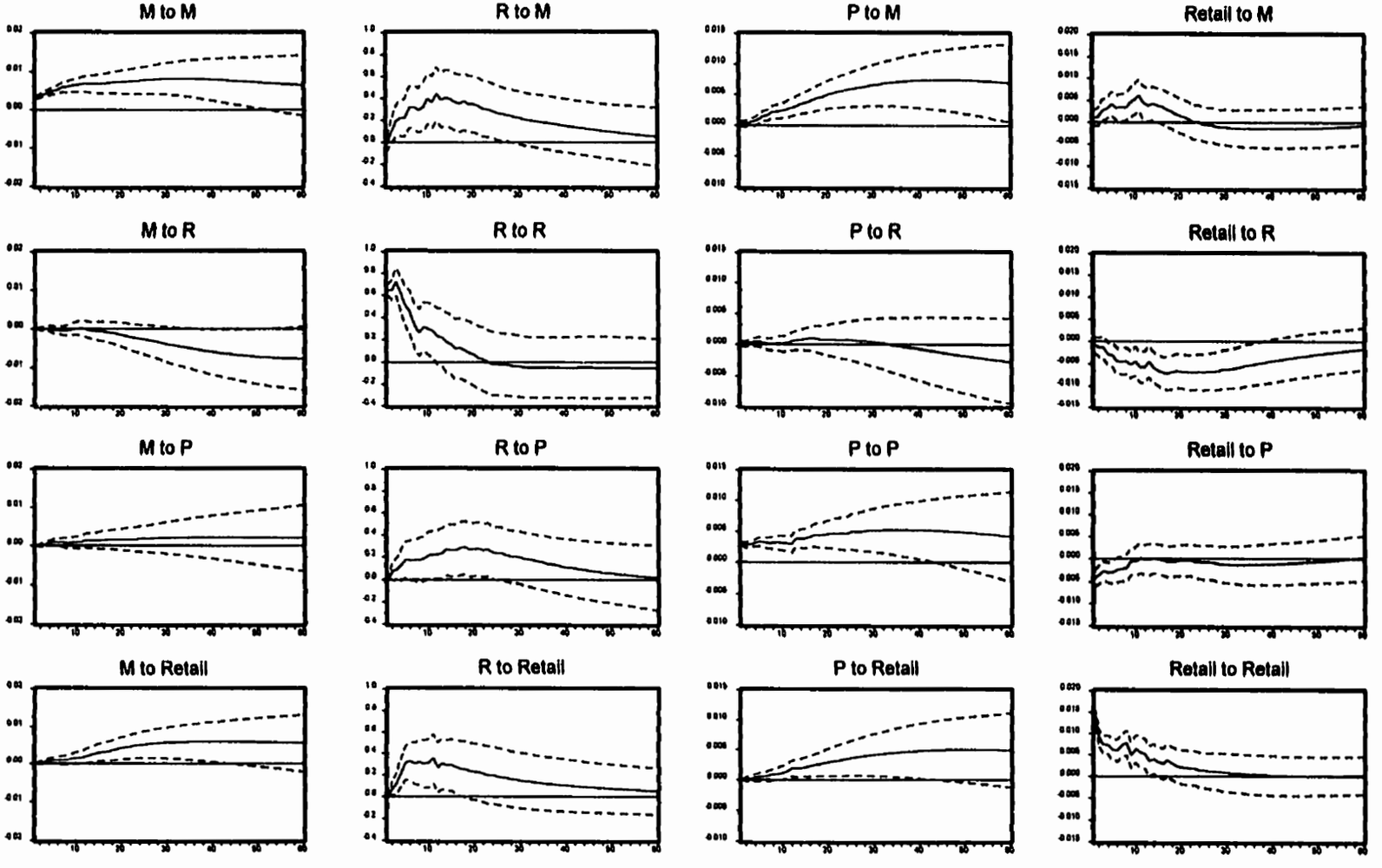


Figure 3.11: Monetary Rule Impulse Response Functions For {Money, Interest Rate, Prices, Unemployment Rate} Model
Response Of

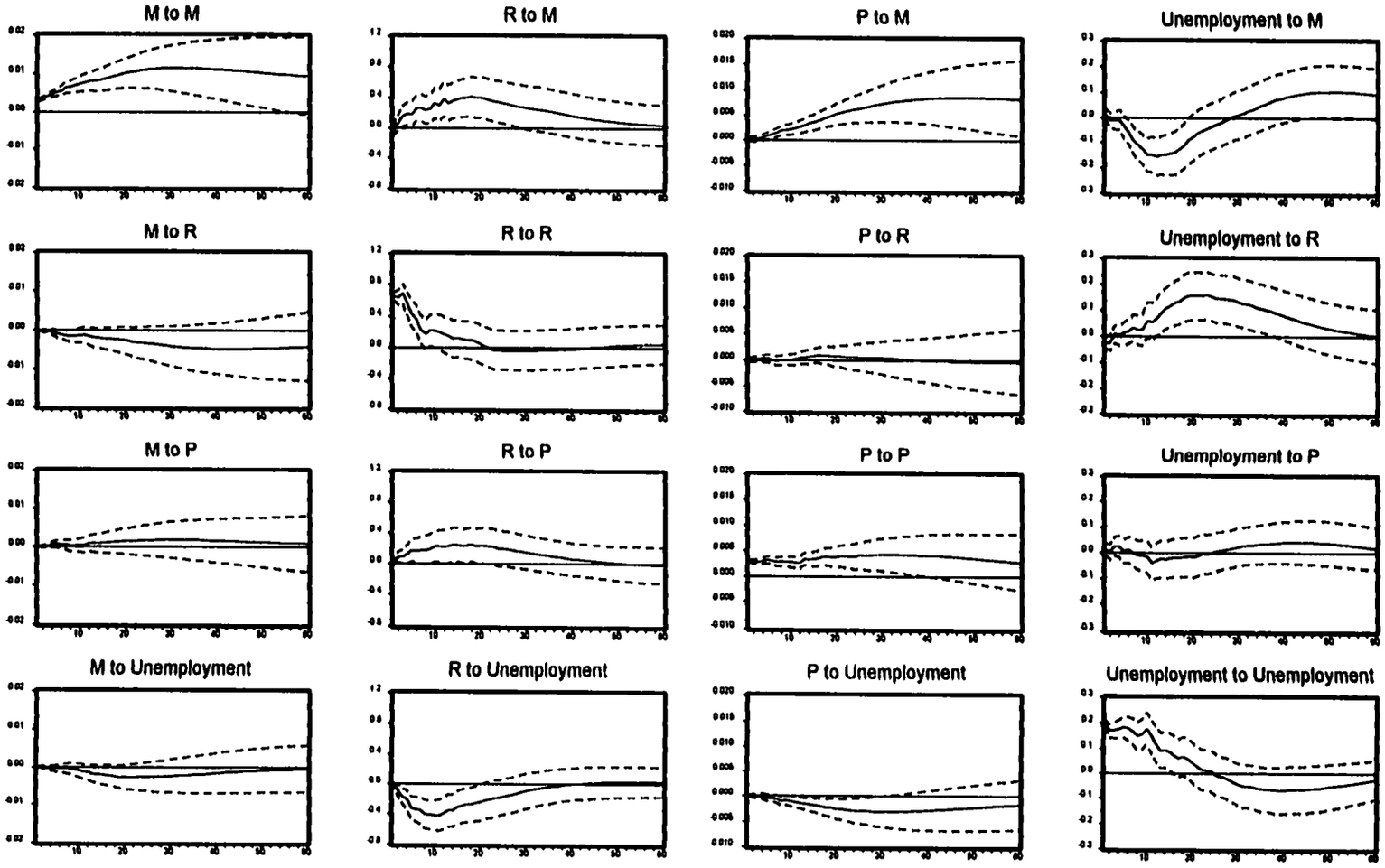


Figure 3.12: Monetary Rule Impulse Response Functions For {Money, Interest Rate, Prices, Housing Starts} Model

Response Of

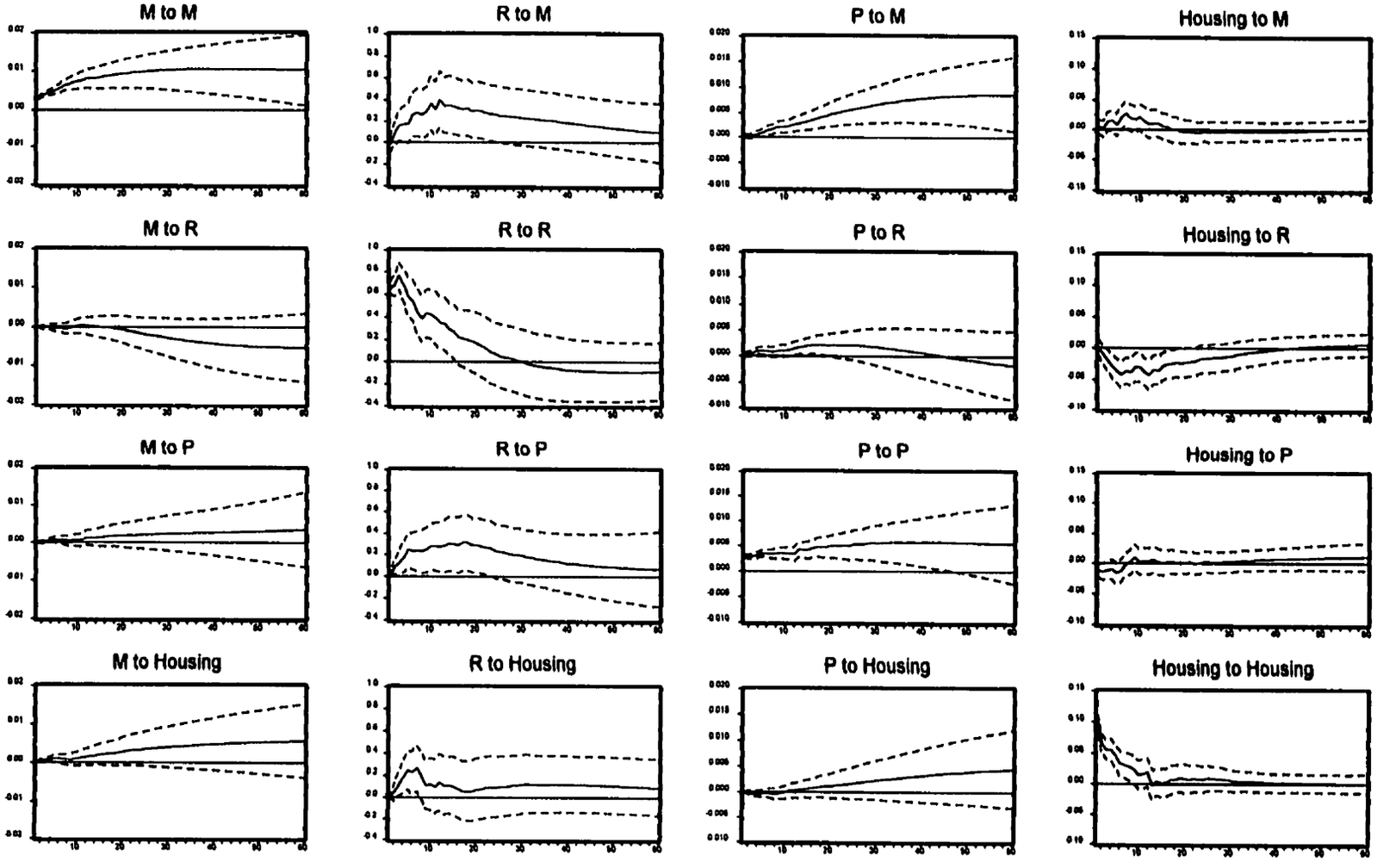


Figure 3.13: Monetary Rule Impulse Response Functions For {Money, Interest Rate, Prices, Building Permits} Model
Response Of

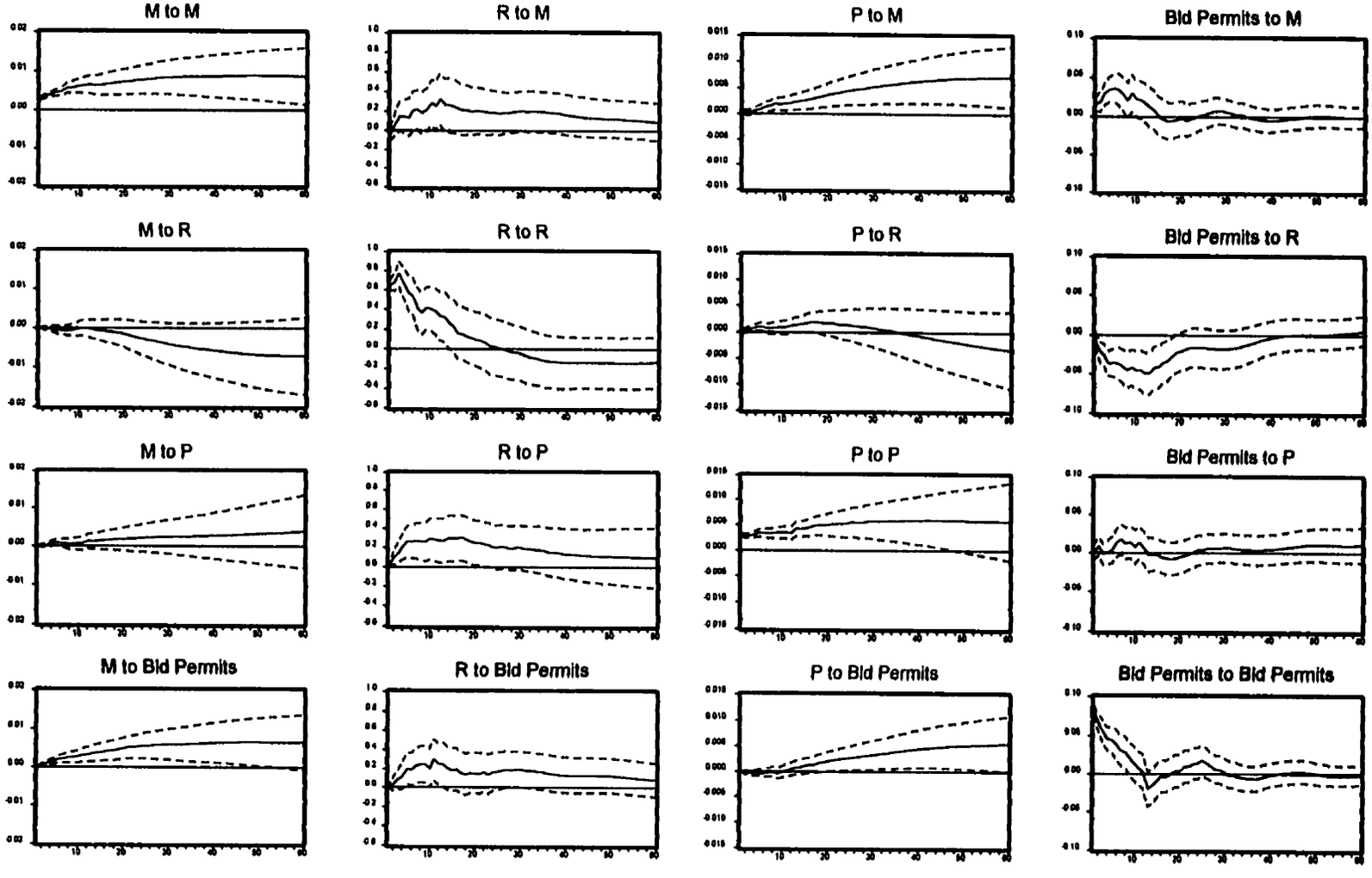


Figure 3.14: Monetary Rule Impulse Response Functions For {Money, Interest Rate, Prices, Manufacturing Orders} Model

Response Of

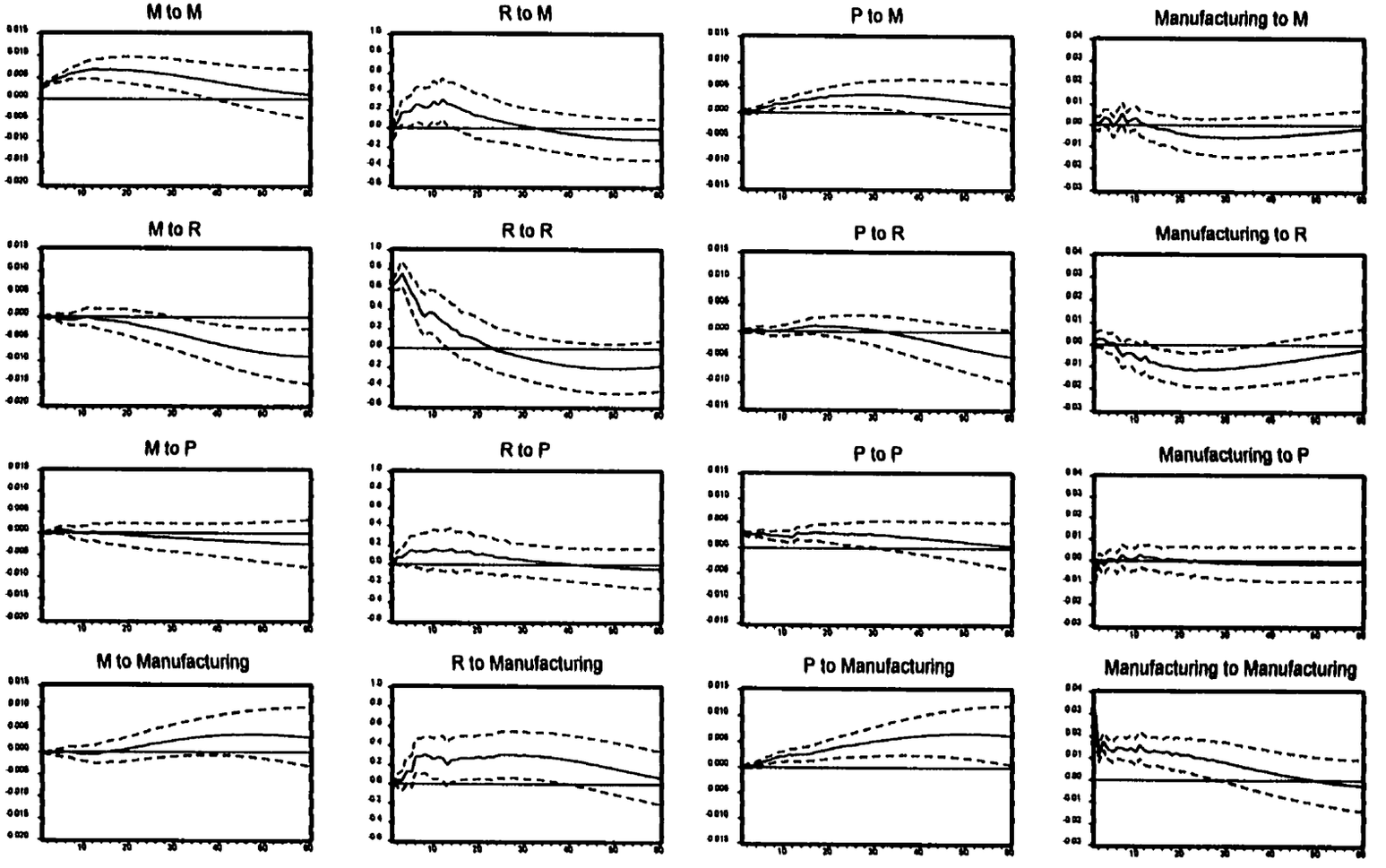


Figure 3.15: Interest Rate Rule Impulse Response Functions For {GDP, Prices, Commodity Prices, Interest Rate, Money} Model

Response Of

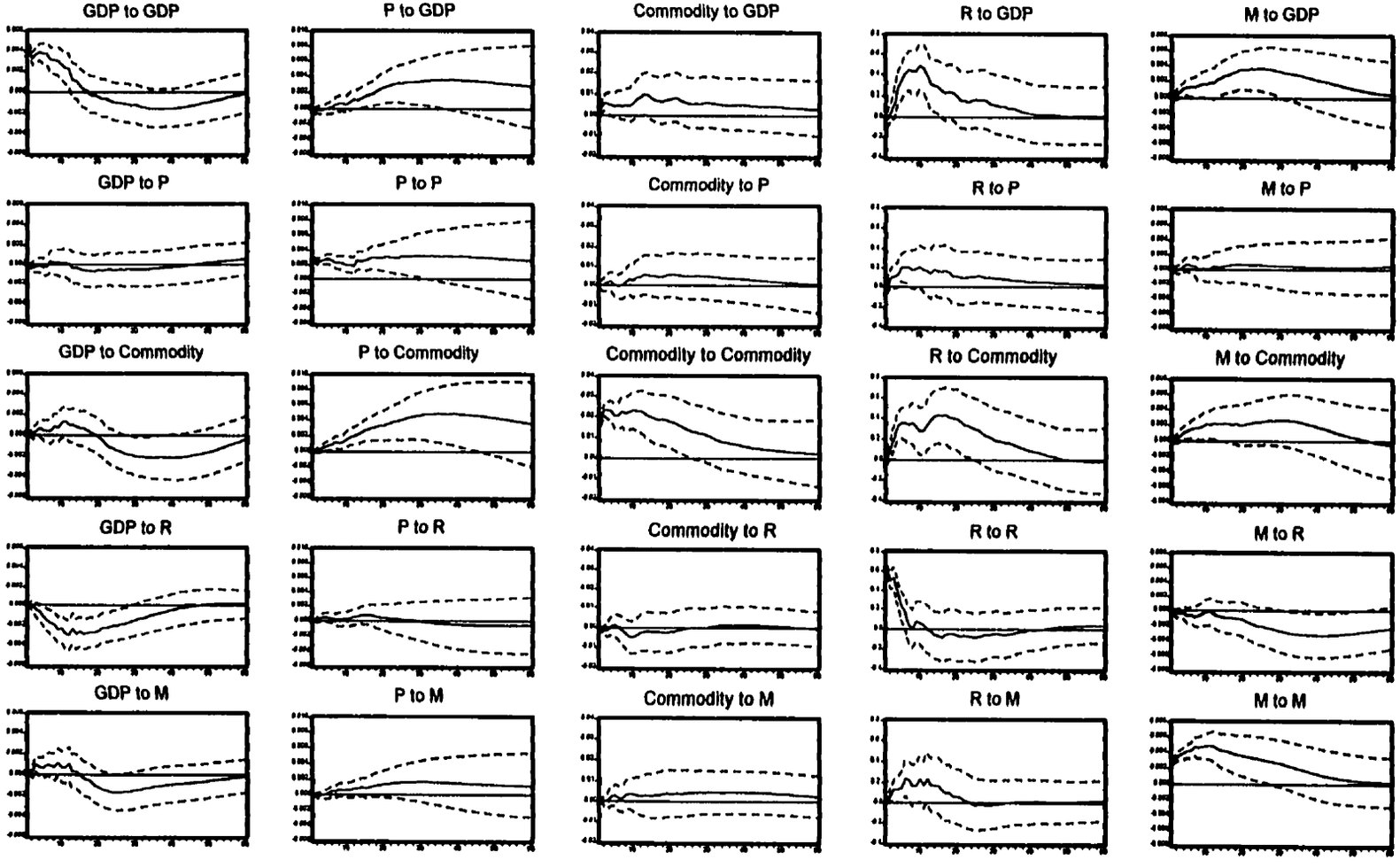


Figure 3.16: Interest Rate Rule Impulse Response Functions For {Industrial Production, Prices, Commodity Prices, Interest Rate, Money} Model

Response Of

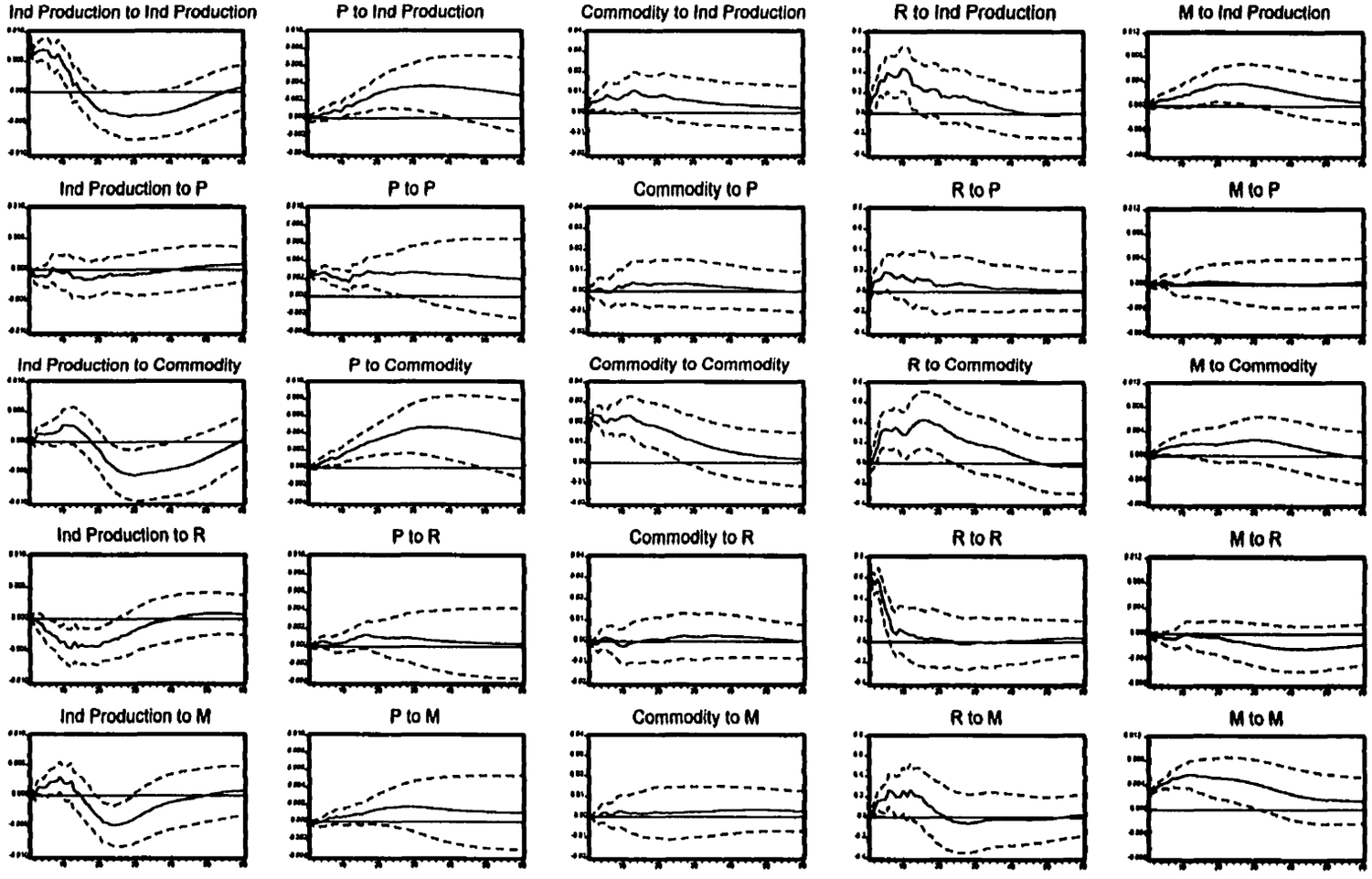


Figure 3.17: Interest Rate Rule Impulse Response Functions For {Retail Sales, Prices, Commodity Prices, Interest Rate, Money} Model

Response Of

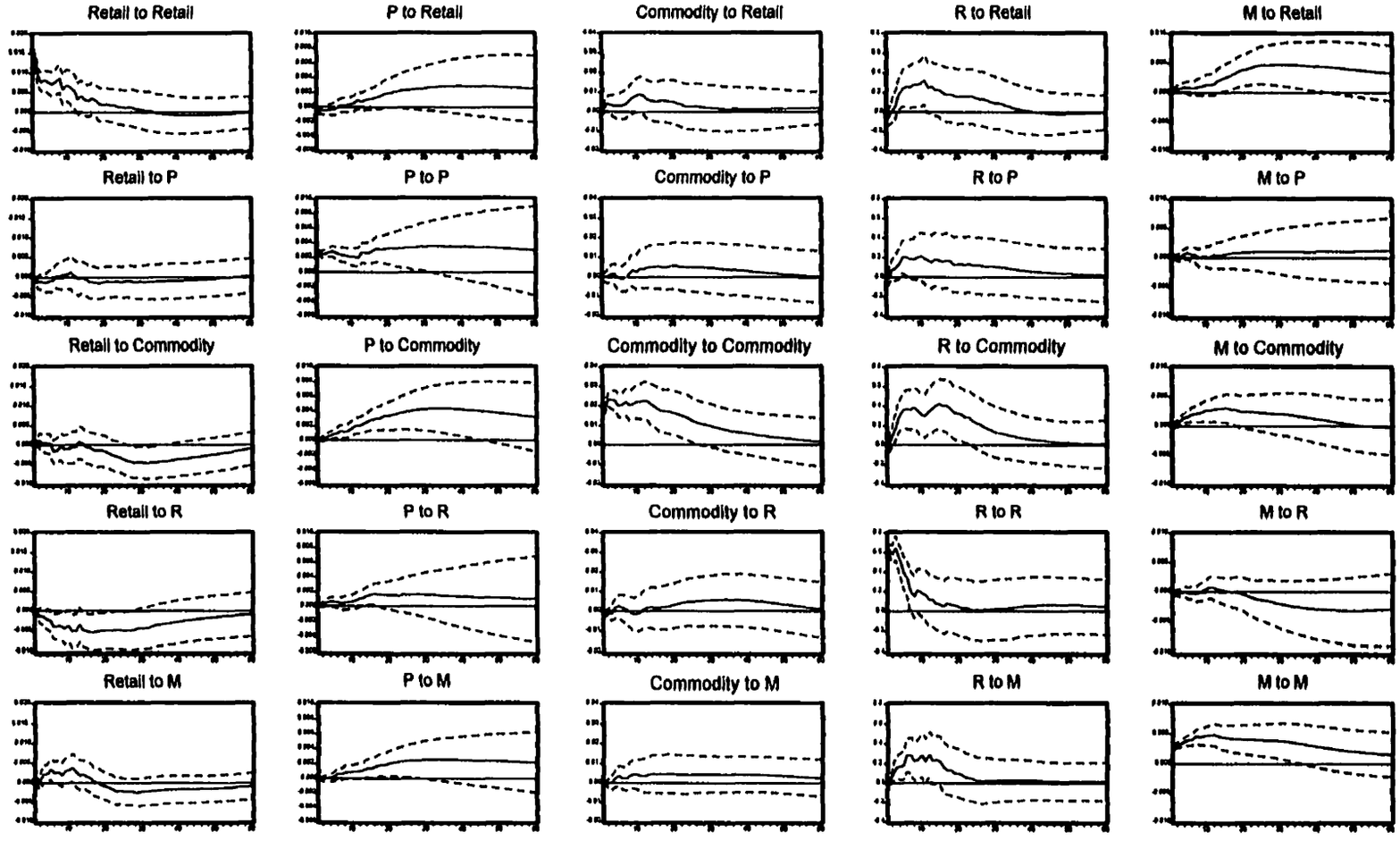


Figure 3.18: Interest Rate Rule Impulse Response Functions For {Unemployment Rate, Prices, Commodity Prices, Interest Rate, Money} Model

Response Of

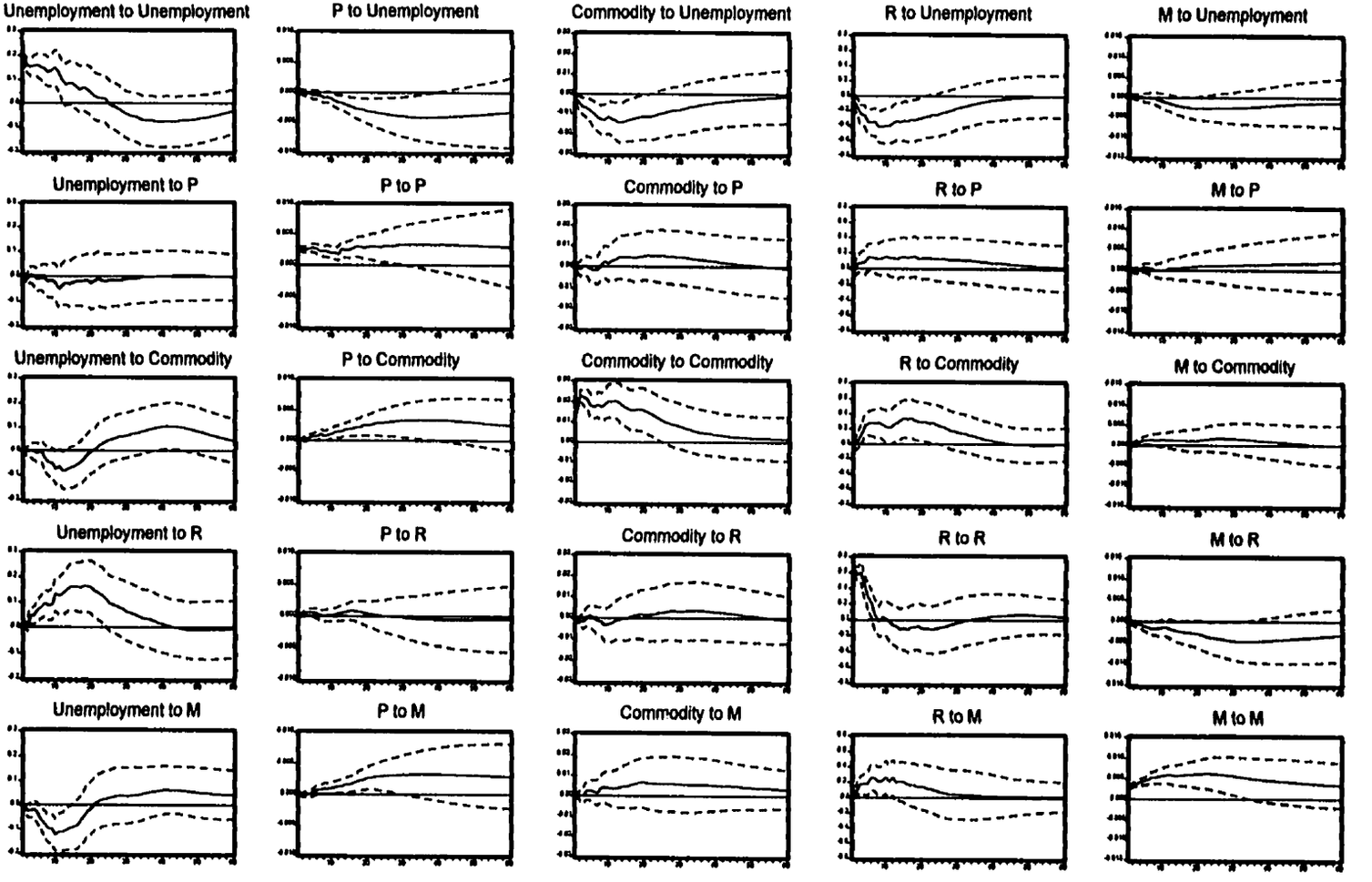


Figure 3.19: Interest Rate Rule Impulse Response Functions For {Housing Starts, Prices, Commodity Prices, Interest Rate, Money} Model

Response Of

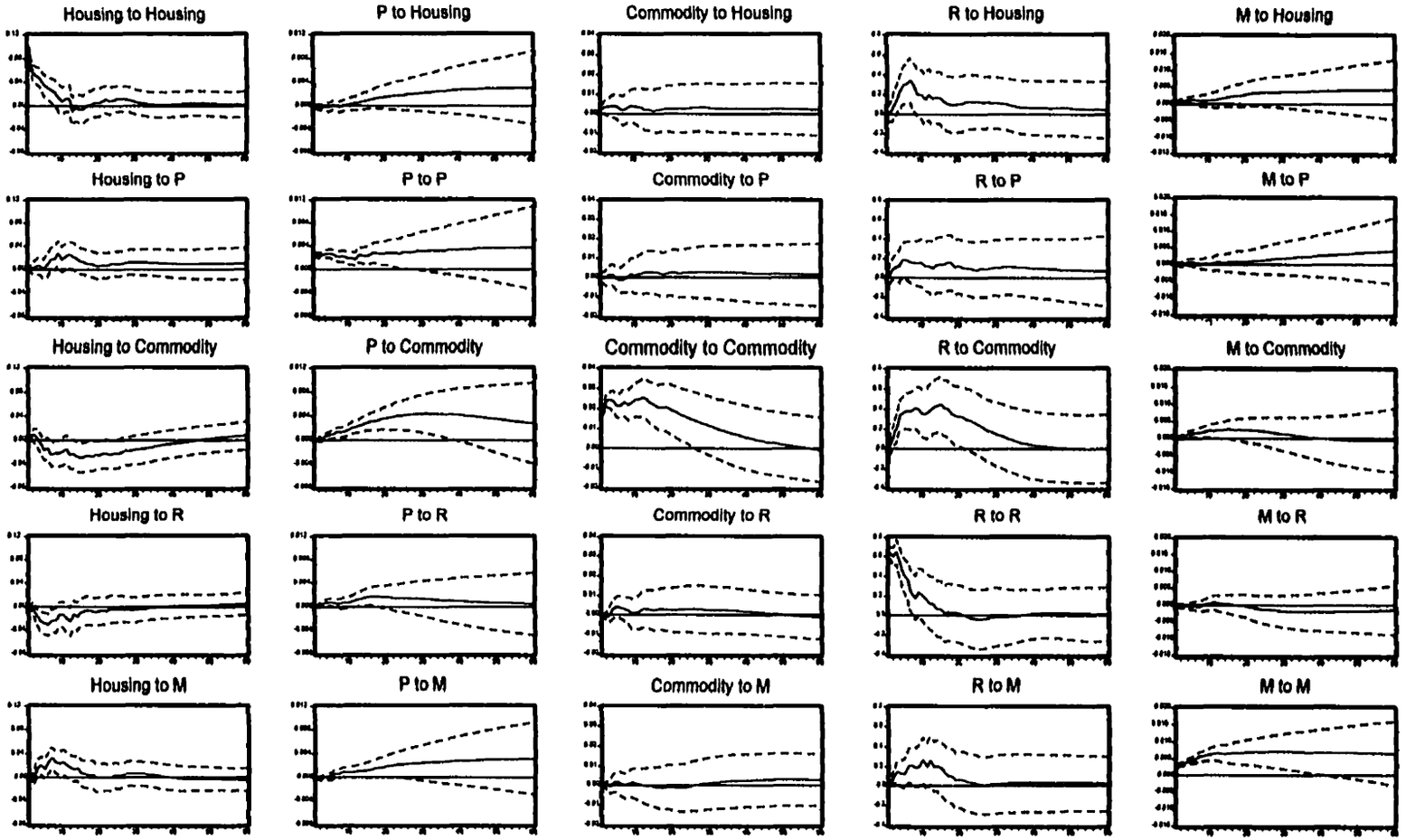


Figure 3.20: Interest Rate Rule Impulse Response Functions For {Building Permits, Prices, Commodity Prices, Interest Rate, Money} Model

Response Of

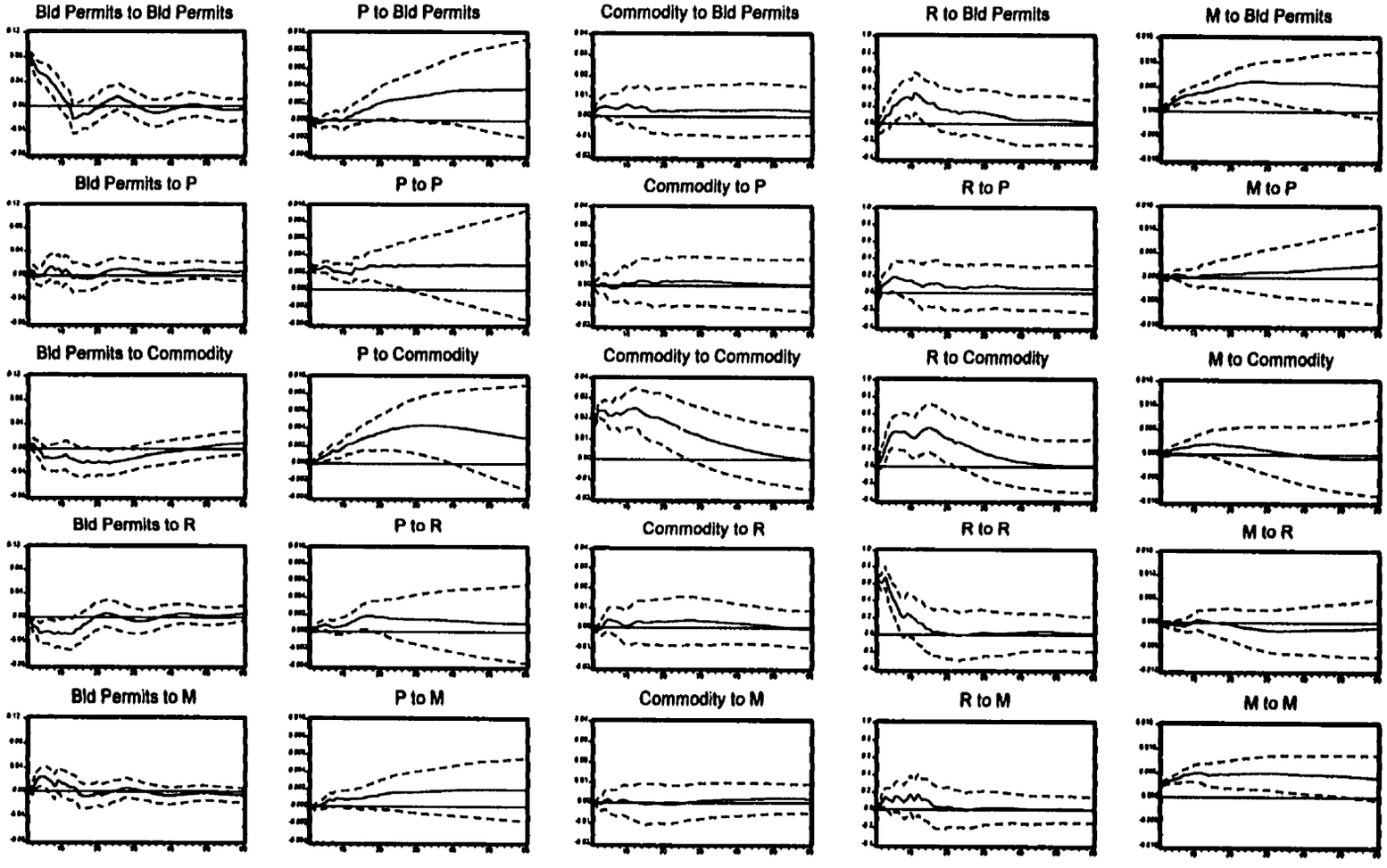


Figure 3.21: Interest Rate Rule Impulse Response Functions For {Manufacturing Orders, Prices, Commodity Prices, Interest Rate, Money} Model

Response Of

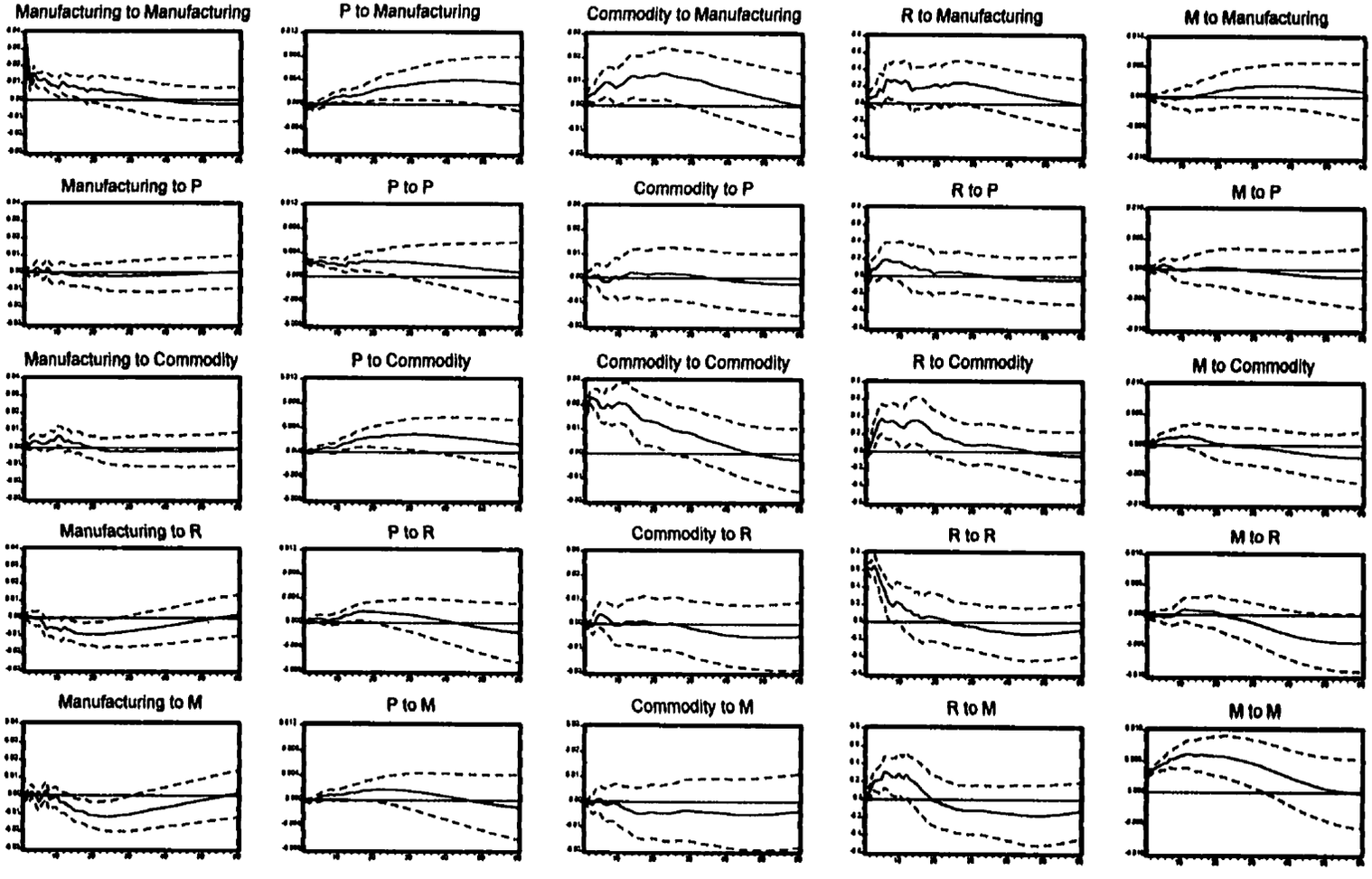


Figure 3.22: Monetary Rule Impulse Response Functions For {GDP, Prices, Commodity Prices, Money, Interest Rate} Model

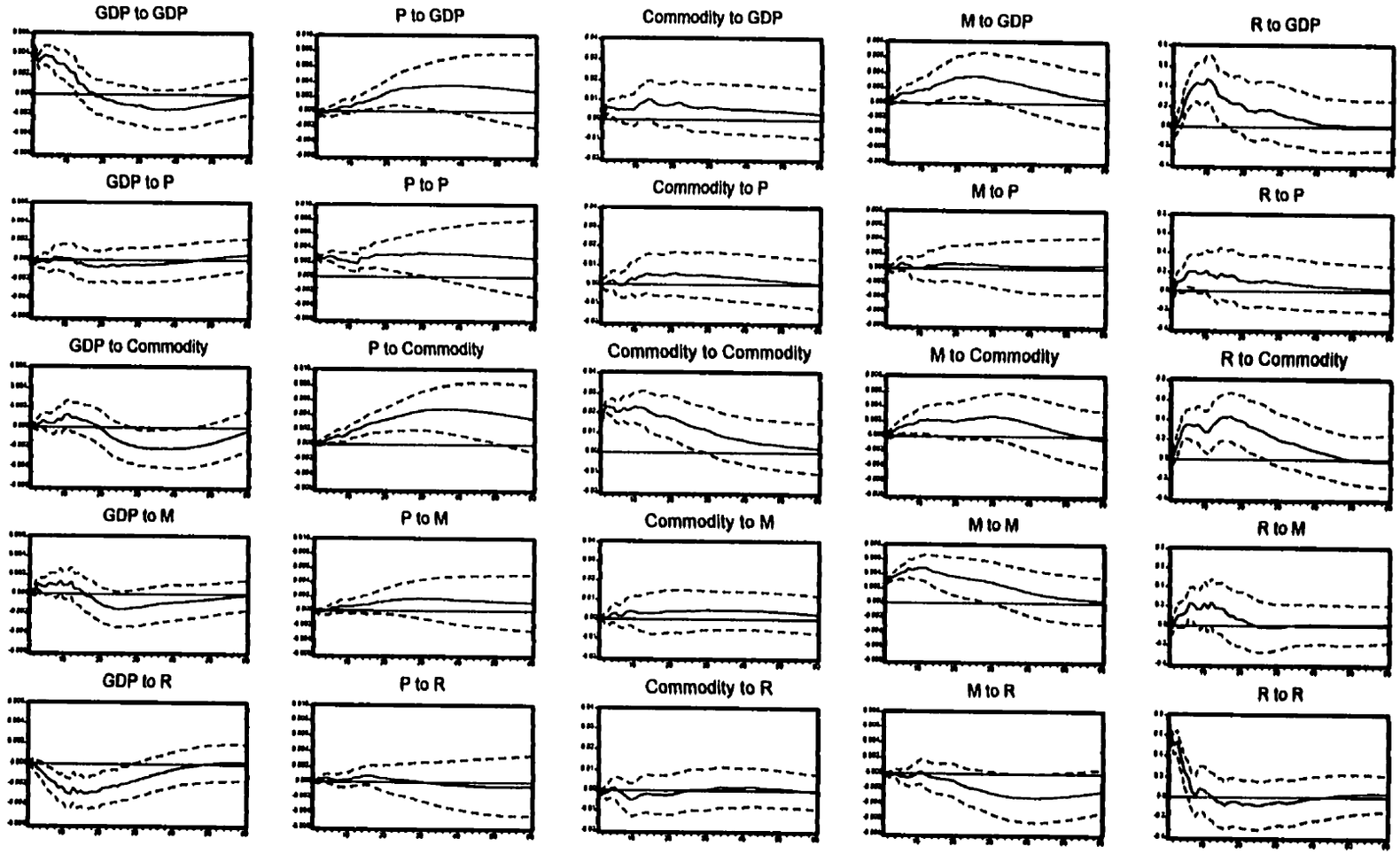


Figure 3.23: Monetary Rule Impulse Response Functions For {Industrial Production, Prices, Commodity Prices, Money, Interest Rate} Model

Response Of

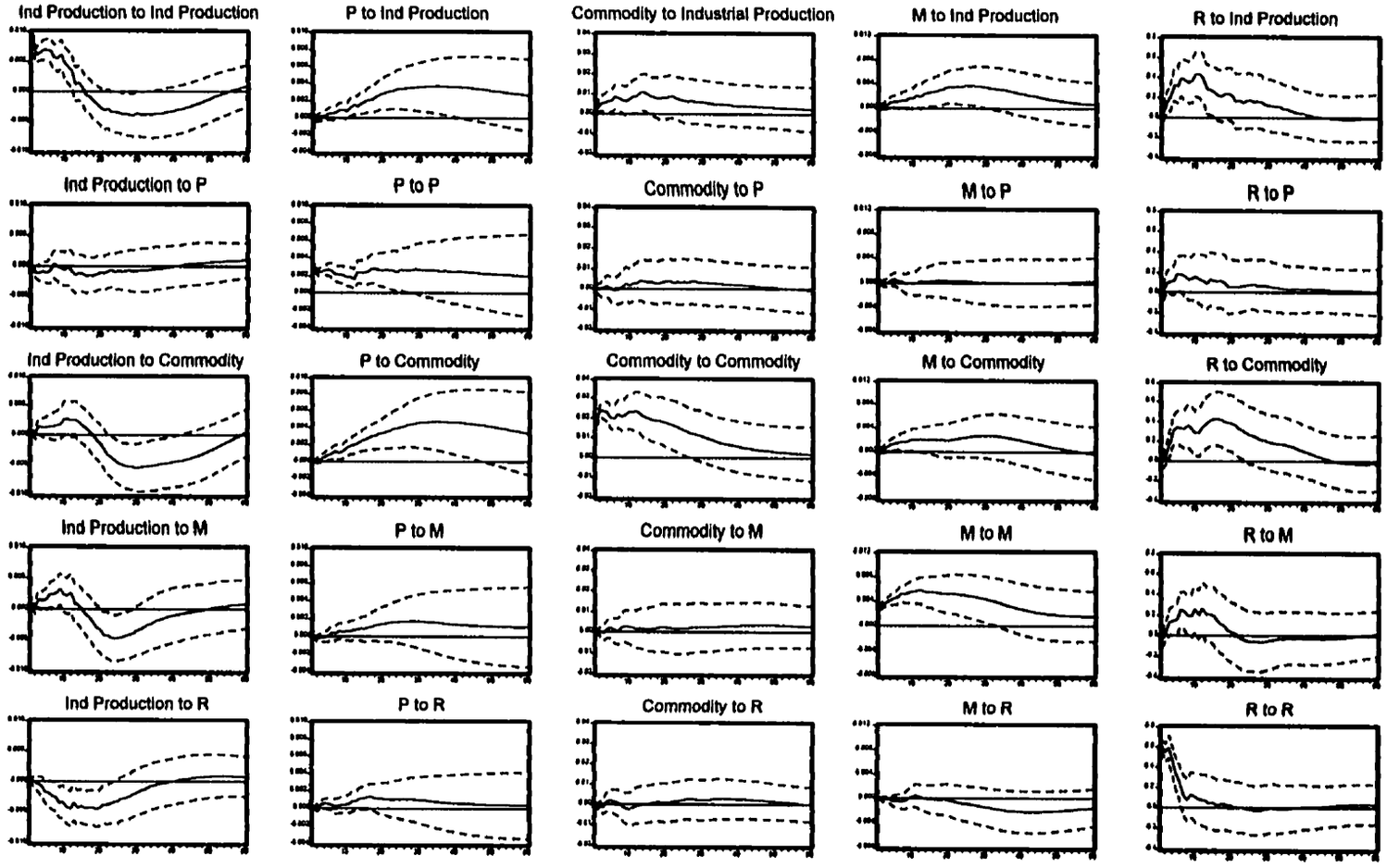


Figure 3.24: Monetary Rule Impulse Response Functions For {Retail Sales, Prices, Commodity Prices, Money, Interest Rate} Model

Response Of

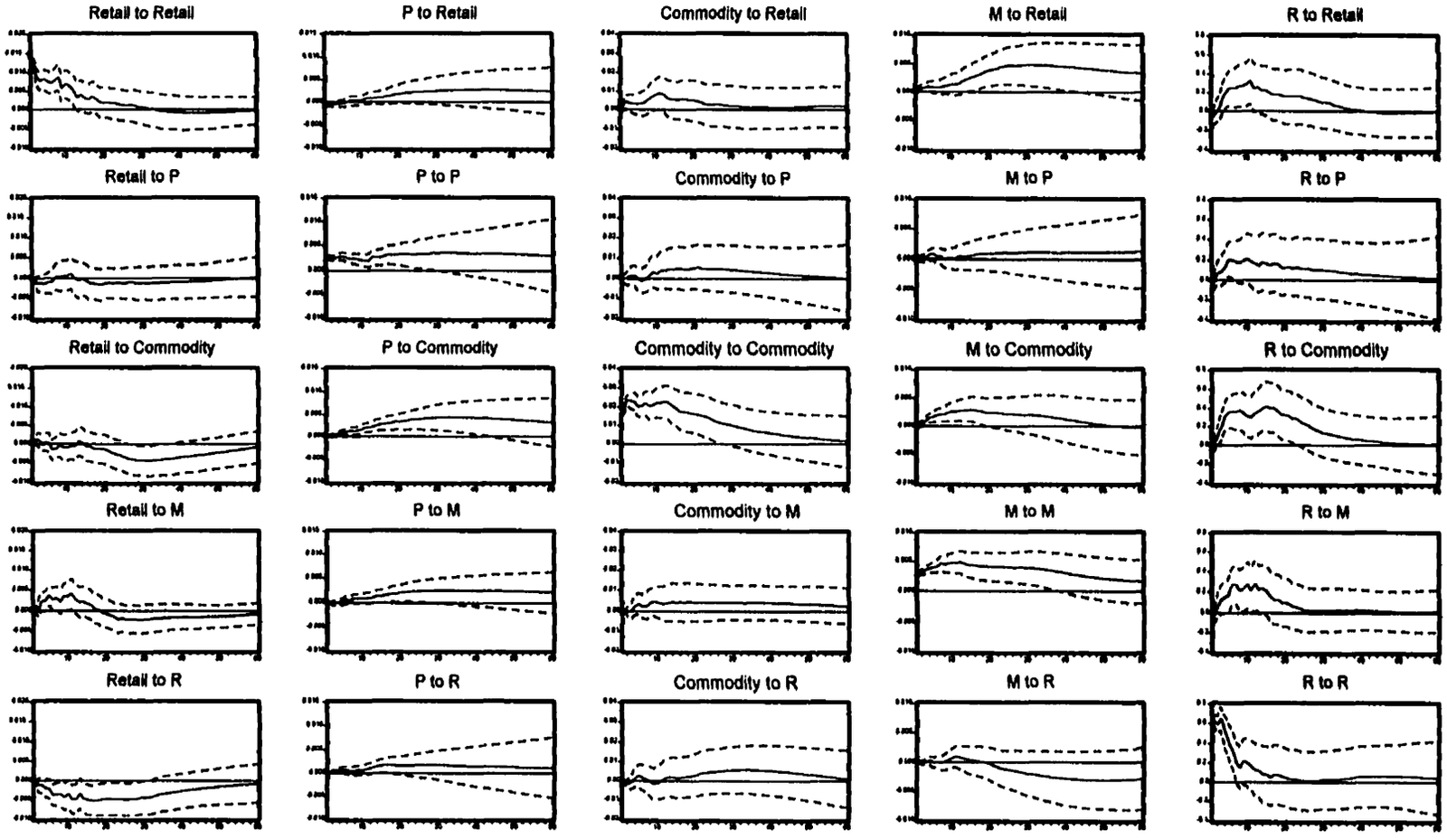


Figure 3.25: Monetary Rule Impulse Response Functions For {Unemployment Rate, Prices, Commodity Prices, Money, Interest Rate Model

Response Of

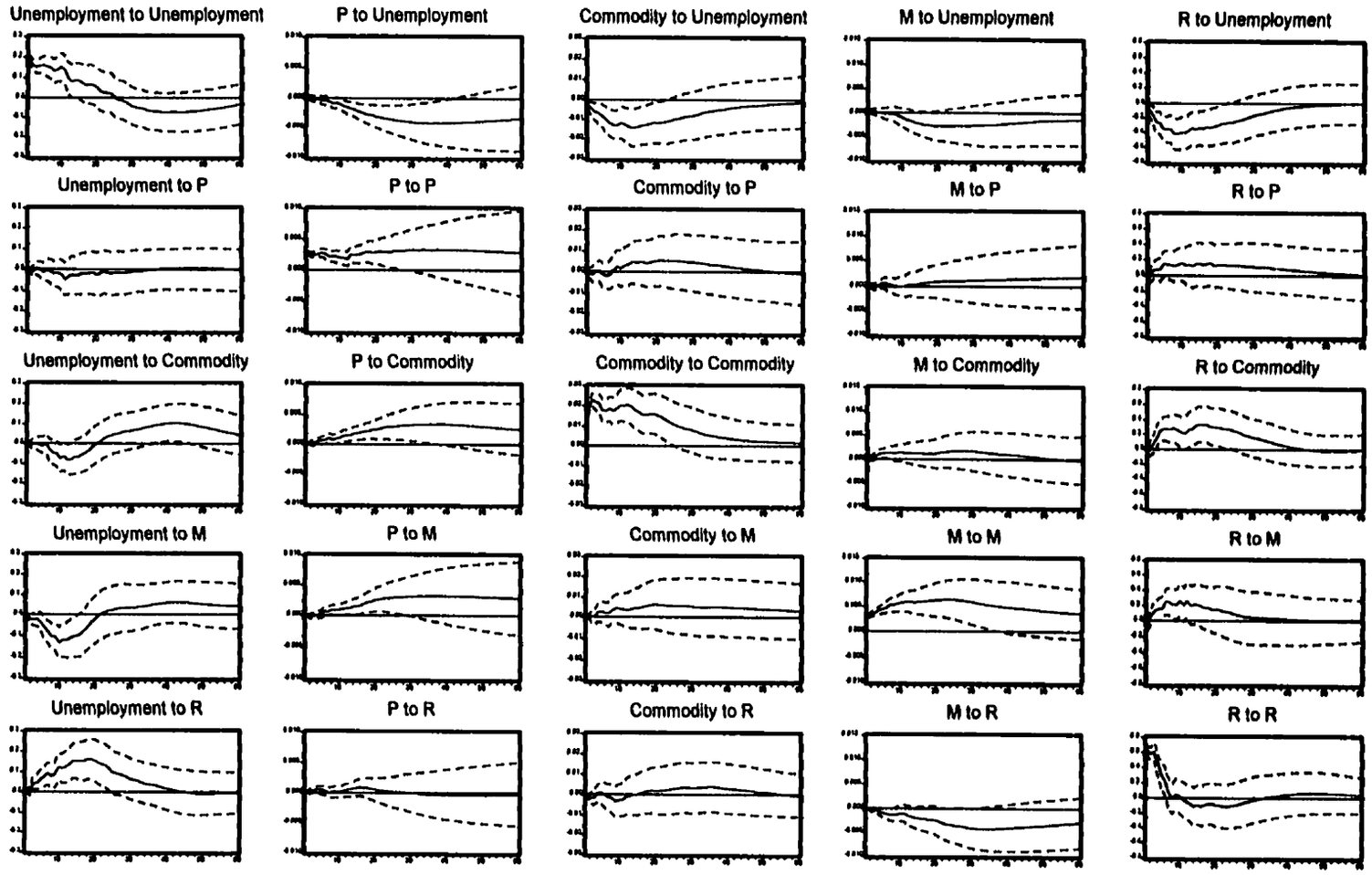


Figure 3.26: Monetary Rule Impulse Response Functions For {Housing Starts, Prices, Commodity Prices, Money, Interest Rate} Model

Response Of

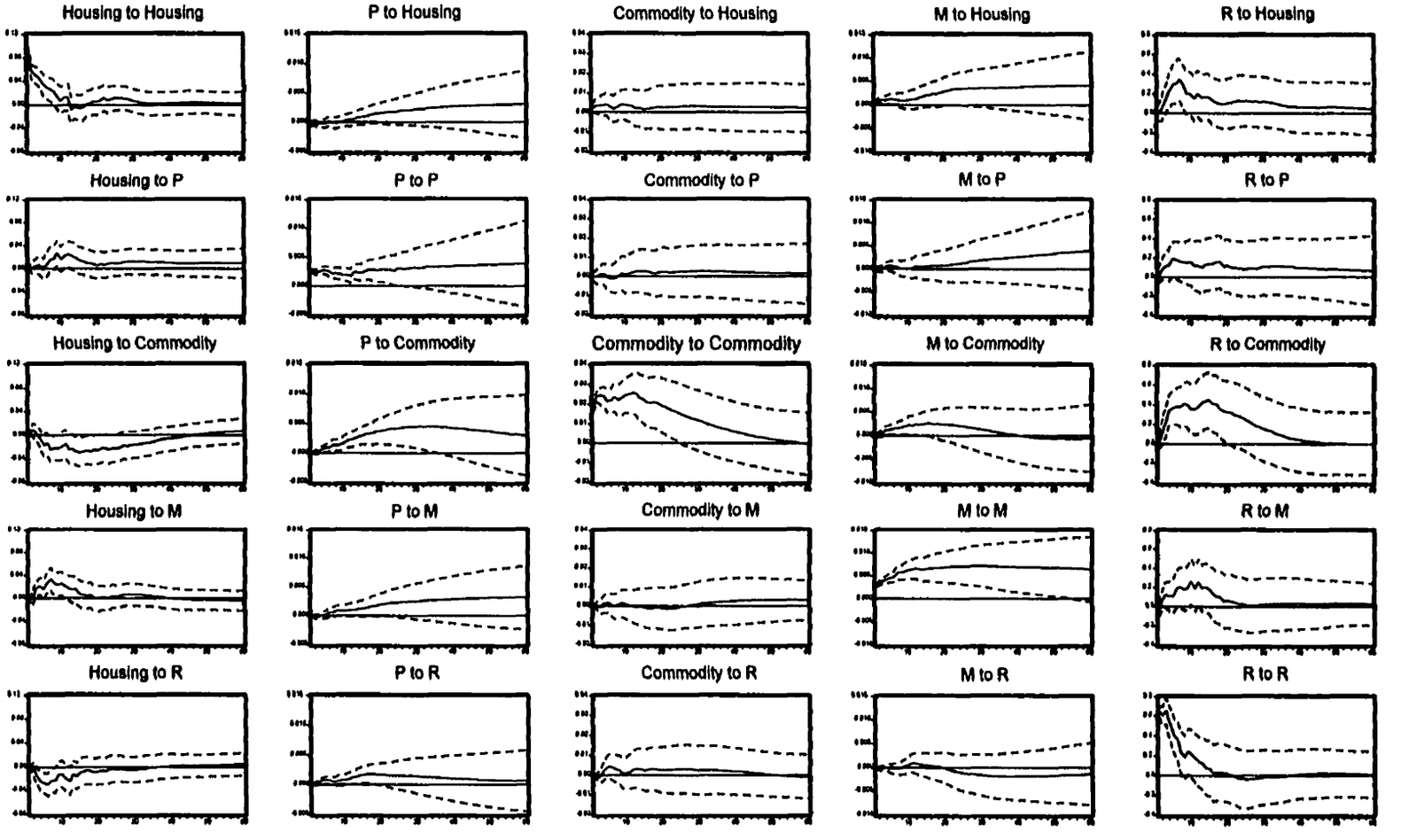


Figure 3.27: Monetary Rule Impulse Response Functions For {Building Permits, Prices, Commodity Prices, Money, Interest Rate} Model

Response Of

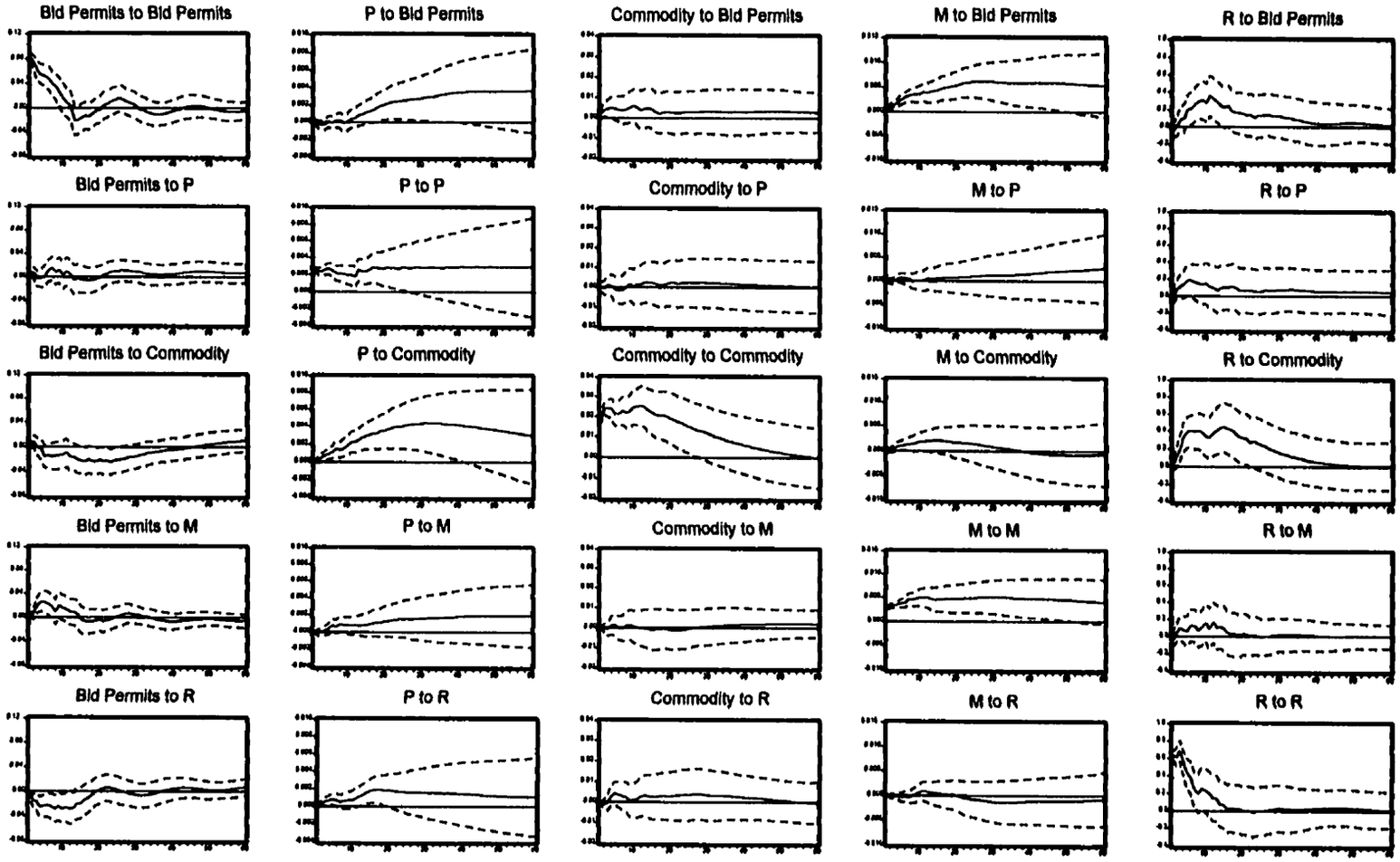
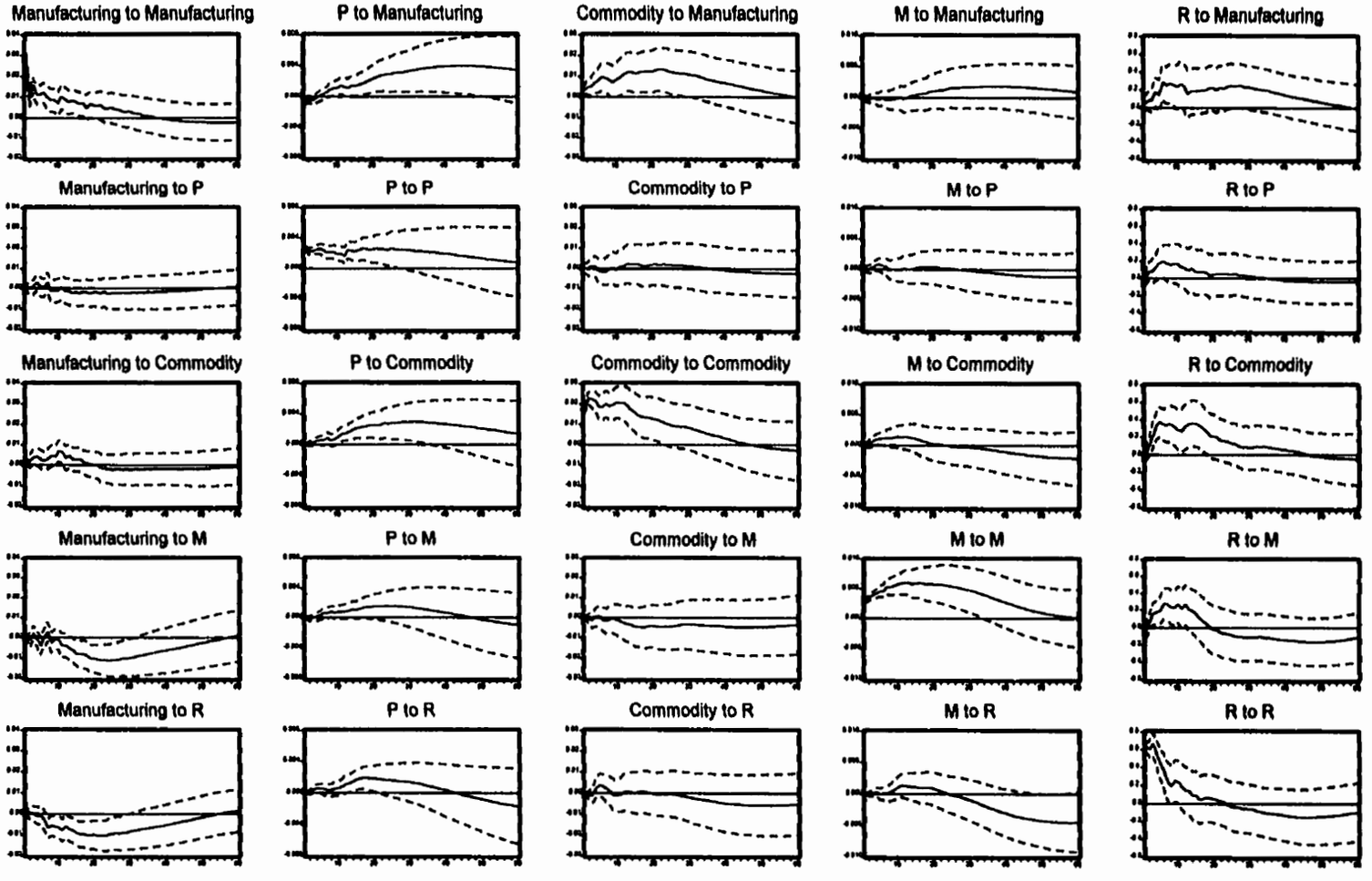


Figure 3.28: Monetary Rule Impulse Response Functions For {Manufacturing Orders, Prices, Commodity Prices, Money, Interest Rate} Model

Response Of



CHAPTER 4

SECTORAL ANALYSIS

4.1 Introduction

Literature on the U.S. (Bernanke and Blinder, 1988), and on the U.K. (Dale and Haldane, 1995), suggest that the channels of monetary transmission may depend crucially upon the degree of substitution between bank and non-bank finance and, is likely to vary across sectors. The analysis undertaken on the Canadian economy thus far, has concentrated on the aggregate response of the economy to monetary policy innovations. This conceals the effects of the differences in the degree of substitution between sources of finance. In addition the aggregate analysis imposes a high collinearity on movements in money and credit. This constraint is removed under sectoral analysis (Dale and Haldane, 1995).

Using the interest rate-rule identification scheme, Dale and Haldane (1995) examine the responses of the corporate and personal sectors in the U.K. to a positive innovation in the interest rate. They then compare these to the response of the aggregate economy. Although the qualitative pattern exhibited by most of the variables following a monetary contraction in the U.K. eventually accorded to priors, the differences in the timing of these effects between the two sectors was unexpected (Dale and Haldane, 1995).

This chapter undertakes a similar sectoral analysis for the Canadian economy. The analysis examines the response of the two sectors in Canada to monetary policy innovations under both an interest rate-rule and a monetary-rule[17]. Section 4.2 describes the data used in the sectoral analysis while sections 4.3 discusses the results. Section 4.4 provides a conclusion to this analysis.

4.2 Data

The monetary transmission process within the VAR methodology used here follows that by Dale and Haldane (1995) in their analysis for the U.K., and is defined over monetary policy instruments (interest rate and monetary aggregate), intermediate channels of monetary transmission (exchange rates, stock prices, loans, and deposits), and final policy objectives (real activity and prices). The commercial paper rate and the M2+ monetary aggregate represent the monetary policy instruments[18], while the Canadian dollar per U.S. dollar exchange rate and the Toronto Stock Exchange Composite 300 represent the intermediate asset prices in this model. Corporate and personal loans from and deposits to chartered banks are utilized to indicate the borrowing and saving decisions by the two sectors. The aggregate analysis uses total loans and deposits appearing on chartered bank balance sheets as a measure of aggregate borrowing and saving decisions. Real industrial production, real retail sales

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[17] Dale and Haldane (1995) assert that the monetary authorities in the U.K. change the official interest rate only when they intend to signal a change in monetary policy. Therefore, unlike Bernanke and Blinder (1992), they do not conduct tests to determine the best policy variable whose movements could be interpreted as monetary policy changes.

[18] See Chapter 3.

and real GDP are the measures of economic activities for the corporate sector, personal sector, and the aggregate economy, respectively. This follows Dale and Haldane (1995). The consumer price index is the price level indicator in this analysis. Seasonally adjusted[19] monthly data from 1969:1 to 1996:2 is utilized for the corporate and personal sector analysis. Due to data availability reasons, the aggregate analysis covers the period from 1976:1 to 1996:2[20].

4.3 Results

Figures 4.1, 4.2, and 4.3 plot the impulse response of each of the variables with respect to an innovation in the interest rate, while Figures 4.4, 4.5, and 4.6 do the same with respect to an innovation in the money supply[21]. The responses, based on orthogonalized innovations with the ordering as shown in the respective figures, cover a 60-month horizon[22]. Dashed lines denote plus and minus two standard deviation bands computed using the Monte Carlo methodology with 500 draws from the posterior distribution of the VAR coefficients and the covariance matrix of the innovations (Dueker and Serletis, 1996). The lag length in the VARs were set at thirteen[23], and all the data except interest rates were logged.

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[19] A moving average ratio was used to maintain consistency with the practices of Statistics Canada.
[20] Monthly data on aggregate loans and deposits at chartered banks was only available beginning in 1976:1.
[21] See Data Appendix for the abbreviations of variables.
[22] The ordering sequence is identical to that used by Dale and Haldane (1995).
[23] See Chapter 3.

4.3.1 Sectoral response to monetary innovations under the R-Rule

There are significant differences in the response of the two sectors to an increase in the interest rate. The most pronounced of these is in the response of loans and deposits. While loans decline and deposits increase almost immediately in the personal sector following an increase in the interest rates, the contrary is true for the corporate sector. In particular, corporate loans respond perversely by increasing, while corporate deposits experience a high degree of volatility but fail to demonstrate any significant response to the innovation. These results are qualitatively similar to those obtained by Dale and Haldane (1995) for the U.K. economy. The short term increase in personal deposits in response to an increase in the interest rate is attributable to the increased attractiveness of interest bearing, capital-certain deposits relative to capital uncertain bonds and equities whose prices fall as interest rates increase. Personal loans decline in response to this innovation because the cost of borrowing increases. Dale and Haldane (1995) explain the unexpected short term response of corporate loans using the "buffer-stock" interpretation. Specifically, corporations meet any short term cash flow shortfall from a monetary tightening by either building up their liabilities (increasing loans) or liquidating their assets (reducing deposits) (Dale and Haldane, 1995).

The timing of the response of economic activity, loans, and deposits to a contractionary monetary innovation differs remarkably between the two sectors. The decline in personal credit precedes that in activity by approximately two months while

personal deposits become negative only after the negative effects of the shock on activity peaks. By contrast, corporate credit becomes negative after the negative effects on activity peaks. Corporate deposits in Canada seemed to move contemporaneously with activity, while in the U.K., they lead activity (Dale and Haldane, 1995). The evidence strongly suggests that credit is a leading indicator for activity in the personal sector, but a lagging one for the corporate sector in Canada. These results, which are consistent with the empirical evidence in the U.K., suggest that the credit channel is an important monetary propagation mechanism for the sector with the lower ability to substitute bank finances for non-bank finances. Moreover, the timing patterns suggests a preference for credit as an intermediate indicator of the effects of monetary policy for the personal sector.

Another significant difference between the two sectors is witnessed in the response of the price level to increases in the interest rate. Prices in the corporate sector increase ("price puzzle") in response to a contractionary monetary innovation, while it declines in the personal sector. Prices in the U.K. on the other hand, increase in response to a contractionary monetary policy. Dale and Haldane (1995) attempt to explain the "price puzzle" using the "cost mark-up strategy". Essentially, prices are set according to some cost mark-up strategy, and an increase in the interest rate directly increases variable costs via the cost of debt financing. This in turn, raises prices in the short-run. This will prevail until demand is sufficiently depressed to provide an offsetting influence.

The remaining variables, the exchange rate and stock prices, respond in accordance to priors. In both sectors, an increase in interest rates causes a decline (appreciation) in the exchange rate[24] , and a very brief decline in share prices which lasts approximately two months. In general, the effects of interest rate innovations upon activity are larger and occur more quickly for the corporate sector than the personal sector.

The loss of information when working with aggregate data is illustrated by comparing the responses in Figures 4.1 and 4.2 to those from an aggregated system, shown in Figure 4.3. Specifically, there is a much closer correlation between the response of loans and deposits in the aggregate VAR which conceals the differences experienced in the two sectors in response to the innovation. The effect on the increase in interest rate in much stronger on stock prices, and much weaker on exchange rates, in the aggregate VAR. In addition, credit and prices respond perversely in the aggregate economy while deposits increase, as expected. The aggregate the effect of a contractionary monetary stance on economic activity is weaker than that in the corporate sector and stronger than that in the personal sector.

4.3.2 Sectoral response to a monetary innovation under the M-Rule

The timing of the response of economic activity and credit to an expansionary monetary innovation under the M-Rule differs significantly between the two sectors as can be observed from Figures 4.4 and 4.5. Figure 4.6 illustrates the response of the

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[24] Given the definition of the exchange rate in this analysis as Canadian dollars per U.S. dollar (Can$/U.S. $), a decline in the exchange rate implies an appreciation of the domestic currency.

aggregate economy to an expansionary monetary innovation. Corporate activity peaks much quicker in response to the shock, while credit appears to be a leading indicator for personal activity and a lagging one for corporate activity. Although corporate deposits demonstrate a high degree of volatility, they fail to show any significant response to the innovation. By contrast, personal deposits respond perversely to the shock by increasing over the time horizon in consideration. The exchange rate also responds contrary to expectations by decreasing for an extended period. Stock prices and the price level increase, as expected. An expansionary monetary policy should cause an increase in stock prices as agents switch from low interest bearing deposits to bonds and equities.

The loss of information when working with aggregate data is once again evident when comparing the sectoral responses in Figures 4.4 and 4.5 to the aggregate economy response in Figure 4.6. Most strikingly, loans and deposits demonstrate a high degree of collinearity. Further, aggregate deposits increase significantly in response to this expansionary innovation. Surprisingly, aggregate activity demonstrates high volatility but fails to respond in any significant manner in the first 12 months of the shock, and then declines thereafter. This is in contrast to the increase in activity witnessed in response to the innovation in the sectoral analysis. The response of the other aggregate variables are qualitatively similar to their responses in the sectoral analysis.

4.3.3 R-Rule versus M-Rule

The impulse responses under the R-rule and the M-rule do not indicate which monetary variable is a better predictor of economic activity in the various sectors. For instance, the R-rule in the corporate sector results in a "price puzzle" and causes loans to respond perversely to an increase in the interest rate. On the other hand, an M-rule in the same sector causes the exchange rate to decrease (appreciate), which is contrary to theoretical predictions. By contrast, no anomalies are observed in the personal sector under either rule. However, an M-rule for the aggregate economy results in an implausible response of output, while an R-rule causes loans to respond perversely to an increase in interest rates.

4.4 Conclusion

Literature on the U.S. and the U.K. suggest that the channels of monetary transmission may depend crucially upon the degree of substitution between bank and non-bank finances. This implies that monetary innovations would have different effects on different sectors of the economy since this degree of substitution is likely to vary across sectors. This chapter examines the responses of the corporate and personal sectors in Canada to changes in monetary policy. The empirical evidence demonstrates that credit is a leading indicator of personal activity and a lagging one for corporate activity. In addition, credit and prices in the corporate sector respond perversely to an increase in the interest rate. Alternatively, personal deposits and the exchange rate demonstrate implausible responses to an increase in the money supply.

In addition, the loss of information when using aggregate data for analyzing monetary innovations is evident as credit and deposits show a high degree of collinearity in their responses to these shocks. Finally, the variance decomposition measures indicate that the interest rate is a better predictor of sectoral and aggregate economic activities.

Figure 4.1: Interest Rate Rule Impulse Response Functions For The Corporate Sector

Response Of

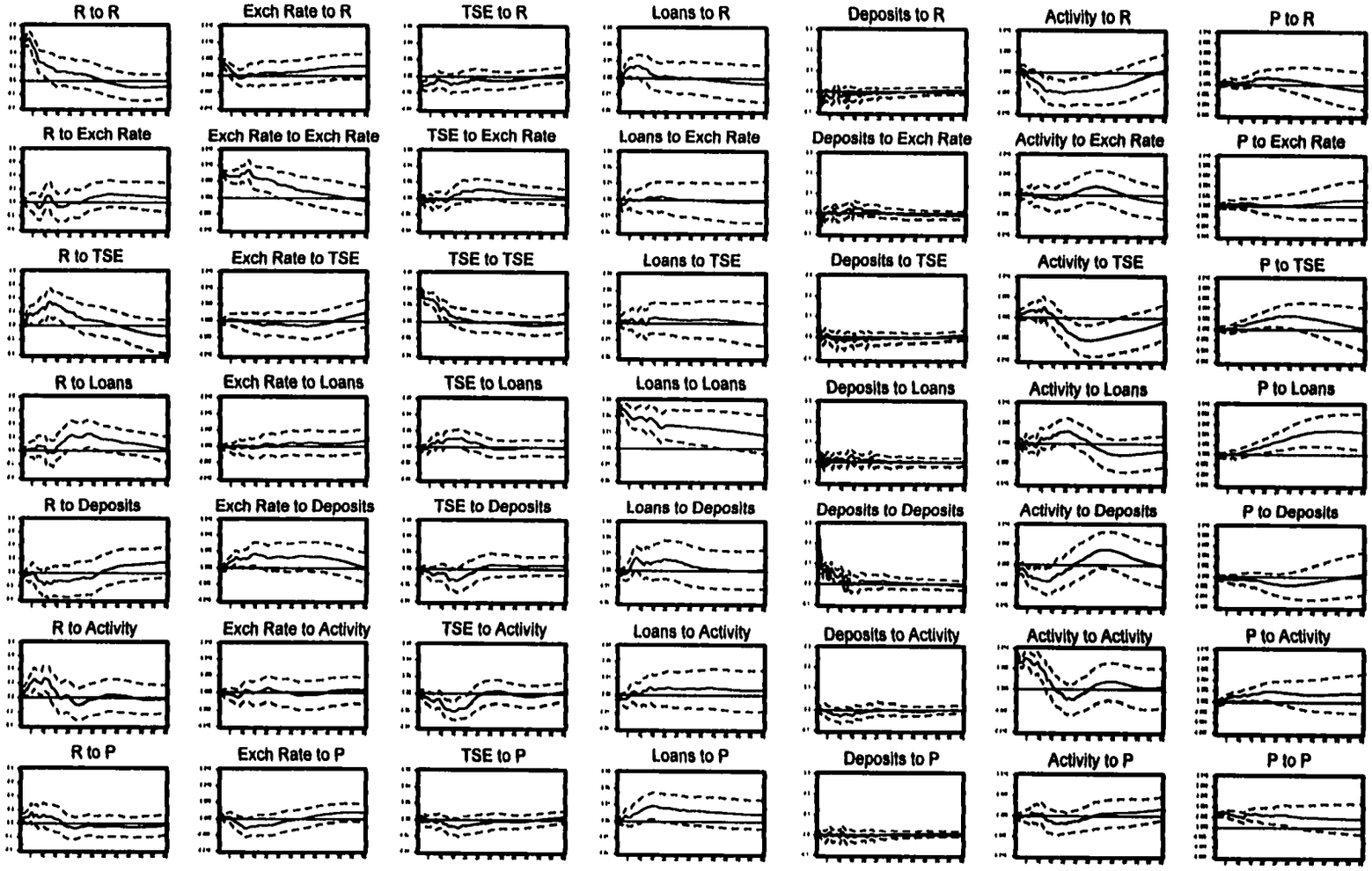


Figure 4.2: Interest Rate Rule Impulse Response Functions For The Personal Sector

Response Of

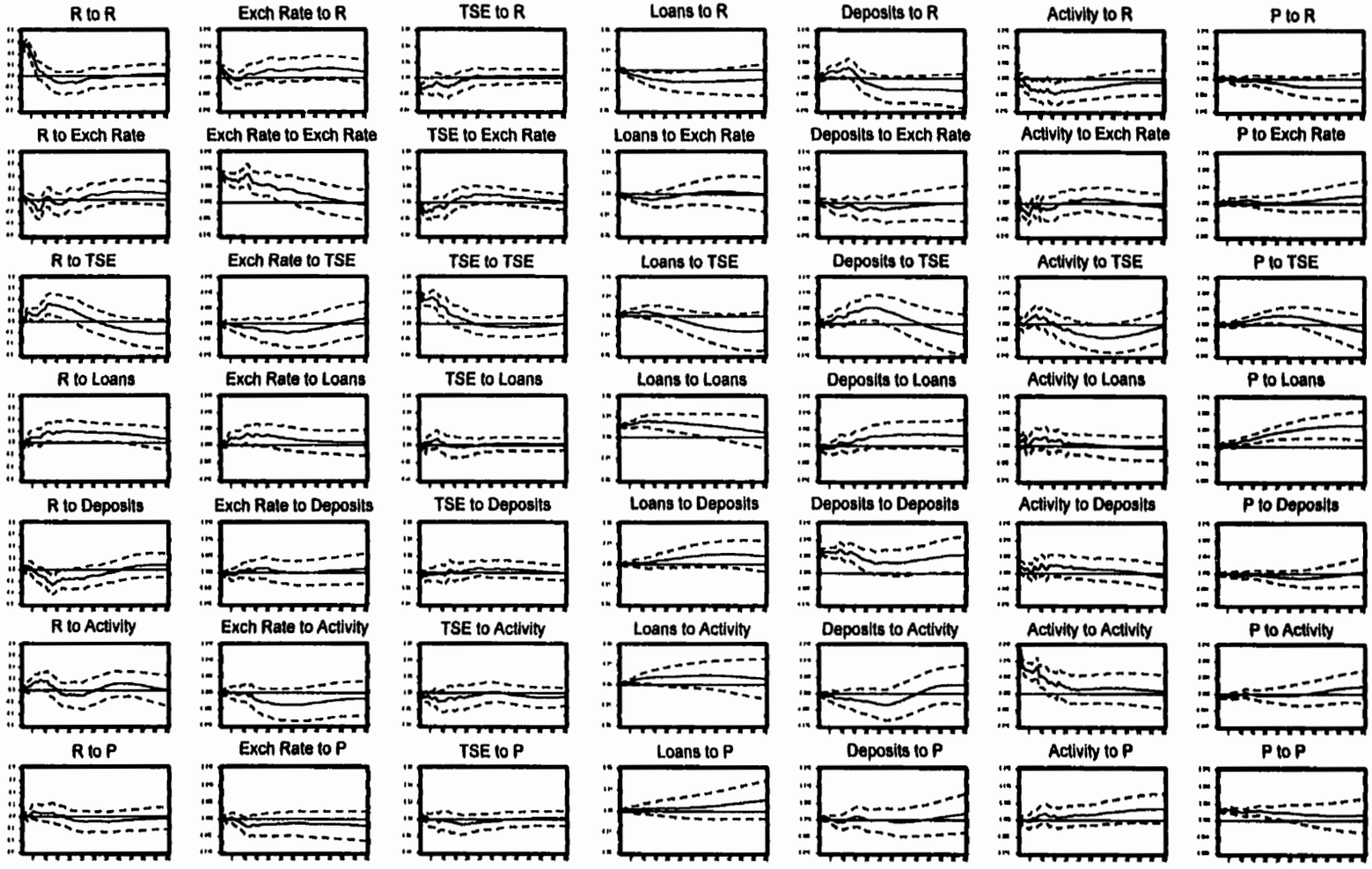


Figure 4.3: Interest Rate Rule Impulse Response Functions For The Aggregate Economy

Response Of

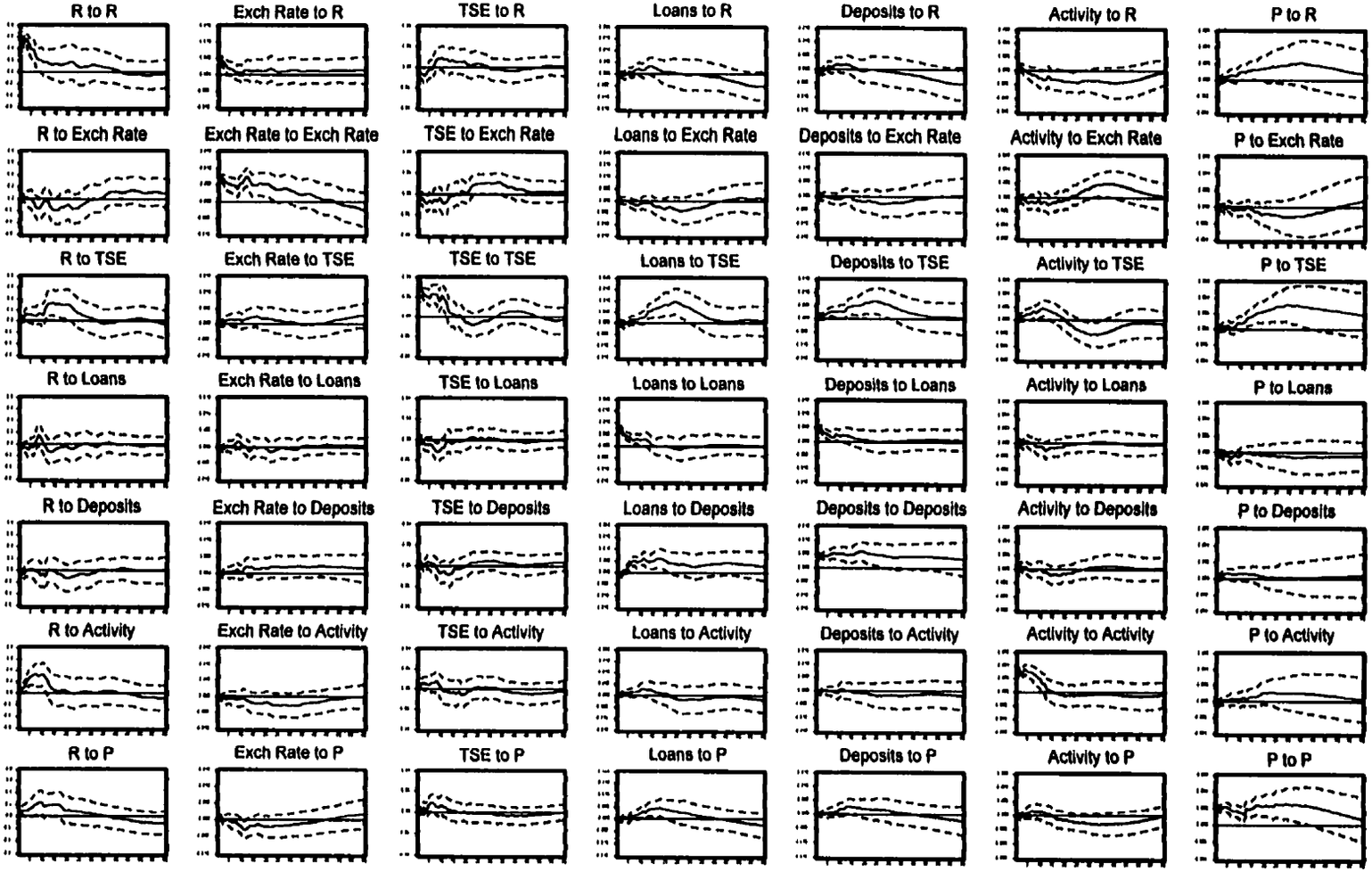


Figure 4.4: Monetary Rule Impulse Response Functions For The Corporate Sector

Response Of

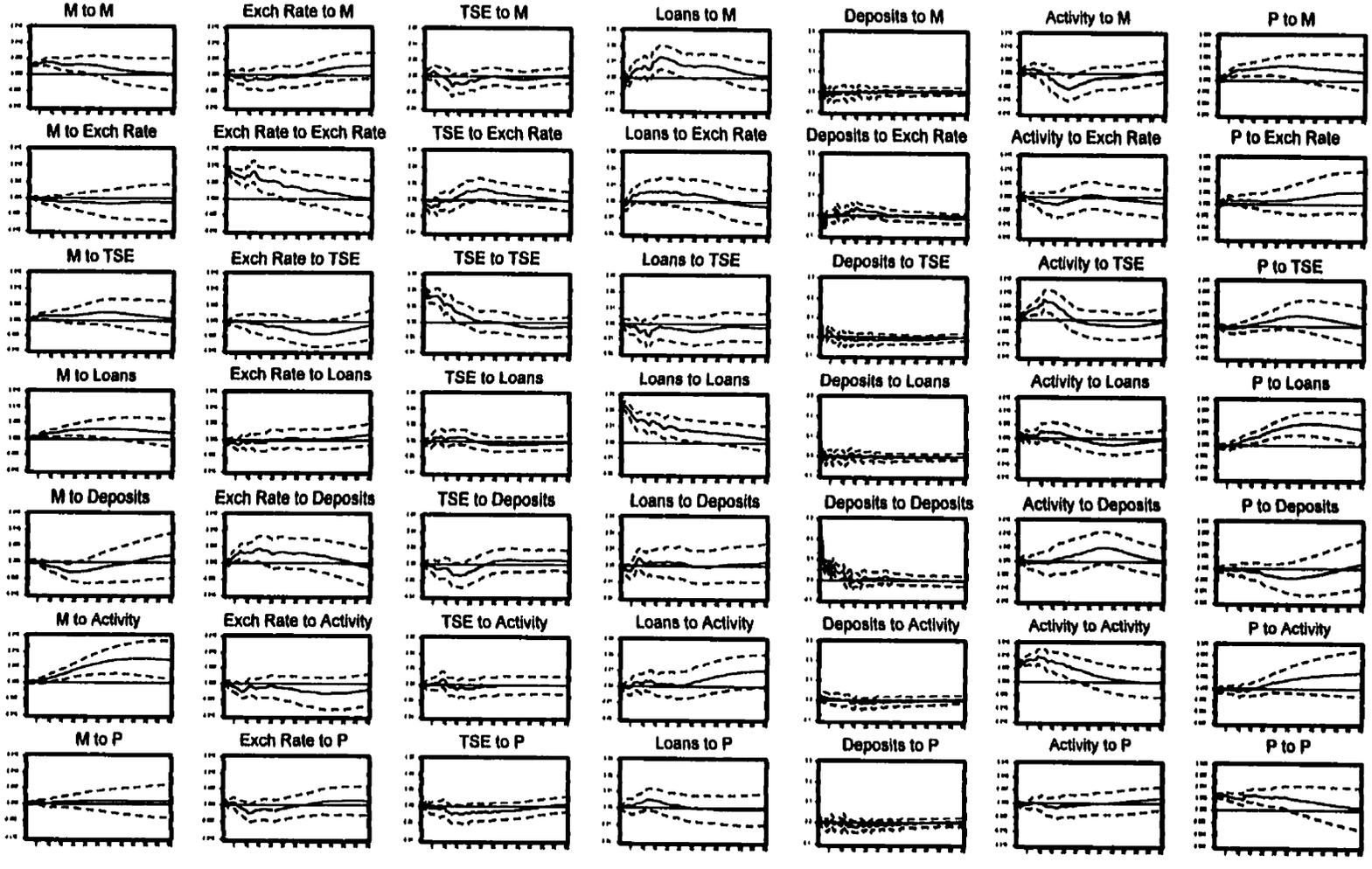


Figure 4.5: Monetary Rule Impulse Response Functions For The Personal Sector

Response Of

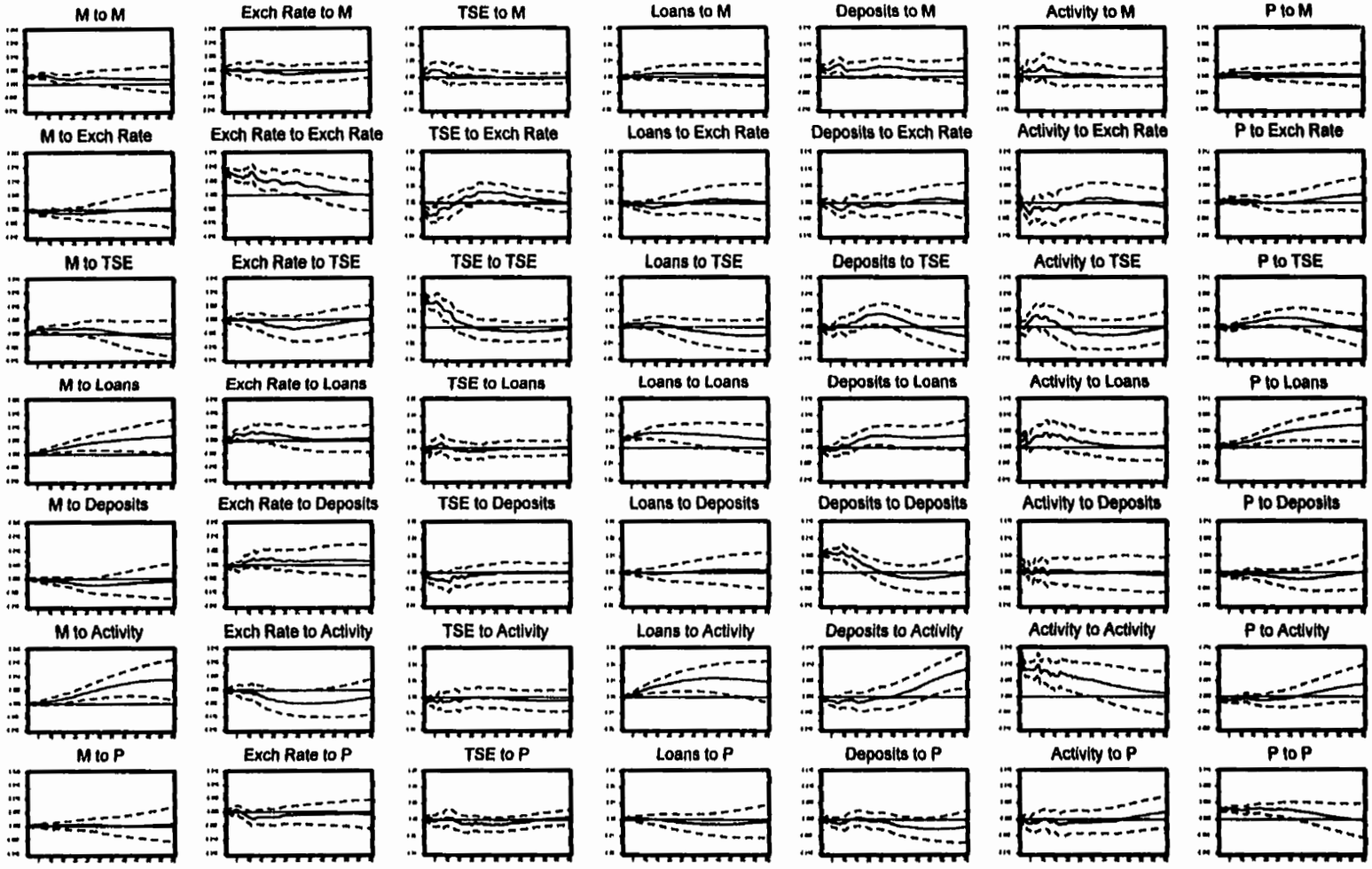
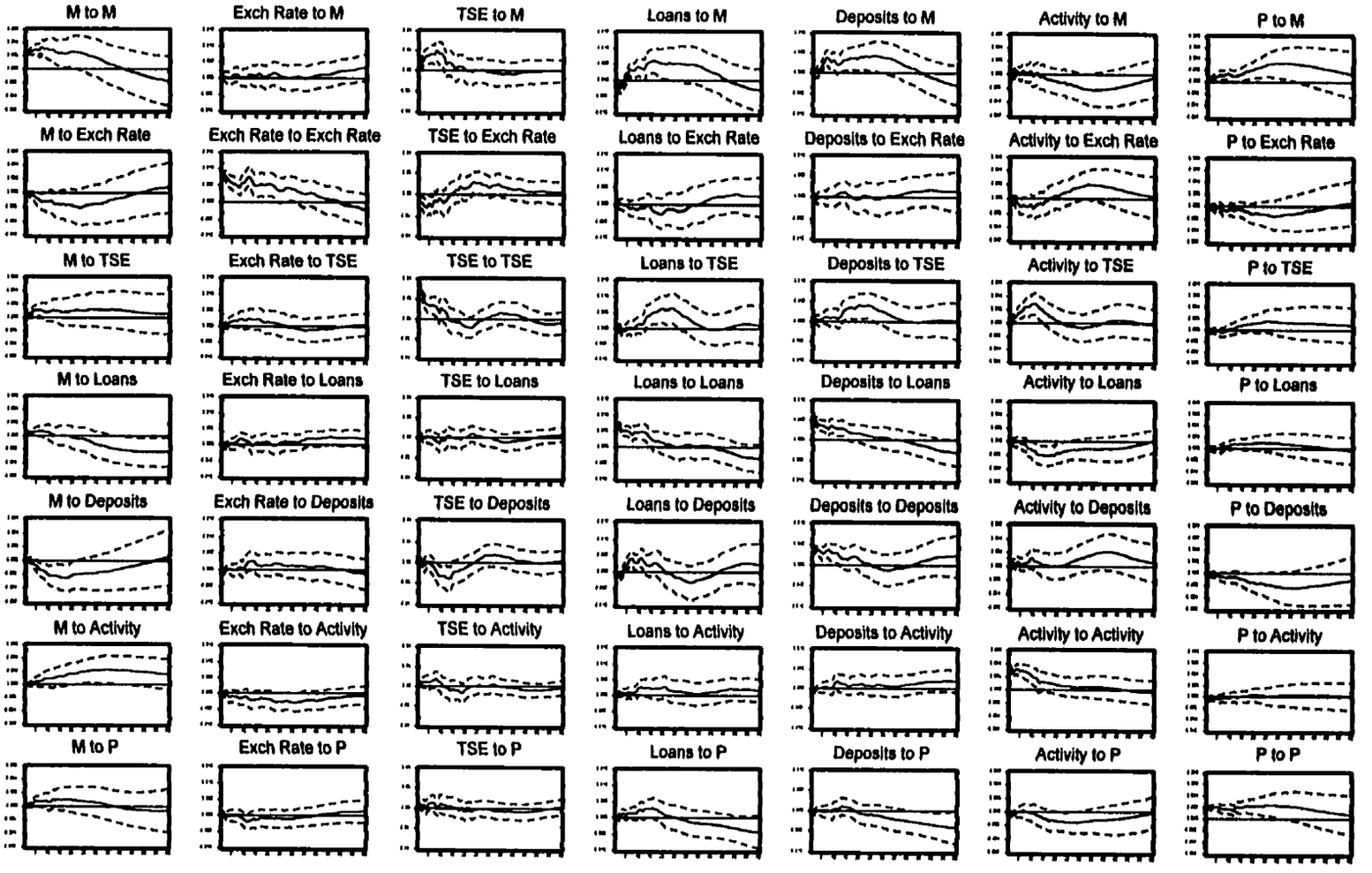


Figure 4.6: Monetary Rule Impulse Response Functions For The Aggregate Economy

Response Of



CHAPTER 5

REGIONAL ANALYSIS

5.1 Introduction

Theoretical analysis presumes monetary actions have a uniform national effect. However, due to the diverse regional composition of the country, these actions may affect the regions differently. This is an extension of the notions of "rolling recovery" and "bi-coastal recession" which suggest that the timing and magnitude of economic cycles vary across regions (Carlino and DeFina, 1996). It is plausible that since different regions possess varying resource potentials and could confront different obstacles to growth, monetary policy could generate retarding factors in some regions and problem intensifying factors for other regions.

Carlino and DeFina (1996) undertake an empirical analysis to determine the differences in regional responses in the U.S. to monetary policy innovations. They conclude that monetary policy does indeed affect regions differently. This chapter undertakes a similar analysis for the Canadian economy. In particular, it considers a region by region response, as well as analysis that accounts for feedback effects among regions, to monetary innovations. The analysis examines the responses of the regions to monetary policy innovations under both an interest rate rule and a monetary rule. Section 5.2 discusses the reasons for the varying effects of monetary innovations on different regions. Section 5.3 describes the data used in the analysis, while Section 5.4 discusses the results. Section 5.5 provides the conclusion.

The Ability of Banks to Alter their Balance Sheets

Monetary innovations can have varied effects on different banks' ability to make loans. During periods of tight monetary policy when bank reserves are restricted, large banks can find alternative sources of funding for loans more cheaply, for instance, by issuing large denomination CDs. Such banks' lending will be less sensitive to monetary policy changes (Carlino and DeFina, 1996). While this may not be as pronounced in Canada as in the U.S. due to the existence of national banks in Canada, it still may have some impact on the lending activities across the regions. Hence, regions in which a disproportionately large share of bank loans are made by small banks might respond more to monetary policy actions than regions in which a large share of loans are made by the nation's large banks.

5.3 Data

The analysis uses real personal income from each of the ten provinces in Canada as a measure for the real economic activity[25], and the commercial paper rate and the M2+ monetary aggregate as the policy variables[26] in the VAR models. Each series comprises of seasonally adjusted monthly data from 1969:1 to 1996:2[27]. All the data except the interest rate are logged, and the lag length in the VAR is set at

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[25] The ten provinces are: British Columbia (BC), Alberta (Alta) Saskatchewan (Sask), Manitoba (Man), Ontario (Ont), Quebec (Que), New Brunswick (NB), Nova Scotia (NS), Prince Edward Island (PEI), and Newfoundland (Nflnd).

[26] See Chapter 3.

[27] A moving average ratio was used to adjust the data that were not already seasonally adjusted. This methodology was chosen in order to maintain consistency with Statistics Canada. Please see Data Appendix for the sources of the data.

thirteen[28]. The analysis undertakes a region by region analysis, as well as an inter-regional analysis which permits feedback effects between regions. For instance, the effects of monetary innovations on Atlantic Canada which comprises of New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland is analyzed. Similarly, the effects of these innovations on Western Canada (British Columbia, Alberta, Saskatchewan, and Manitoba), and the four largest provinces in terms of economic activity and population (British Columbia, Alberta, Ontario, and Quebec) are considered. Then, a model which includes all these provinces is considered. This permits feedback effects between regions. Once again, the effects of monetary innovations under an R-rule and M-rule are examined.

5.4 Results

The impulse response functions derived for this analysis is based on orthogonalized innovations with the orderings shown in the respective figures, and covers a 60-month horizon. Dashed lines denote plus and minus two standard deviation bands computed using the Monte Carlo methodology with 500 draws from the posterior distribution of the VAR coefficients and covariance matrix of the innovations (Dueker and Serletis, 1996).

5.4.1 Regional Responses Under R-Rule

Figures 6.1 through 6.4 illustrate the responses of the various regions to a contractionary shock under the R-rule. Personal income demonstrates a temporary

[28] Following Sims' (1992) paper. See Chapter 3.

perverse response in all the provinces in Atlantic Canada (Figure 5.1) to this innovation, by increasing, and experiences high volatility in the first year after the shock. However, personal income in these provinces declines after the first year. The innovation has the greatest impact on in Prince Edward Island, and the smallest impact in Newfoundland. The responses of the provinces in Western Canada (Figure 5.2) are somewhat similar to that in Atlantic Canada. In particular, Alberta, Saskatchewan, and Manitoba experience an increase in personal income in response to the shock. It takes 24 and 36 months for personal income to decline below its initial level in Alberta and Manitoba, respectively. By contrast, British Columbia's economy experiences an immediate downturn in response to the shock. Figure 5.3 plots the impulse response functions of the four largest provinces in Canada. Once again, personal income experiences a temporary implausible response in all provinces except British Columbia. It eventually declines in the other three provinces after about a year. Figure 5.4 illustrates the regional responses to a contractionary innovation when feedback between the regions is permitted. For practical purposes, personal income in Saskatchewan and Manitoba are combined to form the Sask/Man variable, while the Atlantic provinces are combined to form one variable. The implausible response of personal income to this innovation still persists in all the regions except British Columbia, although Atlantic Canada's response is very weak and insignificant. Overall, the innovation has the greatest negative impact on British Columbia followed by Ontario, while it has the greatest positive impact on Alberta and Saskatchewan.

5.4.2 Regional Responses Under M-Rule

Figures 5.5 through 5.8 illustrate the impulse responses of the various regions to an increase in the money supply. Personal income in all the provinces in Atlantic Canada (Figure 5.5) except Prince Edward Island, increases in response to the innovation. Prince Edward Island experiences a decline in income, which is inconsistent with theoretical postulations, and this persists for almost four years. The shock had the greatest positive impact on Newfoundland. The response of the provinces in Western Canada (Figure 5.6) are similar to that in the Atlantic provinces, albeit at a larger scale. Income in British Columbia, Alberta, and Manitoba increases substantially in response to the shock. Saskatchewan however, witnesses a temporary implausible response, as personal income declines for about seven months before increasing. Figure 5.7 shows the responses of the four large provinces to this innovation. Here, personal income increases in British Columbia but decreases in Ontario and Quebec, in response to the shock. Alberta's economy does not respond significantly to the shock. By contrast, when feedback between regions is permitted, all the regional economies respond positively to the innovation, as can be observed in Figure 5.8. British Columbia, Alberta, and Saskatchewan-Manitoba experienced the largest positive increase in personal income, while Ontario witnessed the weakest increase in personal income.

5.5 Conclusion

Theoretical analysis presumes monetary actions have a uniform national effect. However, due to the diverse regional resource base, these actions may impact regions differently. This chapter examines the dynamic effects of monetary innovations on various regions in Canada. While a region by region analysis produces theoretically inconsistent responses in personal income under both an R-rule and an M-rule, an inter-regional system produces plausible results under the M-rule. However, theoretical inconsistencies remained in the inter-regional VAR under the R-rule. Essentially, under the R-rule, an increase in the interest rate causes income to increase in all regions except British Columbia. This anomaly remains unresolved when feedback effects between regions are permitted. On the other hand, a region by region analysis using the M-rule indicates that income in some provinces decline as the money supply is expanded; a result that is theoretically implausible. By contrast, produced when an inter-regional model is utilized under M-rule, personal income increases in all provinces in response to an expansionary innovation. Thus the anomalies are rectified in this system. Overall, there is strong evidence that monetary disturbances impact differently on the various regions in Canada.

Figure 5.1: Interest Rate Rule Impulse Response Functions For Atlantic Canada

Response Of

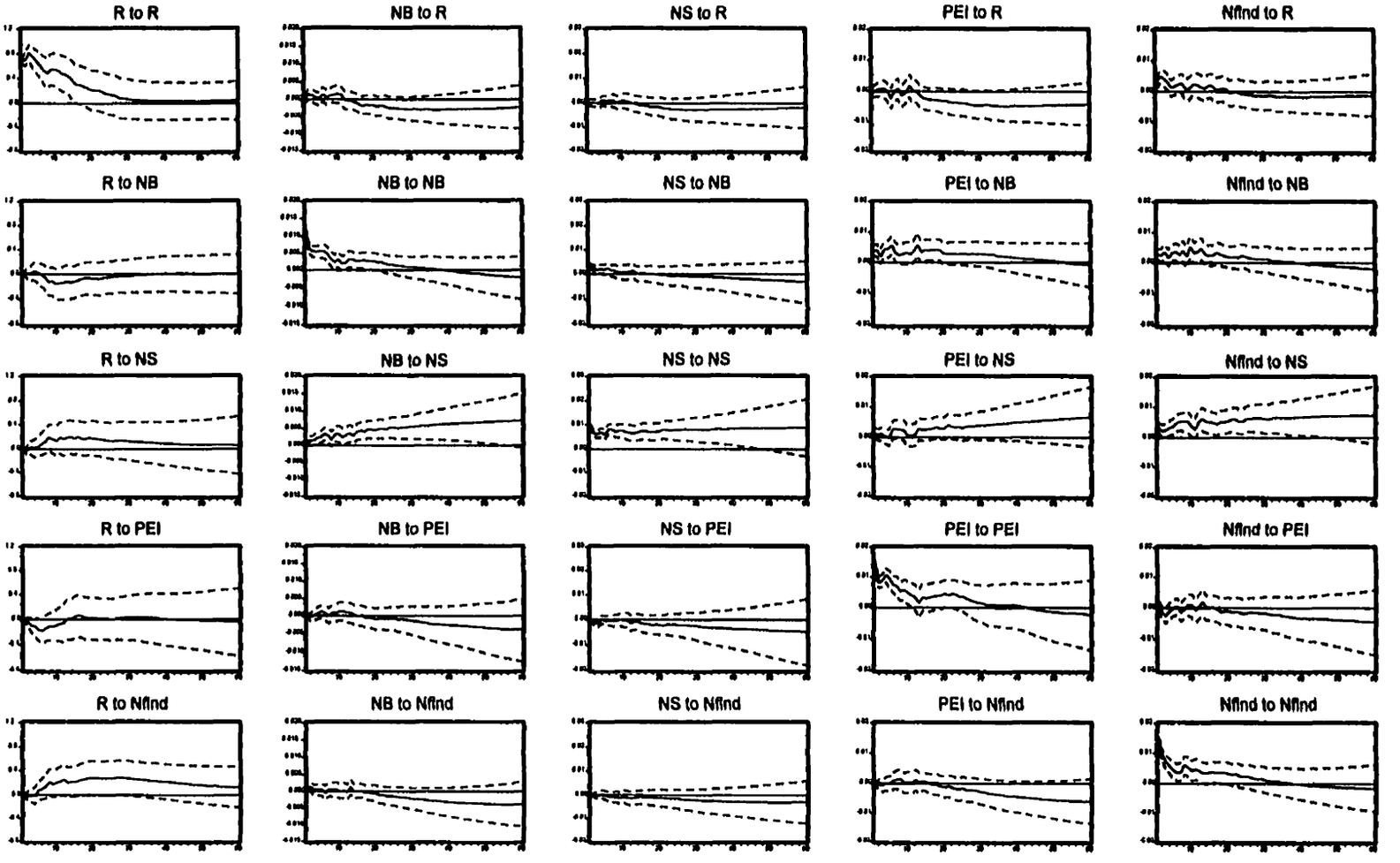


Figure 5.2: Interest Rate Rule Impulse Response Functions For Western Canada

Response Of

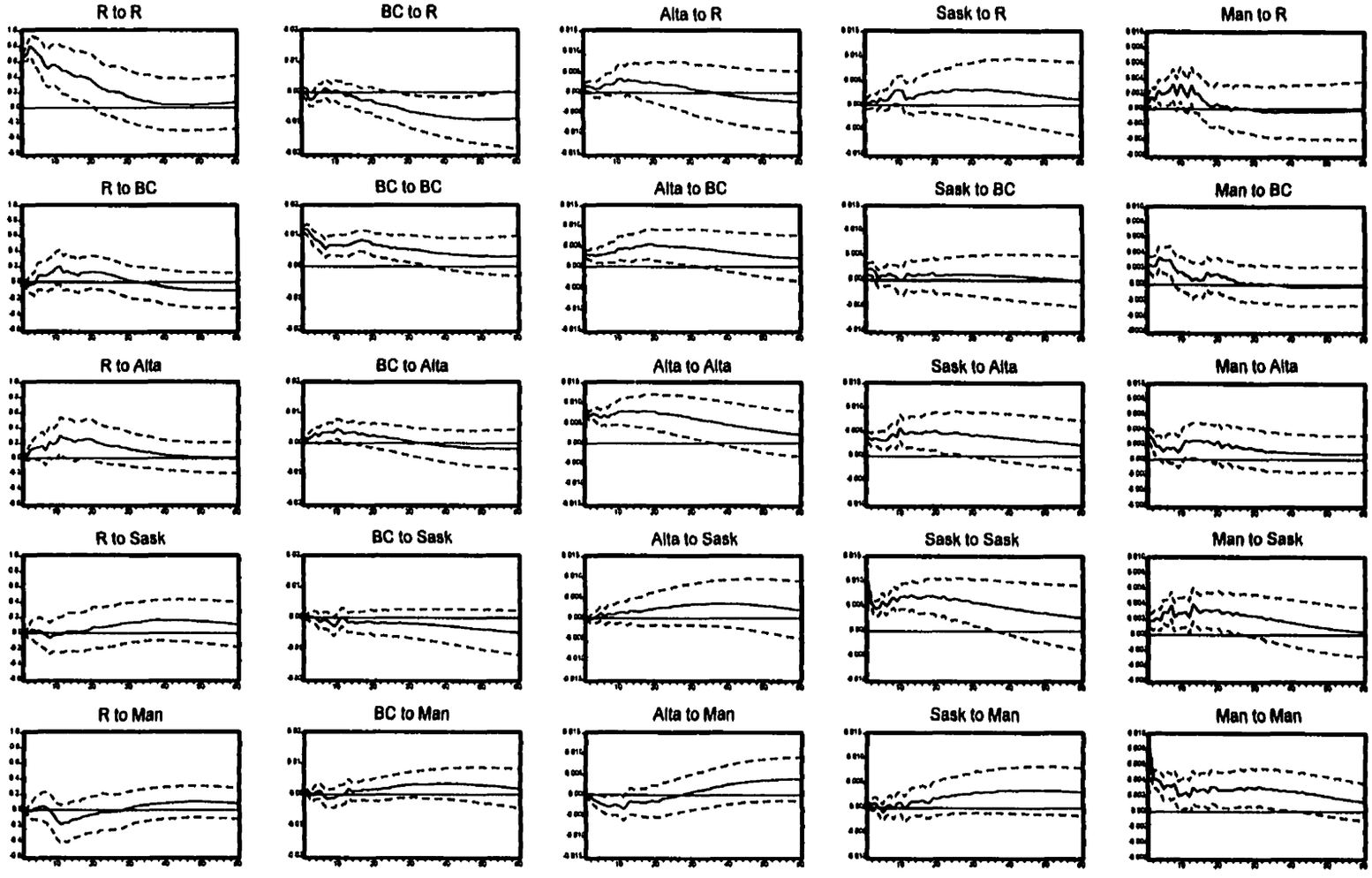


Figure 5.3: Interest Rate Rule Impulse Response Functions For The Largest Provinces In Canada

Response Of

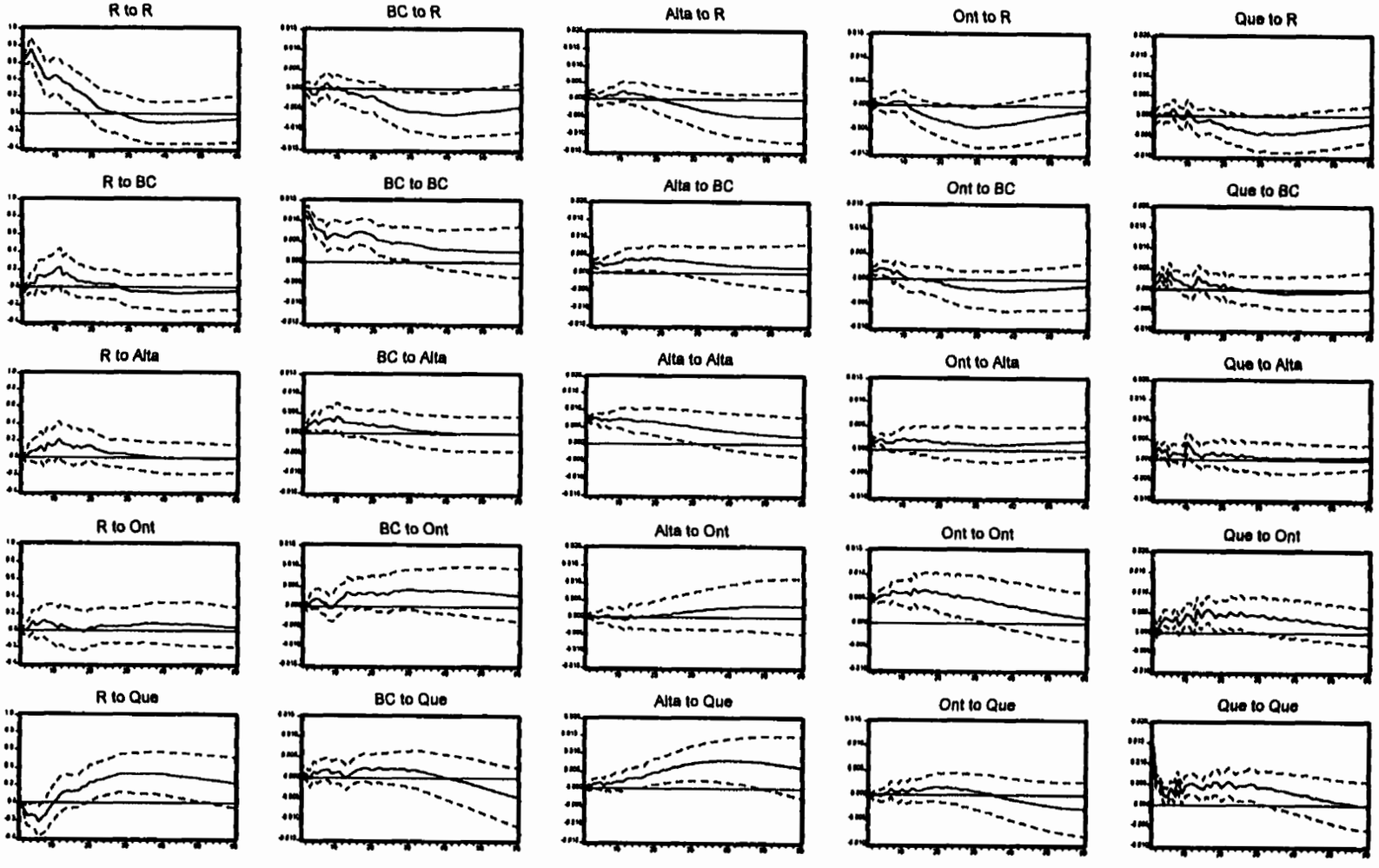


Figure 5.4: Interest Rate Rule Impulse Response Functions For Canada
Response Of

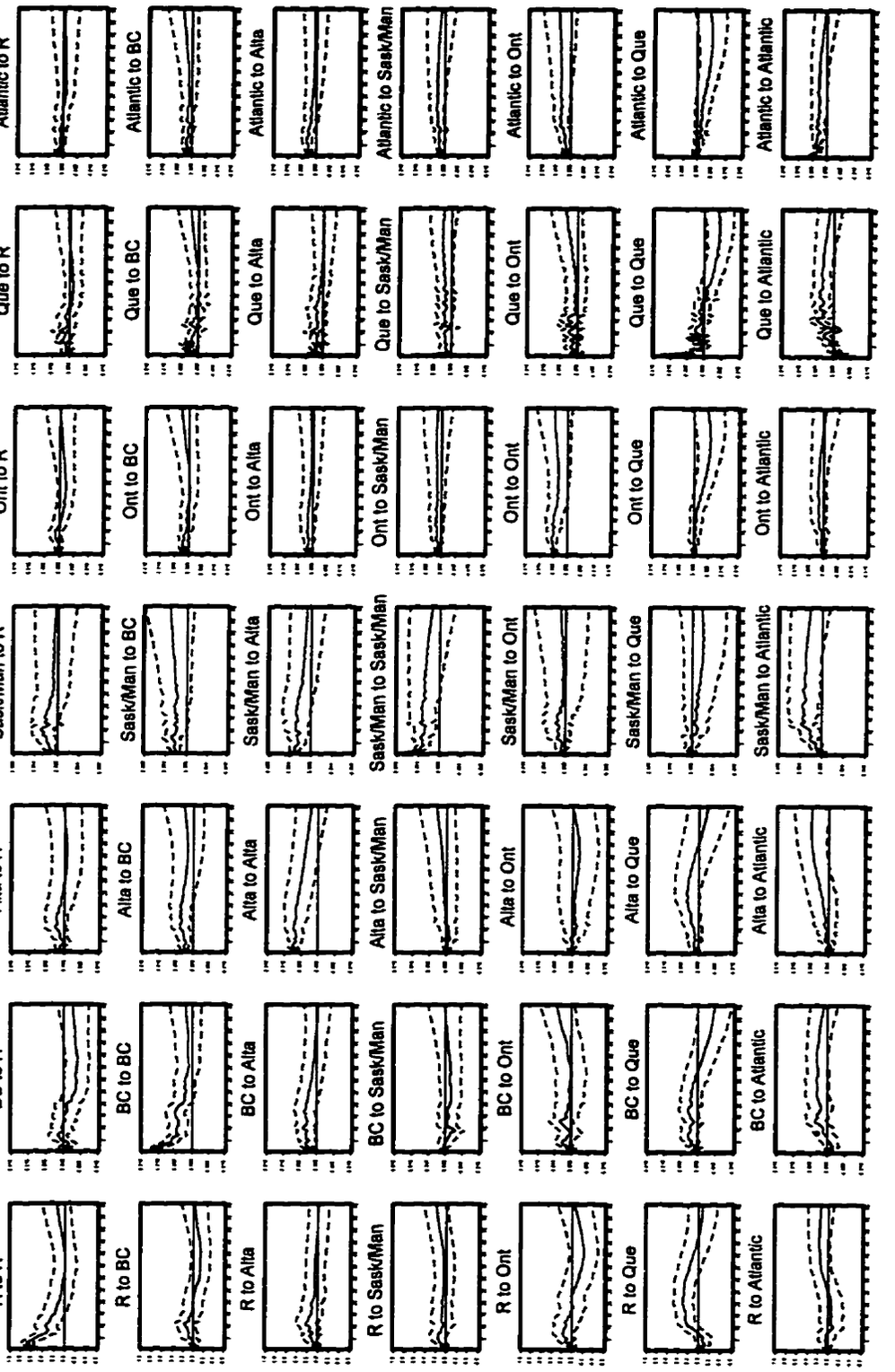


Figure 5.5: Monetary Rule Impulse Response Functions For Atlantic Canada

Response Of

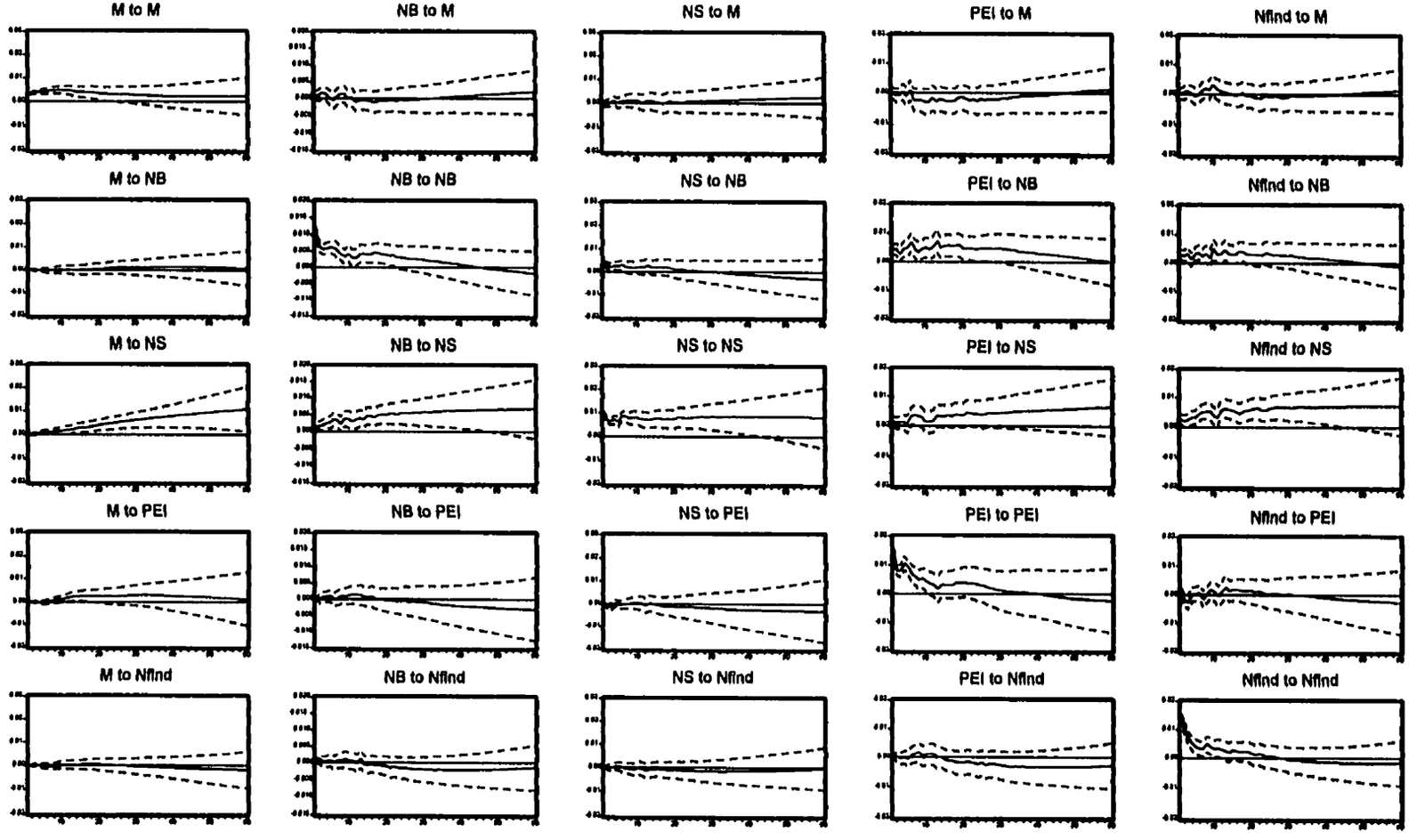


Figure 5.6: Monetary Rule Impulse Response Functions For Western Canada

Response Of

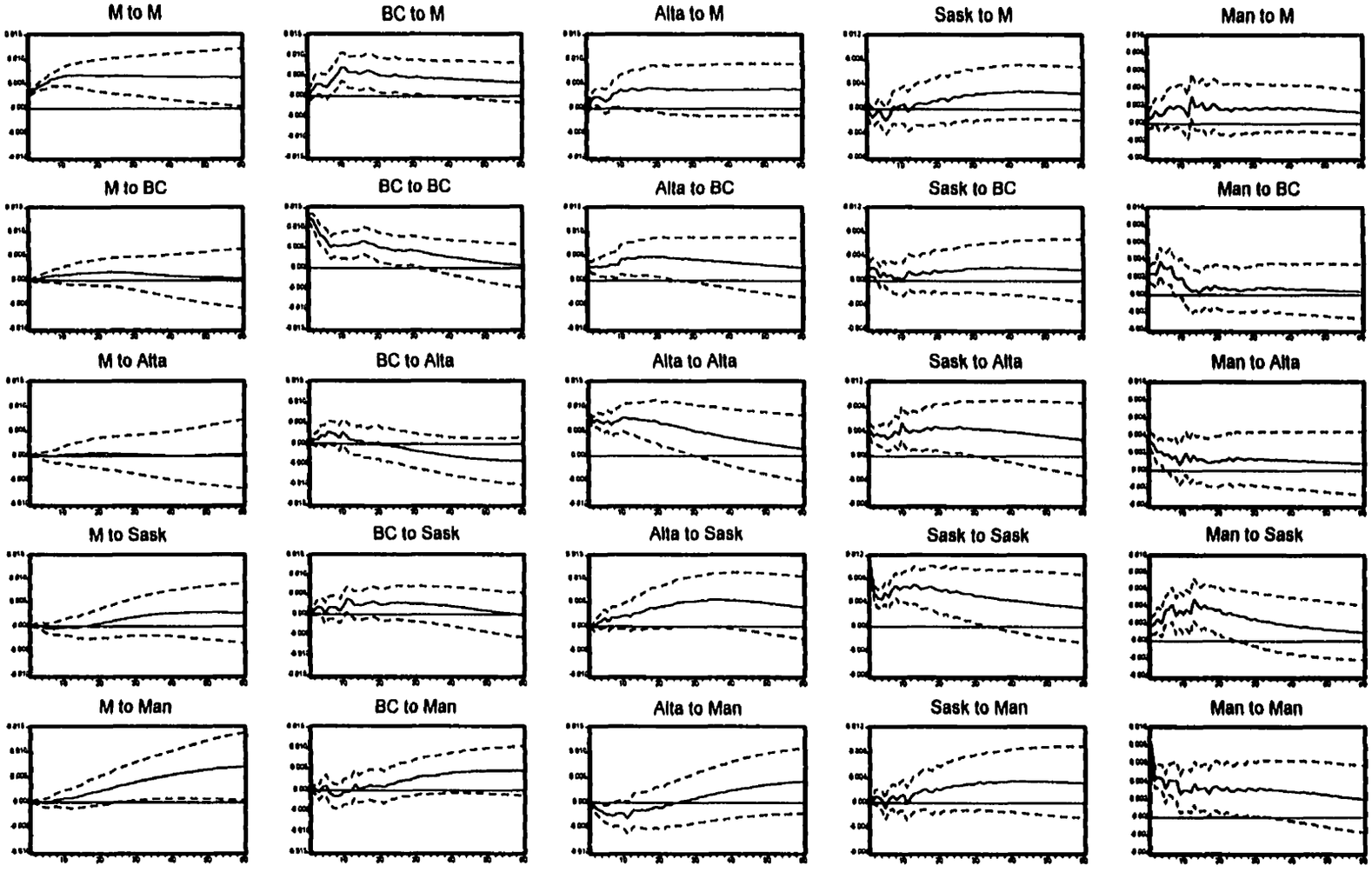


Figure 5.7: Monetary Rule Impulse Response Functions For The Largest Provinces In Canada

Response Of

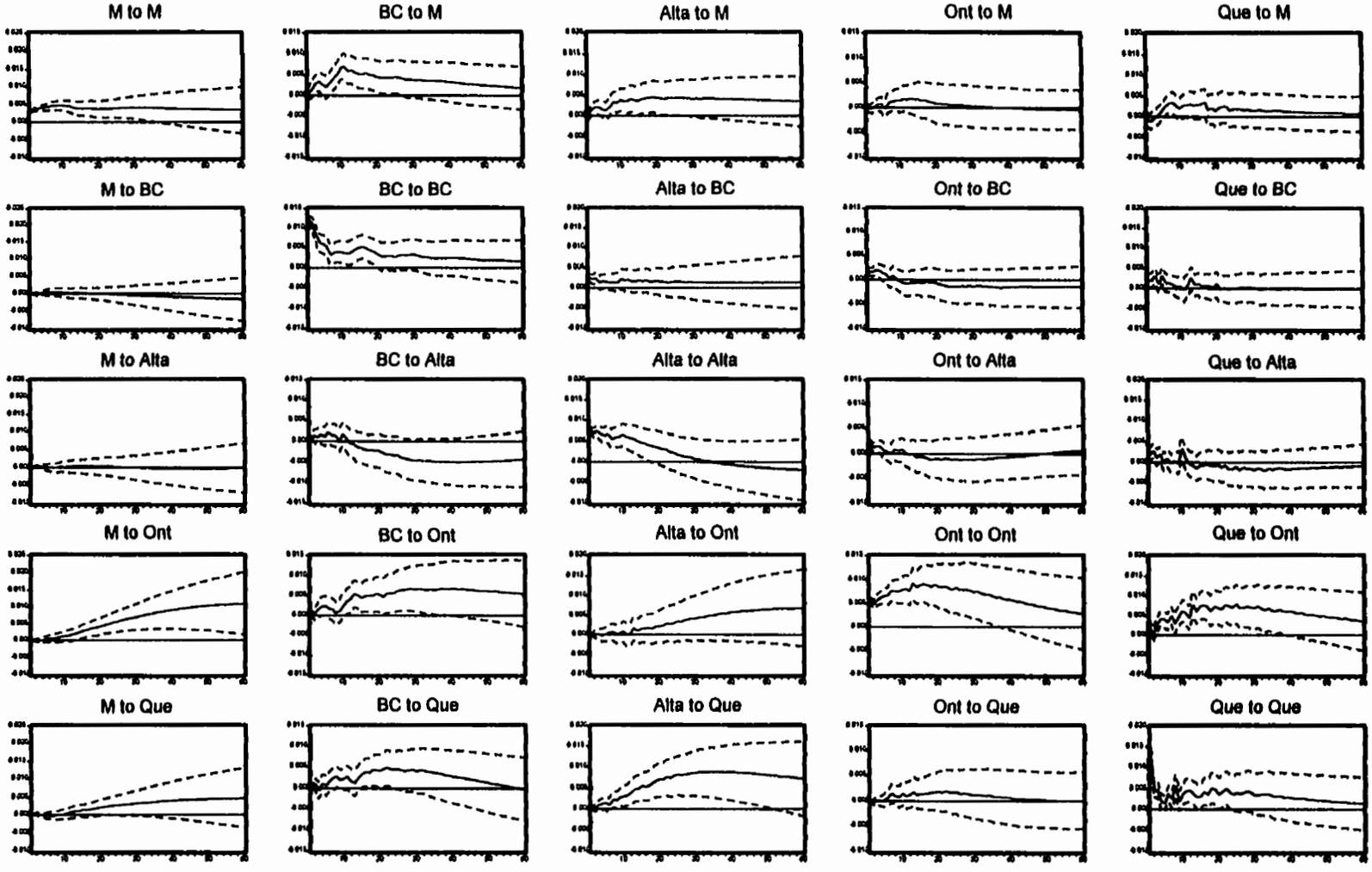
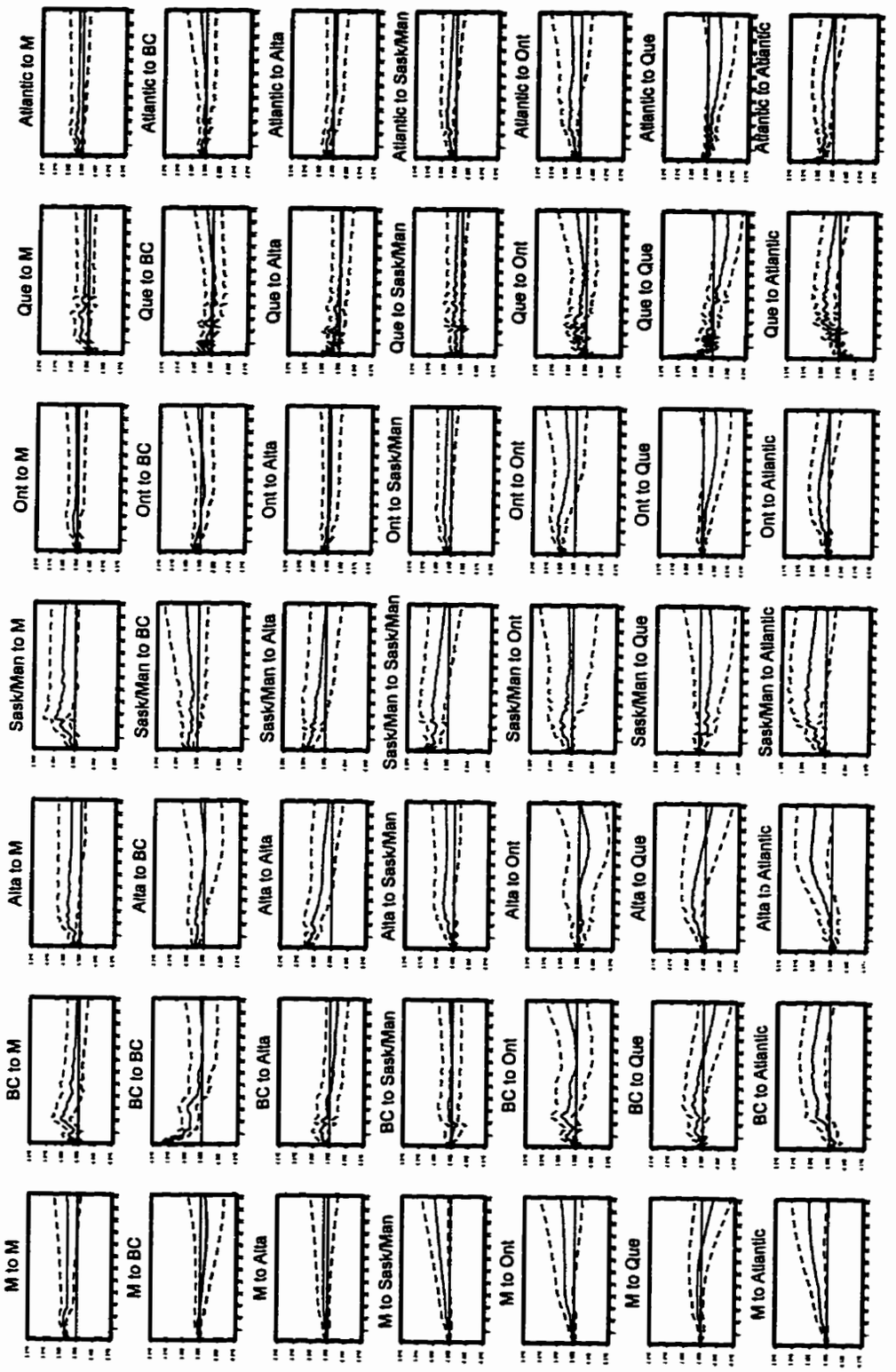


Figure 5.8: Monetary Rule Impulse Response Functions For Canada



CHAPTER 6

CONCLUSION

A significant amount of uncertainty surrounds the role of money and monetary policy within the economy. Although empirical evidence on this subject remains inconclusive, policy discussions often proceed as if the effects of monetary policy were well documented. For instance, theoretical postulations suggest that a contractionary policy stance leads to an increase in the interest rate, and a decline in prices and economic activity. However, the monetary VAR literature for the U.S. economy indicates that such policy leads to an increase in the price level ("price puzzle") under an R-Rule identification scheme. In addition, while an expansionary monetary policy should theoretically lead to an increase in economic activity and prices, and a decline in the interest rate, empirical evidence for the U.S. indicates that interest rates increase ("liquidity puzzle") in such circumstances under an M-Rule identification scheme. The differences between theoretical predictions and empirical findings implies that policy could potentially be counterproductive. Therefore, one of the principal objectives of this thesis was to identify monetary policy innovations in Canada, and then assess the dynamic response of key economic variables to these disturbances.

Identifying monetary policy disturbances required identifying a monetary policy variable, either an interest rate or a monetary aggregate, that was a good

predictor of the Canadian economy, and whose movements could be interpreted as policy disturbances. Three interest rates, the three-month commercial paper rate, the three-month Treasury bill rate, and the long term government bond rate were considered, while M1, M2, and M2+ were the monetary aggregates examined. Granger-causality tests were then undertaken to determine the predictive power of these variables in forecasting seven real economic activity measures. However, these tests did not yield a single dominant monetary policy variable that was a good predictor of all seven economic activity measures.

To continue the search, variance decomposition measures, which are constructed from VARs with orthogonalized residuals, were undertaken. Since these results are potentially sensitive to the ordering of the VARs, several orderings were considered to test the robustness of the results. While these tests indicated that interest rates were better predictors of all the seven measures of the economy, they failed to produce a single dominant interest rate. Specifically, both the commercial paper rate and the T-bill rate performed equally well in predicting the economy under different orderings. Thus, referring to existing literature, the commercial paper rate and M2+ were selected as the variables whose movements could be interpreted as monetary policy disturbances[29].

[29] Bernanke (1990) demonstrated that the commercial paper rate was the best predictor of the U.S. economy even though it is well known that the Federal Reserve targets the Federal Funds rate. Bernanke suggests that the remarkable predictive power of the commercial paper rate is attributable to the information it contains about the cost of borrowing to the private sector. The impulse responses were also obtained using the Treasury bill rate instead of the commercial paper rate as the interest rate variable, but the results were qualitatively identical. Serletis and King (1993) demonstrate that M2+ is the best simple sum predictor of the Canadian economy.

The dynamic responses of the seven economic activity measures under different identification schemes was then investigated. Consistent with the empirical findings in the U.S., there was evidence of the "price puzzle" under the interest rate rule, and of the "liquidity puzzle" under the money rule, although the former was statistically insignificant. Attempts to resolve these anomalies by following the practices in the U.S. literature were unsuccessful. In particular, Sims (1992) extended his interest rate rule model by including an index of sensitive commodity prices to capture information on future inflationary pressure over and above that already contained within the consumer price index, to solve the "price puzzle" for the U.S. economy. This was attempted in this thesis, but the anomalies remained.

In addition to the effects of monetary policy on the economy, there is considerable interest in the transmission mechanism through which policy affects the economy. The conventional "sticky wage/price" view suggests that monetary policy affects output through the interest rate. For instance, a contractionary policy increases the interest rate thereby increasing the cost of borrowing. This reduces investment expenditures which leads to a decline in aggregate economic activity. A second postulation, the "capital-markets-imperfection" view, suggests that different sources of credit, such as bank and non-bank finances, are imperfect substitutes for certain sectors of the economy (Bernanke and Blinder, 1988). In particular, the financial intermediation expertise attained by banks enable them to extend credit to agents who find it difficult to borrow in the open market. A contractionary policy reduces bank

reserves, which reduces the volume of loans extended by these financial institutions. This results in a decline in aggregate demand of agents who depend on the bank credit.

The thesis undertook a sectoral analysis to examine the empirical evidence of these postulations. The impulse response functions revealed remarkable differences between the corporate and personal sectors. Corporate borrowing *increased* temporarily, in response to a contractionary shock, while personal borrowing declined. Dale and Haldane (1995), who observed similar results for the U.K. economy, explain the perverse response of corporate borrowing by using the "buffer stock" interpretation. Essentially, corporations meet short term cash flow shortfalls either by increasing liabilities (loans) or liquidating assets (deposits). Since individuals do not face such distress borrowing situations, personal loans decline in response to an increase in the interest rate. Overall, the empirical evidence indicated that credit was a leading indicator for personal sector activity, and a lagging one for corporate activity implying that the credit channel is an important transmission mechanism for monetary policy disturbances in the personal sector. On the other hand, the more conventional money view of the transmission mechanism of monetary policy applies to the corporate sector.

Another concern about theoretical predictions is that it assumes a uniform response of each region to monetary policy innovations. However, Carlino and DeFina (1996) demonstrate that in the U.S., there are significant variations in the regional responses to these shocks. This, they assert, can be attributed largely to the

variation in the mix of interest sensitive industries, and in the mix of large and small borrowers, across regions (Carlino and DeFina, 1996). The thesis investigated whether this phenomenon existed in the Canadian economy. It analyzed the response of the provinces in Canada to such monetary policy shocks. Two approaches were taken for this purpose. The first analyzed the response of provinces within regions, to policy innovations. The second permitted inter-regional feedback effects. The results did not differ remarkably between the two approaches under the R-Rule, but differed significantly under the M-Rule. Specifically, real personal income responded perversely to an increase in interest rates by increasing, in all provinces except British Columbia. British Columbia experienced a decline in personal income in response to this innovation. By contrast, a positive shock to the money supply produced implausible responses to personal income in Prince Edward Island, Saskatchewan, Ontario, and Quebec in the region by region analysis. Nevertheless, when inter-regional feedback effects were permitted, real personal income in all provinces increased in response to an expansionary stance; this being consistent with theoretical postulations.

The empirical results in this thesis suggest that policy makers should not embrace theoretical postulations as if they were well documented. Instead, they should consider the possibility that certain policy initiatives could be counterproductive. Policy initiatives should be staggered, and therefore, not as drastic as they would otherwise have been had the empirical evidence been ignored.

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DATA APPENDIX

Variable	Abbreviation	Source	Number
	Activity Measures		
Gross Domestic Product	GDP	CANSIM	I37206
Industrial Production	Ind Production	CANSIM	I37035
Retail Sales	Retail	OECD Main Economic Indicators	N/A
Unemployment Rate	Unemployment	CANSIM	D767611
Housing Starts	Housing	CANSIM	D883970
Building Permits	Bld Permits	CANSIM	D845651
Net Manufacturing Orders	Manufacturing	OECD Main Economic Indicators	N/A
Personal Income - Ontario	Ont	CANSIM	D5242
Persoanl Income - Quebec	Que	CANSIM	D5241
Personal Income - New Brunswick	NB	CANSIM	D5240
Personal Income - Nova Scotia	NS	CANSIM	D5239
Personal Income - Newfoundland	Nflnd	CANSIM	D5237
Personal Income - Prince Edward Island	PEI	CANSIM	D5238
Personal Income - Manitoba	Man	CANSIM	D5243
Personal Income - Saskatchewan	Sask	CANSIM	D5244
Personal Income - Alberta	Alta	CANSIM	D5245
Personal Income - British Columbia	BC	CANSIM	D5246
	Policy Variables		
Commercial Paper Rate	Comm. Paper, R	CANSIM	B14017
Treasury bill Rate	T-Bill	CANSIM	B14060
Long-Term Government Bond Rate	L-T Gvt Bond	CANSIM	B14013
M1	M1	CANSIM	B1627
M2	M2	CANSIM	B1630
M2+	M2+, M	CANSIM	B1633
	Prices		
Consumer Price Index	Prices, P	CANSIM	P700000
Commodity Prices	Commodity	CANSIM	B3300
	Financial Measures		
Toronto Stock Exchange Composite (300)	TSE	CANSIM	B4237
Corporate Deposits		CANSIM	B455
Personal Deposits		CANSIM	B451
Corporate Loans		CANSIM	B612
Personal Loans		CANSIM	B109
Aggregate Deposits		CANSIM	B428
Aggregate Loans		CANSIM	B450