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Macroeconomic Monetary Policy and Sub-macroeconomic Impacts: Evaluation across Eras

A Dissertation
Presented for the
Doctor of Philosophy
Degree
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Christopher Douglas Kauffman
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DEDICATION

This Dissertation is dedicated to
my loving wife Sarah,
beautiful daughter Maria, and my parents.

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ABSTRACT

This study examines the impacts of monetary policy on regions of the United States. The purpose is to show how monetary policy decisions affect the average economy relative to disaggregate components, and to examine the effects over different periods. This will provide broader insight into the workings of the economy beyond the aggregate impacts, and should add a significant amount of information to the current literature on regional monetary effects. To allow for endogeneity between variables, the vector autoregression (VAR) method is used. Impulse response functions (IRFs) are derived to show dynamic responses of regions to a monetary policy shock. The monetary policy affects on regions are compared across time by splitting the data into two sub-samples. Also, potential transmission mechanisms for monetary policy are examined.

In general, results indicate that monetary policy shocks affect regional economies differently, and that these effects have changed over time. As a monetary shock increases the federal funds rate, the real per capita personal income in regions will decrease. In addition, these negative responses to a rise in the federal funds rate differ in magnitude across the regions. Some regions, such as the Great Lakes, tend to have a greater response to a shock, while other regions, such as the Southwest, respond less to a federal funds rate shock. The sub-sample periods showed the regional responses between two periods: 1959 – 1979 and 1980 – 2003. The magnitude of the affects in period two are much smaller than those in period one indicating that monetary policy has less of an impact in the later period.

This study also examined potential transmission mechanisms that convey monetary policy shocks through the economy. The results indicate that the interest rate channel, consumption channel, and credit channel are all potential mechanisms for monetary policy. However, the results also indicate that the transmission mechanisms for monetary policy may have changed and that the important mechanisms operative in the first period (1959 – 1979) were diminished in importance during the later period (1980 – 2003).

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Chapter One

Introduction

1.1 General Introduction

In many macroeconomic models and theories, monetary policy and money play an important role. The impacts of money and monetary policy on real macroeconomic variables have been the subject of many debates. There is the question of whether money impacts real economic variables, and then, even if money impacts economic variables, are these effects shorter term or lasting? As the economy grows and expands with the development of new technology, it is possible that any impacts from money on the economy could change over time. In addition, as the government changes the financial regulations, the transmission mechanisms that channel money through the economy could differ. These transmission mechanisms are the paths monetary impacts take to affect the economy. The Federal Reserve controls the supply of money in the economy, yet the Federal Reserve undergoes changes in its policy stances as Federal Reserve chairmen change. If the Federal Reserve has different policies between chairmen, then the flow of money throughout the economy and expectations of the public may vary. All of these lead into questions about the various impacts money may have on an economy.

Several studies, such as Gali (1992), Gordon and Leeper (1994), and many others, have shown that money can and does impact real economic variables, like income or GDP. These studies tend to focus on the impacts money has on the aggregate economy in the United States. In showing that money has real economic

effects, the studies raise questions about impacts beyond pure aggregate level impacts. The United States is such a large heterogeneous country that different areas or regions of the country may respond differently than the aggregate economy to money shocks. Each region has its own makeup of industries and firms, which may lead to differing effects from money shocks. Some firms and industries may respond more to money shocks, while others may respond less. Therefore, when deciding on a policy action that may help the aggregate economy, the responses of different regions need to be considered. Even if the aggregate economy will benefit from a policy action, some regions may suffer and therefore policymakers should be aware of the potential differing and negative impacts. Further, Blinder and Mankiw (1984) demonstrate that results based solely on aggregate level data can differ notably from disaggregate impacts. Aggregate level evidence may create a distorted picture of monetary-macro interactions. Thus, disaggregate level evidence from regional data is needed to gain fuller understanding of monetary-macro relationships through the broad economy.

Carlino and Defina (1998a, 1998b, 1999a, 1999b), who will be examined in greater detail later, examine whether or not changes in monetary policy have different impacts on the various regions of the United States. They estimate a structural vector autoregression (SVAR) model to view the dynamic responses of regional incomes to changes in monetary policy. The estimation of a structural VAR model imposes many restrictions relative to the regular vector autoregression (VAR) estimation. By using a structural VAR, Carlino and Defina may impose more structure than necessary in their model. The methodology of the VAR estimation will be taken up

in a later section of the paper. Carlino and Defina (1998a, 1998b, 1999a, 1999b) find that some regions, such as the Great Lakes and Rocky Mountains, do respond differently to monetary policy. Regions, such as the Great Lakes, showed a stronger response than average to policy shocks, while other regions, such as the Rocky Mountains, responded less than the average. The magnitude of a shock in the different regions can vary from that of the aggregate economy. Following a similar estimation, Schunk (1999) found results consistent with Carlino and Defina. Therefore, these two studies point to the importance of viewing money impacts not only on the aggregate economy, but also on the different regions of the economy. It is important for policy makers to understand and incorporate the differing regional impacts when they make macroeconomic policies as well as regional economic policies.

Based upon their work, Carlino and Defina (1998a, 1998b, 1999a, 1999b) attribute regional impacts to industry mix. The industry mix of each region shows the makeup of a region's type of industries. Regions with a higher percent of manufacturing tended to respond more to monetary policy shocks than regions with less manufacturing. Manufacturing tends to be more sensitive to interest rate changes than other industries, so those regions with a higher level of manufacturing should respond more to monetary policy. Besides the industry mix, there may be other monetary transmission mechanisms, such as the credit channel, that could cause regions and states to differ in their responses to monetary policy shocks. However, Carlino and Defina (1998a, 1998b, 1999a, 1999b) only find the industry mix to be significant among the mechanisms they examine.

As time changes and the economic makeup of a country changes, the way in which money effects macroeconomic variables can also change. Many factors can contribute to altered impacts over time from money shocks. As indicated earlier, the mix of industries and firms may respond differently to money. If, over time, a region's mix of industries were to change, then a region's response to money could differ between periods. With possible changes in industry mixes, it would be important to examine monetary policy shocks over different time periods, rather than one continuous period. If impacts have changed over time, policy makers need to be aware of current effects and instead of only using information on long periods of time, policymakers need to evaluate updated evidence. Policy based on outdated evidence could produce undesirable impacts upon the various regions and on the overall economy. For example, an older heavy manufacturing economy could respond differently to monetary policy shocks than an economy that has experienced rapid growth in technology, such as the United States throughout the 1990s. In addition to different industry mixes, two other factors might impact the way in which money affects the economy, namely the policy stances of the Federal Reserve and the type of financial regulations used by the government.

First, the policy stances of the Federal Reserve impact the directions and expectations associated with monetary policy. The Federal Reserve chairman, who steers the policy stance of the Federal Reserve, changes over time. Some Federal Reserve chairmen have allowed inflation to rise and fluctuate while others have been inflation fighters who keep the rate of inflation low. Dennis (2001) examines two different Federal Reserve regimes to see if they have different policy preferences. He

splits the period from 1966-2000 into two Federal Reserve Regimes: a pre-Volcker era from 1966-1979:3 and a post-Volcker era from 1979:4-2000. Dennis finds that in the pre-Volcker era, the FED allowed inflation to be higher and move more; in the post-Volcker era, the FED maintained a low level of inflation. This indicates different Federal Reserve policy stances that can alter the way money might impact economic variables. Across Federal Reserve regimes, people's expectations toward monetary policy movements may also change, further amplifying the altered impacts from monetary action over time.

The second variable that might affect money's impacts on the economy is the type of financial regulations used by government. For example, prior to the early 1980s regulation-Q restricted the amount of interest different financial institutions could pay on deposits. These restrictions on interest rates produced constraints on the amount of loans a bank could make, since limited deposit funds meant depleted funds for loaning. When regulation-Q was eliminated, deposits interest rates were free to fluctuate with market interest rates. Financial institutions no longer faced a sharp reduction of loans in eras where interest rates rose. By changing the way and the amount of loans that can be made, impacts from monetary actions in the economy may be altered. McCarthy and Peach (2002) examine monetary effects from regulation-Q and post-regulation-Q over the periods 1975-1985 and 1986-2000, respectively. They contend that if regulations change, then the way output responds to monetary policy can differ. Their results show that the economy did differ in its response to monetary policy shocks between these two periods. Given evidence that aggregate level impacts changed across periods, then the regional responses of the

economy could also be affected. Regions with strong interest sensitive components, such as the Great Lakes, might have impacts reduced after the elimination of regulation-Q.

1.2 Objectives of the Research

As indicated in the earlier section, monetary policy can have very important and large impacts in the economy. The way monetary policy shocks affect regions and states in the United States can differ. Some states may respond more to policy shocks than other states. In addition, it is possible that the strength of the responses to shocks can vary over time. As the economy grows, develops new financial innovations, and faces changing government regulations, the impacts created from monetary policy shocks may also change. Another question that was raised above is how monetary policy shocks are transmitted through the economy. Why do states have different responses to monetary policy shocks? This dissertation will examine these ideas and questions to see the different responses of states and regions to monetary policy shocks.

The current literature on the differing affects monetary policy has on regions is very limited. One of the goals of this study is to add a significant amount of information to the limited literature that exists on this subject. A main contribution of the dissertation will be the VAR response functions for the different states and regions of the United States. The response functions will facilitate a comparison of how states and regions respond to monetary policy shocks. It is important for policy makers, both regional and national, to understand the consequences of their actions,

not only on the aggregate economy, but on the different parts of the economy as well. In addition, data employed in prior studies terminate in the early to mid 1990s. Such data sets miss many important changes that have occurred in the economy. Through the 1990s, the United States had a long expansion; the earlier studies capture only a small portion of this. However, by the end of the 1990s, the expansion ended and the United States economy entered a recession, with little or no growth since then. How monetary policy might affect the economy could differ between this period. The current data should add information by capturing the recession and slower growth in the economy, in addition to the long period of expansion.

Besides examining a more recent data set, the study will also provide information on the responses of monetary policy shocks between time periods. The data set will be split to examine the responses in an earlier period of time versus the responses from a more current period. The discussion of how money impacts the economy has been the subject of many discussions and debates. The Federal Reserve is one of the most powerful decision makers in the economy and how it alters monetary policy can have large impacts on the economy. If the Federal Reserve were to only use studies that analyze data over large periods of time, then it may miss important relationships that have occurred in recent years. This is why it is important to study the most recent periods in order to examine how shocks change economic variables in the current economic climate.

Additionally, the research will examine the reasons why states and regions differ in their responses to monetary policy shocks. The state responses can be obtained from the VAR estimation. These state responses then can be used and

regressed on possible explanatory variables that may account for varying state responses. This regression will be used to examine potential transmission mechanisms for the varying responses to monetary policy shocks. For example, a variable to test the interest rate channel will be used as one possible explanatory variable. In addition to the interest rate channel, there may be other mechanisms, such as the credit and/or real asset price channel that can help explain the different responses states have to monetary policy shocks. Therefore, the VAR estimation is not only important to compare responses but it will provide an additional data set to examine another important issue.

The study will examine the impacts of monetary policy shocks on the United States and its regions and states, and should provide a great deal of evidence that is lacking on the regional and state impacts from monetary policy shocks. The study will examine general responses of the different regions to changes in monetary policy. This will provide evidence of the impacts monetary policy has on regional incomes. In addition, the more recent data set will include important changes in the economy that may impact the response from the policy shocks. Also, time periods will be considered to evaluate how the responses may vary over time. Because monetary policy is used frequently to try to maintain economic growth, it is very important to know how economic growth variables will respond to monetary policy shocks. Finally the research will examine potential reasons why states and regions respond differently. This will provide better understanding of how responses might change in a region or state, based upon identified key factors.

The study is organized as follows. Chapter two provides a summary of important literature relevant to the dissertation. Chapter three examines some of the econometric background for the techniques used in the dissertation. Also included in this chapter are the region and variable definitions as well as the model specification used in the research. Chapter four examines the results from the VAR estimation and provides explanations for the findings. Chapter five provides the estimation to examine the possible explanations for differing impulse responses among the states. A summary of the results and conclusion follow in chapter six.

Chapter Two

Literature Review

2.1 Monetary Transmission Mechanisms

This section will provide an overview of general transmission mechanisms for monetary policy. The transmission mechanisms will show the channels that monetary impacts work through to affect the economy. There are several mechanisms, such as the interest rate channel and the credit channel, which will be described further in this section. The transmission mechanisms will lead into possible explanations for the varying responses of states to monetary policy shocks.

Mishkin (1995) provides a summary paper of many of the possible transmission mechanisms for monetary policy. The main mechanisms addressed include the interest rate channel, real asset prices, and the credit channel. In the interest rate channel, the Federal Reserve causes a shock to the monetary system. This affects interest rates, which in turn cause investment, housing, and durable goods spending to change. Mishkin examines two types of real asset price channels. The first is Tobin's q. Tobin's q is the firm's market value, relative to the replacement cost of capital. In Tobin's q, the monetary shock causes a change in equity prices. If the shock were negative, then it is expected that the price of equities would decrease. This would cause the cost of capital to rise relative to the value of the firm. As a result, investment should decrease, leading to a reduction in real economic activity. The second asset price channel is the wealth effect on consumption. In the wealth channel, changes in equity prices cause people's wealth to change, and the amount of

consumption out of wealth should be altered. When consumption changes, this causes income to change.

The last transmission channel is the credit channel. In the credit channel, a shock to money changes the amount of borrowing and lending that takes place in an economy, and thus the amount of investment and spending that occurs. Mishkin points to three main explanations for the credit channel. These are the bank lending channel, balance sheet channel, and the firm's cash flow channel. In all three of these channels, a reduction in money causes reduced investment and income in the economy, due to decreased lending.

Many studies examine these different monetary transmission channels for the aggregate economy. For example, Romer and Romer (1990) and Gertler and Gilchrist (1994) examine possible credit channels. Bernanke and Blinder (1992) also examine the possibility of a credit channel. They find that when monetary policy is restrictive, the amount of loans extended by banks does fall over time. Bernanke and Blinder provide more evidence that a credit channel may exist in the aggregate economy. Ludvigson, et al (2002) examine the wealth-consumption channel. The study finds little evidence to support the wealth channel. In their paper, they find that consumption changes very little in response to the changes in wealth. However, Ludvigson, et al (2002) provide more evidence for a straight interest rate channel. They find that changes in the interest rate have direct affects on the level of consumption spending. If restrictive monetary policy raises interest rates, then the level of consumption spending should fall. Thus, aggregate level studies point to several key transmission mechanisms for monetary actions.

2.2 Regional Monetary Policy Shocks

The following section provides a review of the literature relating to an evaluation of regional policy shocks. The main source of literature for regional shocks comes from Carlino and Defina who have conducted several studies using the vector autoregression (VAR) framework to examine regional impacts of monetary policy. Several of their papers (Carlino and Defina, 1998a, 1998b, 1999a, 1999b) provide foundations for the work here. They measure monetary policy shocks on different regions of the United States, as well as the 48 contiguous states. Their findings show that there are differences in the way states and regions respond to policy shocks. Carlino and Defina (1998a, 1998b, 1999a, 1999b), use a structural vector autoregression (SVAR) model to examine the effects of monetary policy shocks on the 8 different BEA regions as well as the 48 contiguous states.

In their papers, Carlino and Defina find that regions and states vary in the size and degree of effects from monetary policy shocks. The area that had the largest impact was the Great Lakes region and the Great Lakes states. On the other hand, the Rocky Mountain Region and its states have a much smaller impact from the monetary policy shocks. Several states show notable differences in their impacts from the monetary policy shocks. For example, Michigan, Indiana, and several other states had responses to shocks that were much greater than the national average. Other states, such as Oklahoma and Louisiana, had responses that were much smaller than the national average response. Carlino and Defina's papers also investigate possible

reasons for the differing effects from the policy shocks.[1] Of these possible transmission mechanisms, Carlino and Defina point to three main explanations, which include: regional mixes of industries, the number of small and large banks, and the proportion of the number of small and large firms in a region.

Two studies provide evidence related to these explanations. Gertler and Gilchrist (1994) focus on the large firm versus small firm issue, by examining the impacts monetary policy could have on different size firms. They find that tight money reduces the sales of output of both small and large firms in the economy. Gertler and Gilchrist's results indicate that small firms tend to have a greater reduction in sales than larger firms in a tight money economy. Their most important result was to show that a decrease in money reduces the level of sales of output by firms, whether large or small, in the economy.

In another paper, Romer and Romer (1990) explore another transmission mechanism. They find that monetary shocks affect the economy through impacts on the balance sheet at banks. The aggregate demand shocks, which can reduce income, come from these impacts on reserves. They suggest, from standard monetary theory, that a contractionary monetary policy raises the interest rates causing the negative aggregate demand shocks on the economy. The ways that the interest rates change arise "from the special characteristics of the liability side of banks balance sheets."(Romer and Romer, 1990) Therefore, monetary policy can impact the

[1] Carlino and Defina present tables indicating the values for the state characteristics. Their tables show that state characteristics varying greatly among the states.

economy with aggregate demand shocks, but these shocks are working through the banks' balance sheets.

In their papers, Carlino and Defina explore these three potential reasons for the different effects from the monetary policy shocks (industry mixes, the size of banks in a region, and the size of firms in a region). They find that some of the reasons can be discounted. First, they find no significant effects are associated with the number of small and large banks in a region. Similarly, the proportion of small and large firms does not account for the varying regional effects from monetary policy shocks. However, Carlino and Defina (1998a, 1998b, 1999a, 1999b) find that different local industry mixes are the most likely cause for spatial variation in such outcomes. Those regions and states with a large share of manufacturing industries tend to have larger impacts from shocks than regions and states with a smaller proportion of manufacturing industries. Although Carlino and Defina examine these three possible reasons for differing response functions, there may be other ways in which monetary policy shocks could affect regions differently. For example, states' population density could raise or lower the possibility of a consumption channel for monetary policy depending on the types of goods consumers buy. Even with the channels Carlino and Defina examine, there may be alternative measures of a variable that help explain the differing responses among states. In general there are several potentially relevant transmission mechanisms not yet explored in the existing regional studies, such as the wealth effect.

Carlino and Defina's papers evaluate the full data set from around 1960 to 1993. Over this period, multiple oil shocks had dominant impacts on the economy

and the conduct of monetary policy was focused on the challenge presented by higher inflation in the economy. Following 1993, when Carlino and Defina's sample stops, the United States economy has been through many changes. The economy experienced a prolonged expansion through the 1990s. In the early 2000s, the stock market contracted and the economy began a downturn. A more recent data set will include both the rise and fall from the technology bubble that occurred in the 1990s.

An earlier regional policy impact study, by Garrison and Chang (1979), used a reduced form model of regional incomes to examine the Monetarist and Keynesian theories on whether monetary policy alone, or monetary and fiscal policy combined, have impacts on regional incomes. In Garrison and Chang (1979), income is regressed on measures of monetary and fiscal policy actions. Their results indicate that monetary and fiscal policies do have varying effects on different regions in the economy. Therefore, their paper provides another example showing that monetary policy can affect regional incomes in addition to just the aggregate levels of income. However, Garrison and Chang (1979) do not allow for any interregional feedback effects from regional income changes. Carlino and Defina (1995) show that interregional feedbacks *do* occur; a shock in one region has significant and varying spillovers into other regions of the United States. Their impulse response functions from the VAR estimation show lasting spillovers into other regions from income shocks to one region. Therefore, anytime a shock occurs in one region, it leads to effects on all regions of the economy. By not using a VAR, Garrison and Chang (1979) leave out the possibility of these regional spillovers. They also use ordinary least squares estimation, which can produce spurious results when used with time

series data (as are the data here). More modern econometric techniques, such as VAR estimation, address the econometric problems inherent in time series estimation.

2.3 Monetary Policy in Different Time Periods

In addition to the evidence on differing economic impacts across regions, there are also potential variations in monetary impacts that could occur across time periods. As the economy grows and expands, the way the economy is structured could change. If the economy transitions, then the impacts from monetary policy may also change over time. This section will examine some of the research into differing economic impacts across time.

Besides the transmission mechanisms of monetary policy, there is the issue of whether these responses from monetary policy shocks are stable over time. Have monetary-macro interactions changed over time? Several aggregate level studies, for example Estrella, et al (2002), find evidence of significant changes in monetary-macro relationships. Chauvet and Potter (2001a & 2001b) provide further evidence that a structural break occurs in monetary-macro relationships. Carlino and Defina, in their now-dated sample, do not examine whether the impacts of monetary policy have changed overtime. This study will examine not only a large sample period but sub-sample periods as well to examine any potential impacts being missed in the entire sample.

McCarthy and Peach (2002) provide evidence that money shocks can have differing impacts across time periods, and attribute it to regulatory change from the removal of regulation-Q in the 1980s. Focusing on the housing sector and mortgage

rates, McCarthy and Peach use a VAR to estimate impulse response functions to examine aggregate affects of a shock in the federal funds rate using data from 1975:1-1985:4 and 1986:1-2000:3. The impulse response functions trace out the dynamic responses of a variable to a shock. McCarthy and Peach conclude that monetary actions do still have aggregate impacts. However, the timing of those impacts has changed across periods. They point to regulation-Q as a possible explanation of why monetary policy may lead to differing impacts on variables between periods. If interest rates rise, then it becomes more costly to borrow funds, which should reduce the level of output. Under regulation-Q, the government restricted the maximum interest rate that banks and thrifts could pay on deposits. When the economy experienced inflation or the Federal Reserve used restrictive monetary actions, the market interest rate on other assets rose, which kept banks and thrifts from receiving new deposits. People also began to withdraw deposits from banks. This kept these financial institutions from having enough funds to continue to make mortgage loans in the economy. During the regulation-Q era, restrictive monetary actions had quick and harsh impacts on some economic sectors. The loan market was no longer subject to these credit restrictions starting in the early 1980s, when regulation-Q was phased out. After regulation-Q, mortgage credit was available at the market interest rate. (McCarthy and Peach, 2002) Therefore, monetary policy shocks may have altered impacts over time. To test this, McCarthy and Peach use a VAR to estimate the responses of a monetary policy shock over the two periods described above. Results indicate that economic variables do respond differently to the policy shock between periods. In the earlier time period, the economy was affected mainly from "choking

off" mortgage credit. However, in the later period, it is affected through the pricing of mortgage credit. The results from this paper provide aggregate level evidence that monetary policy could impact incomes differently between time periods, via the lending channel of money.

Dennis (2001) focuses on changes in Federal Reserve regimes and their varying policy priorities. The main comparisons across Federal Reserve regimes come from the Burns-Miller years (1966-1979) and the Volcker-Greenspan years (1979-present). Dennis (2001) finds that there was a shift in policy stances that occurred when Volcker became chairman of the Federal Reserve. Dennis estimates a system of equations via maximum likelihood methods and examines the policy preferences of each regime. He finds that policymakers had an inflation target of about 5.9% in the Burns-Miller era and 2.0% in the Volcker-Greenspan period. In the pre-Volcker period, the Federal Reserve tended to allow nominal interest rate changes, while the post-Volcker period appeared to allow real interest rates to change. The policy stance in the post-Volcker period allows the Federal Reserve to have better control over inflation (Dennis, 2001).

Chapter Three

Econometric Methods and Background[2]

3.1 VAR Econometric Background

The major objective of the research is to provide an empirical examination of monetary policy impacts on the aggregate economy and the different regions of the United States. The econometric method used will be Vector Autoregression (VAR). The VAR method is appropriate to examine macroeconomic data because it addresses the dynamic relationships among the different variables examined. Specifically, the relationship that a monetary policy shock has on regional and aggregate economic activity will be analyzed in the dissertation. The VAR method permits a researcher to use very little structure in the model. On the other had, a structural VAR (SVAR) can be used to impose structural parameters on the VAR model.

Sims (1980) was the first to criticize the traditional structural macroeconomic models. To estimate these conventional structural models, many simplifying restrictions have to be implemented, which limit the usefulness of these models. The VAR method allows for the variables in a model to impact one another without imposing any restrictions. In the VAR model, variables are treated as endogenous and are not forced to be exogenous. These tools are more appropriate for macroeconomics, where there is no consensus on how macroeconomic variables impact one another. For example, some theories treat money as neutral so it has no

[2] The information, provided in the econometric section, comes from a variety of sources. Included in the sources are Carlino and Defina (1998), Enders (1995), Greene (2000), Jaradat (2000), Schunk (1999), and the EVIEWS (version 4) help menu.

impact on real economic activities. However, others, such as the Keynesians, believe that money can impact economic activity. To examine relationships between economic variables, such as money's impact on income, many structural models would impose many restrictions that could bias the estimation toward the researcher's desired results. The VAR model imposes no such assumptions, but instead permits the variables to indicate whether or not they have impacts on one another.

The general form of the VAR is as follows:

$$y_t = A_1 y_{t-1} + ... + A_p y_{t-p} + \varepsilon_t \quad \ldots 3.1$$

where: y_t denotes an (n x 1) vector containing values of n variables at time t,

$A_1 ... A_p$ are (n x n) matrices of autoregression coefficients,

$\varepsilon_t \sim$ iid N(0, Ω), such that Ω is an (n x n) matrix of the variance-covariance of the VAR residuals.

This form of a VAR is referred to as the unrestricted VAR, in which all of the variables are treated as endogenous. The model can be adjusted to include a set of exogenous variables by added another term (Bx_t) to the right side of the equation; where B is a matrix of autoregression coefficients and x_t is a vector containing exogenous variables at time t.

To make the VAR model easier to interpret, it is standard practice to impose the Choleski Decomposition. In the Choleski Decomposition, the error terms are transformed to have orthogonal innovations. This decomposition allows each equation to be used separately to view the impacts from a policy shock. Given that a VAR model only has lagged or exogenous variables on the right hand side of the

equation, the VAR can be estimated by Ordinary Least Squares (OLS), which will provide consistent estimates.

From the estimated VAR model, impulse response functions (IRF) can be generated. IRFs examine the dynamic behavior of a simulation model. The IRF traces out the response of a variable y_{it} at time t, t+1, t+2,..., to a one-time shock in the disturbance term from another variable at time t. The response functions are found by taking the partial derivative of the moving average representation of the VAR with respect to the stochastic shock. (Enders, 1995 and Jaradat, 2000) The IRF is given by:

$$\frac{\partial y_{i,t+s}}{\partial \varepsilon_{jt}} \qquad for \quad s = 0,1,2,... \qquad \ldots 3.2$$

where $y_{i,t}$ is the endogenous variable that is changing, ε_{jt} is the innovation in variable y_{jt}, and s is the horizon.

The IRFs will be used to analyze the effects of a unit shock in the federal funds rate on the time paths of the real personal incomes of the aggregate economy as well as real income for U.S. states and regions. The response functions will be the main tool used to analyze these impacts.

Two issues remain with the estimation of the VAR model. The first is the proper lag structure of the variables. For most quarterly macroeconomic variables the proper lag length to use is four lags. Following many of the previous studies, the specification chosen for the dissertation will also be four lags.[3]

[3] For example, see Carlino and Defina (1999).

Second, there is the issue of data specification. In order for a VAR to be efficient, the data need to be stationary. Problems encountered in creating stationary data are discussed later in this section. For data to be stationary, their means and variances must be independent of time movements. However, if the processes rely on time, then the variables are non-stationary and they are referred to as having a unit root. Generally, most macroeconomic variables are non-stationary in levels, but are stationary in their first difference. It is important to determine whether to use data in levels or in differences because of the efficiency of VAR estimates. When data are non-stationary, the VAR estimates will lose their efficiency properties. In this case, the estimates no longer have the smallest variance among possible estimators. To keep the estimators efficient, it is important to specify variables so they will be stationary.

To test for stationary data, the Augmented Dickey-Fuller test (ADF) will be used. In the ADF test, a γ variable is tested to see if $\gamma = 0$ in the following equation:

$$\Delta y_t = a + \gamma y_{t-1} + \sum_{i=1}^{p} B_i \Delta y_{t-i} + \varepsilon_t \qquad \ldots 3.3$$

where y is the variable being tested for a unit root. (Enders, 1995) If the test for $\gamma = 0$ is rejected, then the variable is stationary. However, if the test fails to reject $\gamma = 0$, then the variable has a unit root and is non-stationary. Therefore, the variable needs to be differenced until it is found to be stationary.

3.2 VAR Estimation: Regions, Data, and Variable Specification

Following the example of Carlino and Defina, as well as the setup of available data, the nation is split into the eight Bureau of Economic Analysis (BEA) regions: New England, Mideast, Great Lakes, Plains, Southeast, Southwest, Rocky Mountains, and Far West. The states comprising each region appear in Appendix A. By using the eight regions, sufficient spatial disaggregation is provided to examine policy shocks on different parts of the country. Additional examinations will take place to measure the impacts of the policy shocks on individual states. The overall sample time period will run from 1958:1 through 2003:2. These years will also be separated into two sub-periods to evaluate whether regional monetary-macro impacts change over time. A number of aggregate studies that examine structural breaks identify a break around 1980. This corresponds with the date of regulatory change (removal of regulation-Q). It also is consistent with the switch in major Federal Reserve regimes. Thus, the overall sample period will be divided into two sub-periods, with a break around 1980.[4]

The variables included in the analysis are real personal incomes in the United States, each region and state, the relative price of energy, the BEA index of leading indicators, and the federal funds rate. Real personal income will act as the measure of economic activity for the United States and the regions, and is derived from personal income based upon the aggregate core CPI.[5] Carlino and Defina examined other

[4] The results from the estimates are robust against differing divisions of the sample around 1980. Therefore, for simplicity, 1980 was chosen as the split date.
[5] Since regional price deflators do not exist, Carlino and Defina used the aggregate CPI to create the real personal incomes.

measures of economic activity but found that real personal income was robust against them. Changes in energy prices can lead to shocks in an economic system. In order to account for potential supply shocks, the relative price of energy is included in the model. To incorporate overall economic changes the index of leading indicators will also be included. General trend movements and the growth of the economy should be captured by this index. The energy price variable and index of leading indicators are used purely for control variables and are not provided specific attention. The federal funds rate will be used as the measure of monetary policy. Although the federal funds rate is affected by factors other than the decisions of the Federal Reserve, Carlino and Defina find their results are robust against alternative monetary variables.

The quarterly data on real personal incomes, energy prices, and the core CPI come from the BEA. The federal funds rate was obtained from the FRED database at the Federal Reserve, while the index of leading indicators was provided by the Conference Board. Finally, the software package EVIEWS (Econometric Views) is used to estimate the model.

3.3 VAR Econometric Model Specification

The research will examine the effects discussed above by utilizing the VAR framework described in the econometrics section and below. The VAR model does not impose a particular structure on the system. They are a widely used method in current macroeconometrics. One of the main reasons for a movement to VARs is the lack of consensus as to what model appropriately represents the economy. A nonstructural VAR does not impose exogeneity on specific variables; it allows each

variable to be endogenous. Impulse response functions, which can be derived from the VAR estimates, identify the dynamic responses of a variable to a shock in the model. This enables a researcher to trace impacts over a number of different periods, and thus to examine the short-term and longer-term responses to the shock.

The specific estimation equation is dependent on a number of initial diagnostic tests conducted on the time series data. For example, the Augmented Dickey Fuller (ADF) test, noted in the econometrics section, is used to determine whether or not data are stationary. This will indicate whether to use levels or first differences of the data for this study. The general structure of the estimation will regress an (n x 1) vector, containing the variables of interest, on lags of that vector. For the state level assessment, following Carlino and Defina (1999), the model estimates the dynamic behavior of 48 state level, (12 x 1) covariance-stationary vectors ($y_{s,t}$):

$$y_{s,t} = \{x_{s,t}, x_{r\text{-}s,t}, x_{r2,t},\ldots, x_{r8,t}, c_{1,t}, c_{2,t}, m_t\}' \quad \ldots 3.4$$

where t indexes time, x_s is real income in state s, $x_{r\text{-}s}$ is real income in the BEA region containing the state less the state's real income, x_{r2} through x_{r8} are incomes of the other seven major BEA regions, c_1 is the relative price of energy, c_2 is the BEA index of leading indicators, and m is the measure of monetary policy. The only difference between the state and regional specifications is that only the incomes of the eight regions are included in the VAR estimation. Therefore, for the regional estimation the model becomes:

$$y_{s,t} = \{ x_{r1,t},\ldots, x_{r8,t}, c_{1,t}, c_{2,t}, m_t\}' \quad \ldots 3.5$$

where t, c1, c2 and m remain the same as above, while x_{r1} through x_{r8} are the incomes of the eight BEA regions.

The ADF test results for the regional and aggregate variables are listed in Table 3.1.[6] The ADF tests indicate that the null hypothesis of a unit root (non-stationary) cannot be rejected for any series (in levels). The variables are stationary once they are first differenced. This was true for the regional and state levels of income as well as the other macroeconomic variables. Based on the results of the ADF test, the variables will be transformed into first differences.

These vectors $y_{s,t}$ (now in first differences) will be regressed on lags of this vector, such that a one lag structure is as follows:

$$y_{s,t} = A_{s,1} y_{s,t-1} + \varepsilon_{s,t} \quad \ldots 3.6$$

where $A_{s,1}$ is an (n x n) matrix of autoregression coefficients and $\varepsilon_{s,t}$ is a vector of disturbance terms. From this each of the regions' and states' impulse response functions can be found by:

$$\frac{\partial y_{i,t+w}}{\partial \varepsilon_{jt}} \qquad for \quad w = 0,1,2,... \quad \ldots 3.7$$

where $y_{i,t+w}$ is the regional or state level of income and ε_{jt} is an innovation in the m_t variable representing the monetary policy shock. The impulse response functions will then be used to examine how regions' and states' responses to monetary policy shocks compare with one another. Also, the response functions can be found for the different time periods and the regional responses can be compared across time.

[6] The results of the ADF test for real per capita incomes of each state were similar to the regions. Each of the state income variables was non-stationary in levels, but when first differenced the variables became stationary. Therefore, all of the variables in the state models are in first differences.

Table 3.1: Augmented Dickey Fuller Tests for Unit Roots

1959 - 2003 Series	Levels	First Differences
Far West	-0.97	-3.708 **
Federal Funds Rate	-2.456	-10.513 **
Great Lakes	-0.521	-5.628 **
LEI	-0.521	-7.9 **
Mideast	-0.226	-14.1 **
New England	-0.114	-4.173 **
Plains	-0.327	-12.569 **
Relative Energy Prices	-1.323	-7.088 **
Rocky Mountains	-0.456	-4.634 **
Southeast	-0.375	-6.016 **
Southwest	-0.749	-4.977 **
1959 - 1979 Series	Levels	First Differences
Far West	-0.451	-3.826 **
Federal Funds Rate	-1.228	-3.4 *
Great Lakes	-1.054	-3.735 **
LEI	-1.71	-4.12 **
Mideast	-1.018	-6.57 **
New England	-1.022	-6.298 **
Plains	-0.695	-6.434 **
Relative Energy Prices	-1.96	-5.329 **
Rocky Mountains	-0.223	-3.55 **
Southeast	-0.806	-4.874 **
Southwest	-0.86	-4.803 **
1980 - 2003 Series	Levels	First Differences
Far West	-1.239	-3.36 *
Federal Funds Rate	-1.593	-8.845 **
Great Lakes	-0.116	-5.628 **
LEI	-1.779	-8.149 **
Mideast	-0.876	-11.171 **
New England	-0.972	-4.735 **
Plains	-0.516	-6.249 **
Relative Energy Prices	-2.082	-7.529 **
Rocky Mountains	-0.332	-3.274 *
Southeast	-1.046	-3.183 *
Southwest	-0.145	-3.79 **

**Test significant at the 1% level *Test significant at the 5% level

These estimations will provide information on how real per capita personal income in each region will be impacted by a one standard deviation increase in the federal funds rate. It is expected that the regions and states will respond differently from one another to the monetary policy shocks. Therefore, one can see how different policies would impact each of the states relative to the aggregate economy. In addition, the different time periods are expected to show that states and regions have different responses not only relative to each other but over different periods of time as well. The later time period will provide evidence on how the economy would respond to current monetary policies. The IRFs will also provide cumulative responses for each state. The state responses can then be used as a dependent variable to examine why monetary policy has differing impacts on regions and states.

Chapter Four

VAR Estimation Results

4.1 Introduction

This section provides the results for the vector autoregression (VAR) estimation. The results presented are from the impulse response functions (IRFs) described in chapter three. The IRFs show key variables' responses after a one standard deviation shock in the federal funds rate, which represents a monetary policy shock. Each of the cumulative responses shows the change in the real per capita personal incomes from the shock for each quarter through a total of 24 quarters. The results are presented for a positive one standard deviation shock in the federal funds rate.[7] The results are shown and compared for the whole sample period and two sub-sample periods for the regional responses. The individual state responses are examined and used in estimation of transmission mechanisms in chapter five.

4.2 Results for the Period 1959 – 2003

The results in Figure 4.1 show the cumulative responses for each region across the entire sample period from 1959 – 2003. As shown in the figure, all of the regions' real per capita personal income shows a negative response after an increase

[7] In the VAR estimation, responses are symmetrical. Therefore, responses to shocks in the opposite direction will have the same level of impacts but the responses will have the opposite sign. In order to see the impacts of a decrease in the federal funds rate, one would simply take the results and change the sign of the cumulative responses.

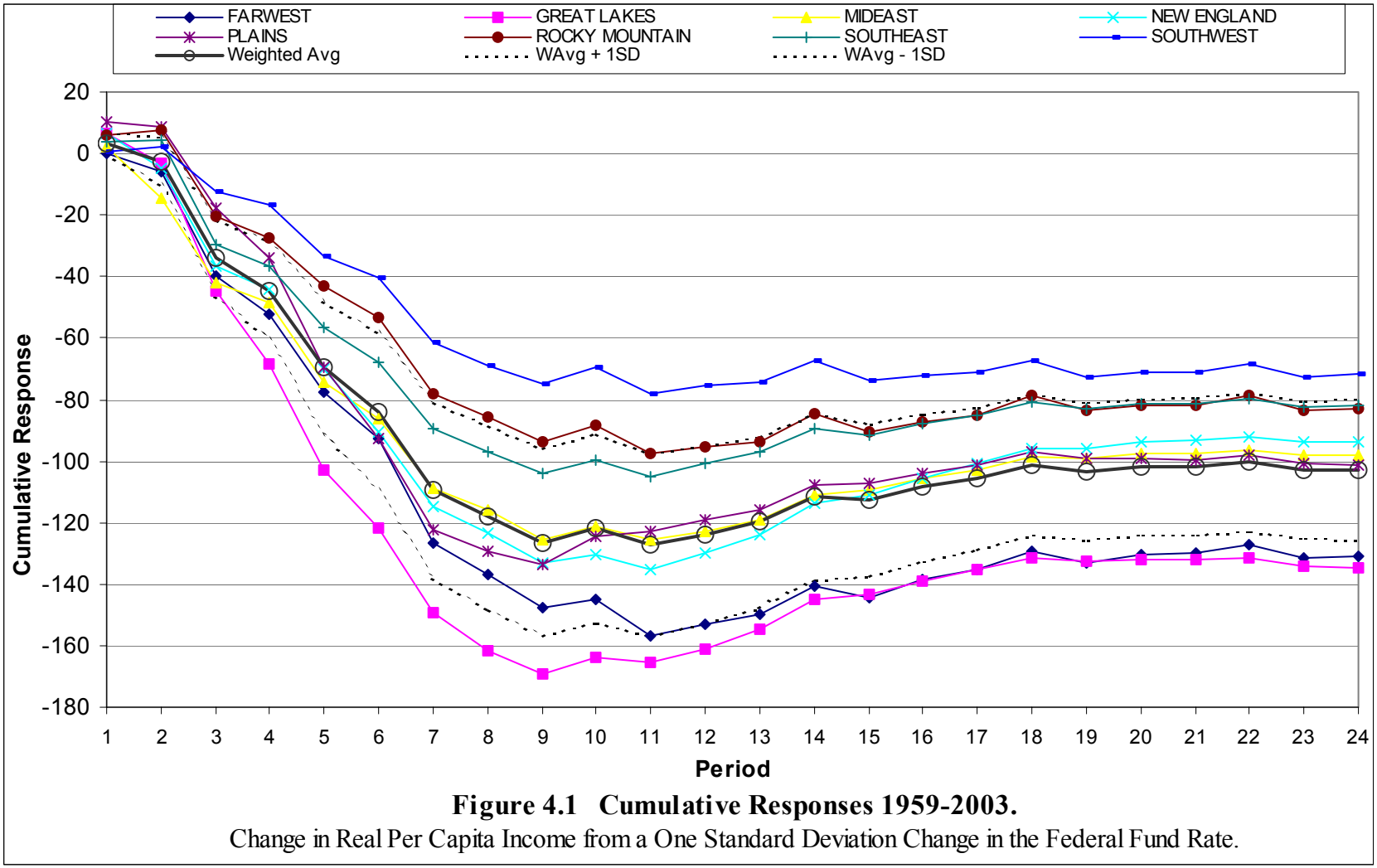

Figure 4.1 Cumulative Responses 1959-2003.

Change in Real Per Capita Income from a One Standard Deviation Change in the Federal Fund Rate.

Note: Dotted line indicates one standard deviation confidence interval on the average response.

in the federal funds rate. The responses tend to be very consistent across the different regions and each region experiences its maximum decline in real per capita personal income after roughly 10 quarters. However, the strength of the responses differs between regions. After 10 quarters, the cumulative responses moderate then level off (for a net negative impact from a federal funds rate increase).

The results in Figure 4.1 indicate that regions do respond differently to changes in monetary policy. Four regions, the New England, Plains, Southeast and Mideast, had cumulative responses that were similar to the average response. However, four other regions had responses that differed from the average. Two regions, the Southwest and Rocky Mountains, responded less than the average by one standard deviation or more. In each of these regions, a monetary policy shock has less of an impact on real per capita personal income than is felt on average. For an average region, real per capita personal income declined by about -$120 and tapered off at roughly -$100. The Southwest region showed the minimum response (-$70). Responses in two other regions, the Great Lakes and Far West, exceeded the average by one standard deviation or more. Both of these regions had maximum responses of more than -$150 (compared to the average response of -$120), with the Great Lakes region demonstrating the overall maximum response, with real per capita personal income declining by -$170 and eventually leveling off at -$140. Shocks to the federal funds rate tend to have a very large effect on the real per capita personal income in the Great Lakes and Far West regions.

Therefore, the results from the whole sample period indicate that increases in the federal funds rate impart a negative impact on real per capita personal income,

and that these responses differ significantly among regions of the United States. Regions such as the Southwest responded less than the average and other regions such as the Great Lakes responded by more than the average. Thus, monetary policy can have differing impacts on regions of a country.

4.3 Results for the Period 1959 – 1979

The whole sample was separated into two sub-periods to compare responses of regions during different periods of time. The first sub-period is from 1959 – 1979 and the cumulative responses for each region are shown in Figure 4.2. As with the whole sample, all of the regions show a negative response in real per capita personal income to a one standard deviation shock in the federal funds rate. However, the range on the vertical axis on Figure 4.2 is larger than Figure 4.1. This reflects the impacts of a federal funds rate shock being larger in the first period relative to the whole sample. In period one, the average response has a greater negative value than the whole sample. In addition, the maximum regional response in the Great Lakes is larger in period one. Thus, the entire sample has more moderated responses, while in period one, the responses are sharply negative and do not rebound with the additional quarters of time.

The responses start out with a decline in incomes and each region experiences its maximum decline in real per capita personal income after 12-quarters. Once the regions reach their maximum negative response, the cumulative response functions level out near the maximum decline. For an average region real per capita personal income declines about -$120 at 12-quarters and tapers off around the same amount.

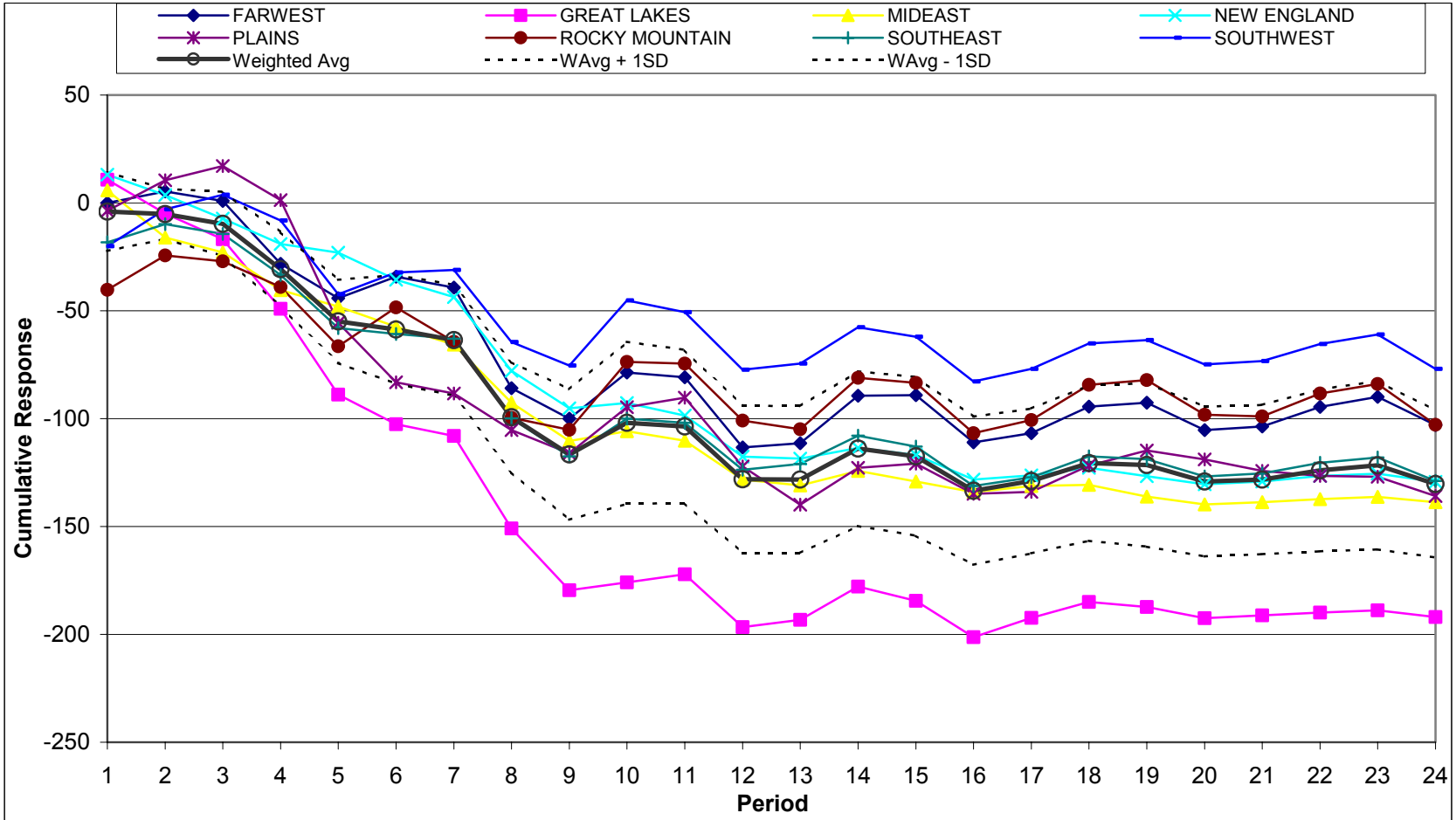

Figure 4.2 Cumulative Responses 1959-1979.

Change in Real Per Capita Income from a One Standard Deviation Change in the Federal Funds Rate.

Note: Dotted line indicates one standard deviation confidence interval on the average response.

The minimum response of -$70 occurred in the Southwest region. Meanwhile, the Great Lakes region experienced the maximum response with real per capita personal income declining by a maximum of -$200 and leveling off near the same value.

The results in Figure 4.2 indicate that regions do respond differently to changes in monetary policy. However, in this sample period, the Great Lakes region was the only region to respond by more than one standard deviation beyond the average in the first period. In this period the Great Lakes region had a response almost twice as large as the average response. This indicates that increase in the federal funds rate had severe and negative impacts on the real per capita personal incomes in the Great Lakes region. Four regions, the New England, Southeast, Plains, and Mideast had cumulative responses that were similar to the average response. However, four other regions had responses that differed from the average response. The Southwest, Far West, and Rocky Mountains all responded less than the average by one standard deviation or more. In each of these regions, a monetary policy shock has less of an impact on real per capita personal income than is felt on average.

Therefore, the results from the 1959 – 1979 period indicate that increases in the federal funds rate have a negative impact on real per capita personal income and the results indicate that regions respond differently to monetary policy shocks. Regions such as the Southwest responded less than the average and other regions such as the Great Lakes responded by more than the average. In the early sample period, monetary shocks had much stronger than average impacts on the Great Lakes

region. However, the results from this period show overall greater responses to monetary policy shocks than the whole sample period.

4.4 Results for the Period 1980 – 2003

The second sub-period is from 1980 – 2003. The cumulative responses for each region are shown in Figure 4.3. The vertical axis differs between Figures 4.3 and the earlier Figures 4.1 and 4.2. Figure 4.3 has a smaller range and the negative values are not as great as the previous figures. Again in this period, all of the regions show a negative response in real per capita personal income after a federal funds rate shock. However, in this period the responses do not have a sharp decline in incomes, but a slower more gradual decline. Each region experiences its maximum decline in real per capita personal income between 10 and 12 quarters. Once the regions reach their maximum negative response, the cumulative response functions increase by a small amount and then they level off.

The responses in this period tend to be smaller than those seen in the whole sample and earlier periods. For the average region, real per capita personal income had a decline of only –$80 and tapered off around -$60. The minimum responses occurred in the Southwest and New England regions. Within the 10 – 12 quarter period, the Southwest region had the minimum response of -$40, while the New England region had the smallest final response at -$40. In the 1980 – 2003 period, the maximum negative response now occurs in the Far West region, which responded with a decline in real per capita personal income of -$120 that leveled off near -$100. The maximum decline no longer occurs in the Great Lakes region, which responds

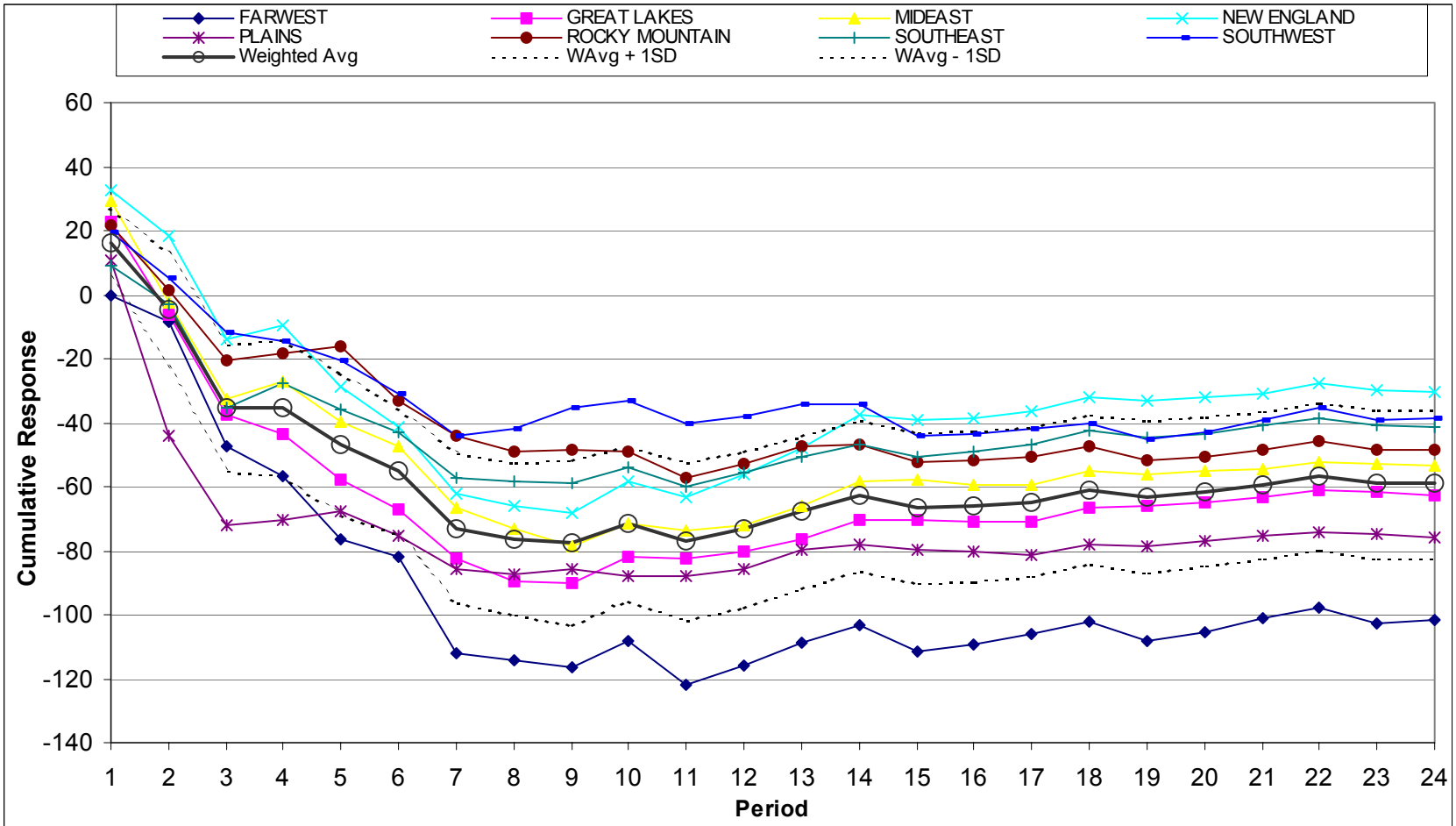

Figure 4.3 Cumulative Responses 1980-2003.

Change in Real Per Capita Income from a One Standard Deviation Change in the Federal Funds Rate.

Note: Dotted line indicates one standard deviation confidence interval on the average response.

closer to average in the later period. This indicates that something might have changed between the two sub-sample periods.

The results in Figure 4.3 continue to indicate that regions do respond differently to changes in monetary policy. However, in this later period, monetary policy shocks appear to affect regions less as shown by the moderated responses. Four regions, the Great Lakes, Southeast, Plains, and Mideast had cumulative responses that were similar to the average response. The most notable of these is the Great Lakes region, which appears to be, affected significantly less from a monetary policy shock in period two. However, four other regions had responses that differed from the average response. Three regions, the Southwest, New England, and Rocky Mountains all responded less than the average by one standard deviation or more. In each of these regions, a monetary policy shock has less of an impact on real per capita personal income then is felt by the average. The other region, the Far West, responded more than the average by one Standard Deviation or more. In this region, monetary policy shocks have a much larger impact on real per capita personal income then the average. The Far West region had maximum response of more than -$120, while the average response was only around -$80. In the later period, interest rate shocks have a larger effect than average on the Far West region. However, much of the relative increase in the Far West response is due to the average being reduced while the Far West response stayed near the first period levels.

To summarize, the results from this period indicate that increases in the federal funds rate cause a negative impact on real per capita personal income and these negative responses differ between regions. Regions such as the Southwest

responded less than the average, while the Far West region responded by more than the average. The results in period two are more gradual and moderated relative to the responses found in period one. Thus, it appears that monetary policy has become less effective overtime. In addition, the results continue to show that monetary policy can have differing impacts on regions of a country.

4.5 Comparisons across Periods

The results from the previous sections indicate that regions respond differently to monetary policy shocks. Results also show that the responses to a federal funds rate shock have changed across periods. In general, the responses for each region tended to be moderated in the second period. Monetary policy in the more recent period has less of an impact on real per capita personal income. In the period from 1959 – 1979, the maximum response by any region occurred around -$200, while the response falls to only -$120 in the period from 1980 – 2003. In addition, the first period average response occurs at -$130, but in the second period the average only reaches about -$80. Both of these results indicate that the regional responses to a rise in the federal funds rate are moderated in the second period.

The standard deviation bands around the average also support these differences across periods. For the first period, the standard deviation band shows a movement less than the average to be -$100. While, in the second period, the standard deviation band around -$100 shows a movement that is greater than the average. Therefore, a response that would be considered small in the first period is actually quite large when compared to the second period. Almost all of the regional

responses in the early period are greater than the one standard deviation confidence band in the later period. Thus, these results indicate that real per capita personal income responses to monetary policy shocks are greater in the 1959 – 1979 period than in the 1980 – 2003 period, such that, a rise in the federal funds rate would reduce real per capita personal incomes by more in the earlier period. In other words, in order to have the same magnitude of impact in period two, the Federal Reserve would have to use a stronger interest rate change in period two than period one.

Figures 4.4 to 4.11 show each individual region's cumulative responses for both periods from 1959 – 1979 and 1980 – 2003. As shown in the earlier sections, all of the regions have a negative cumulative response to a one standard deviation shock in the federal funds rate for both periods. Seven of the eight regions have noticeable differences in their responses between the two periods, in which the responses are moderated in the second period. As the responses for a federal funds rate shock is lessened in most of the regions, the Far West response stays the same. This means that the Far West goes from having a near average response in the first period to having the largest response in the second period. The average response in the 1980 – 2003 period is lessened such that the response in that period for the Far West becomes more than one standard deviation larger than the average. This means that even though the cumulative response for the Far West remains constant, it becomes the most severely impacted region to a monetary policy shock in the second period.

Four of the regions, the Great Lakes, Mideast, New England, and Southeast have very large changes (across periods) in their responses. The responses for each

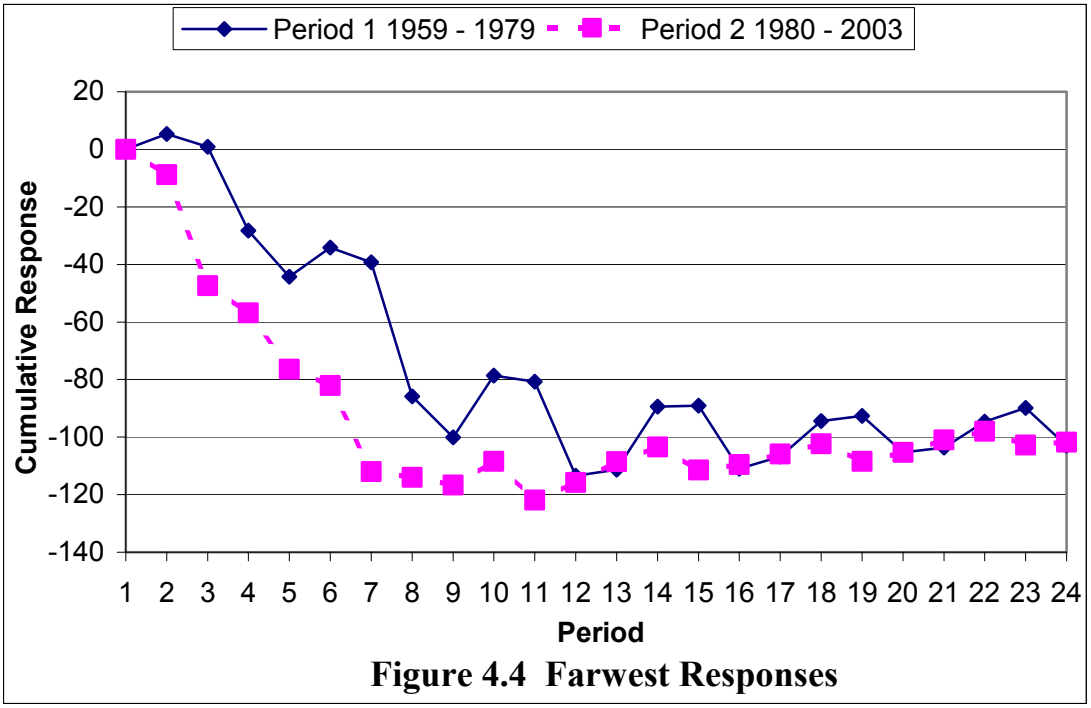

Figure 4.4 Farwest Responses

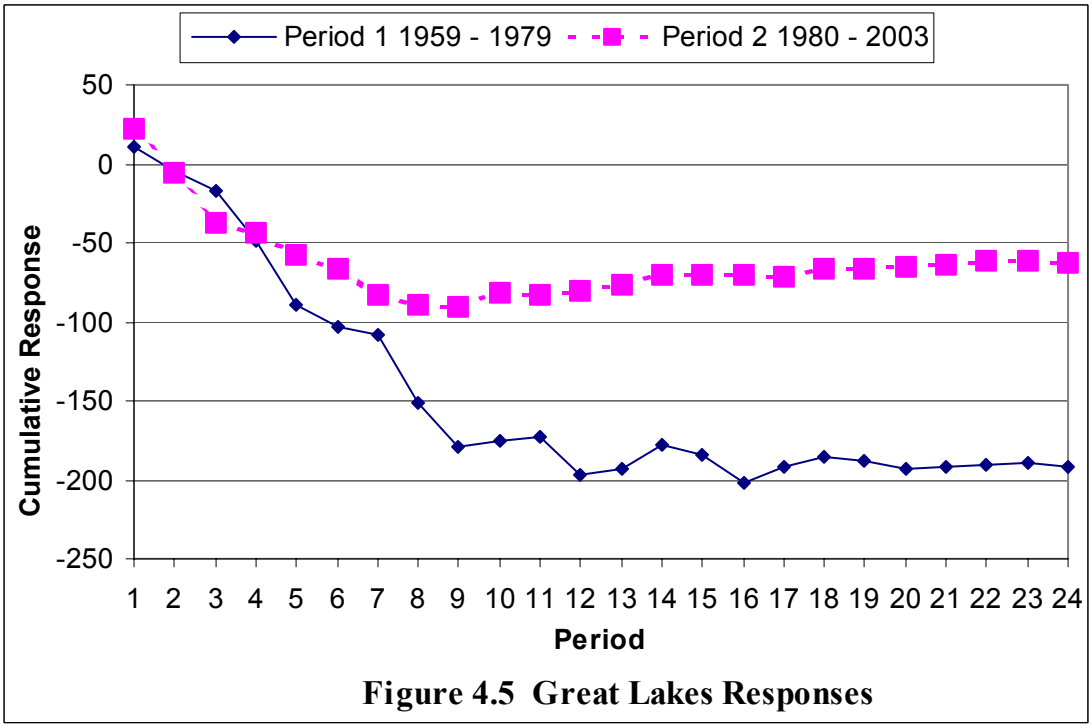

Figure 4.5 Great Lakes Responses

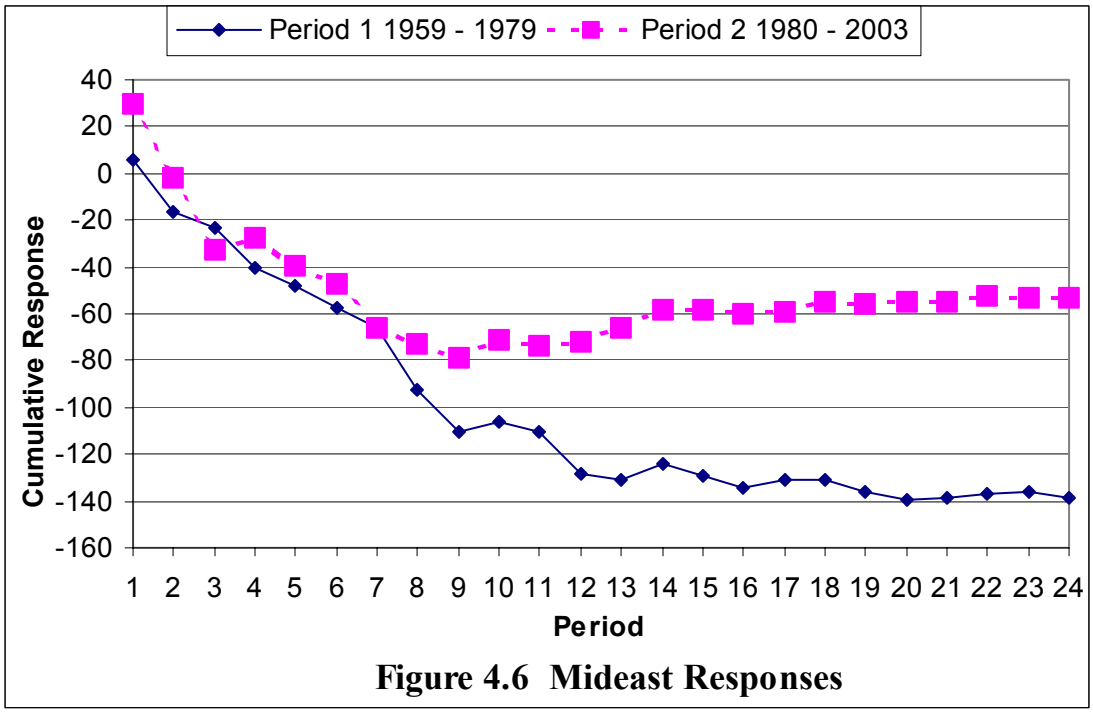

Figure 4.6 Mideast Responses

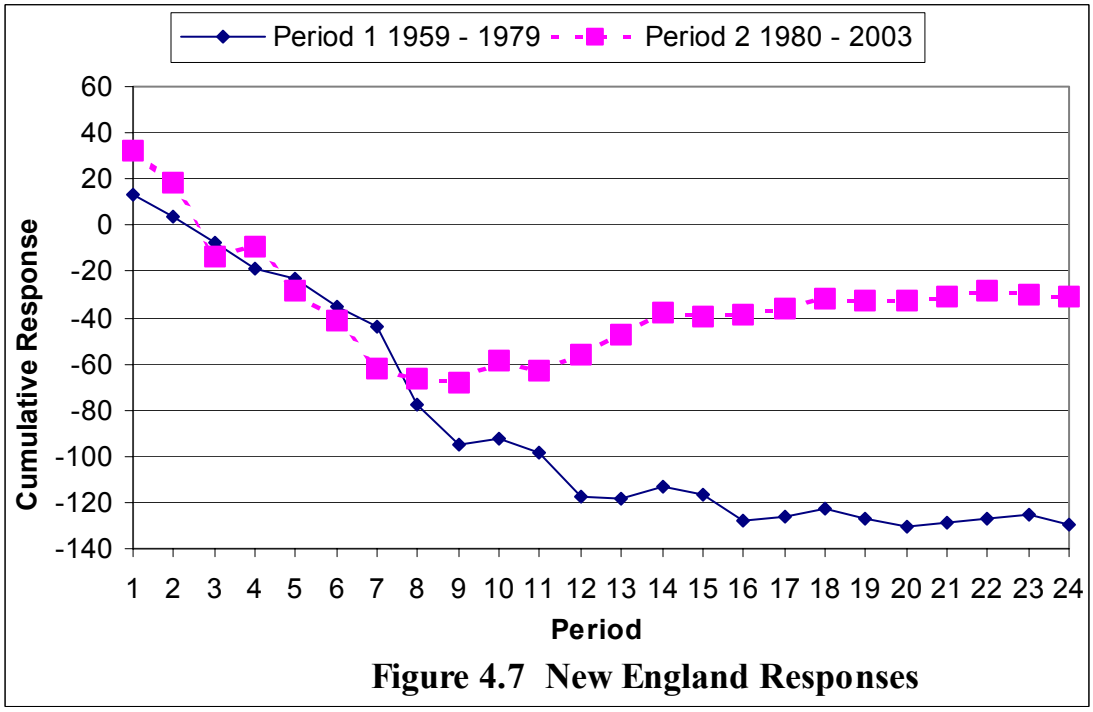

Figure 4.7 New England Responses

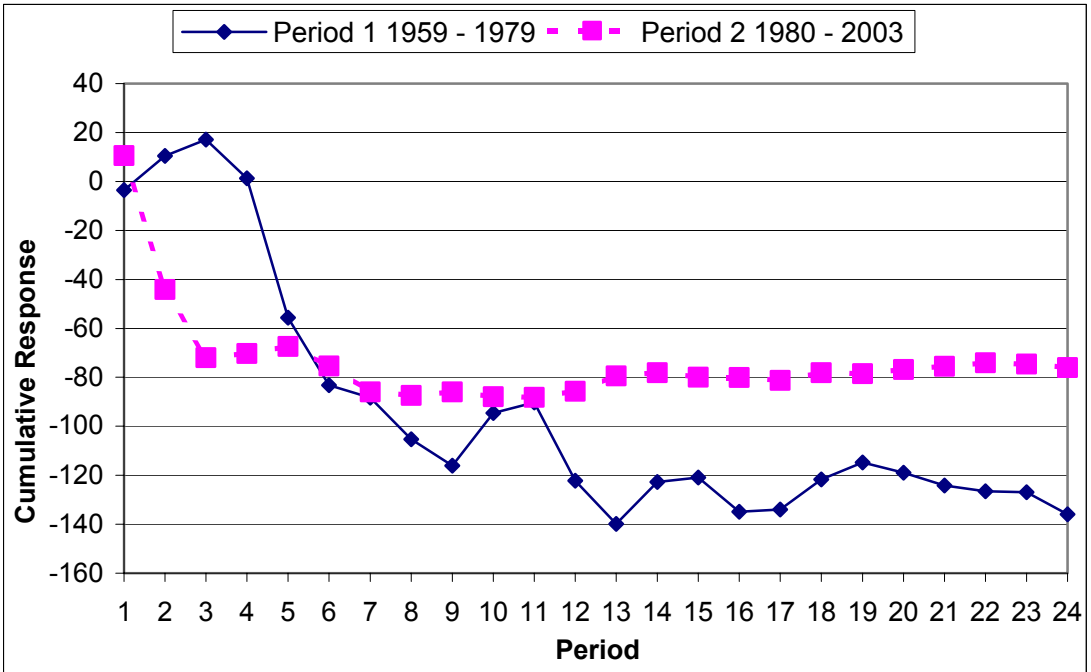

Figure 4.8 Plains Responses

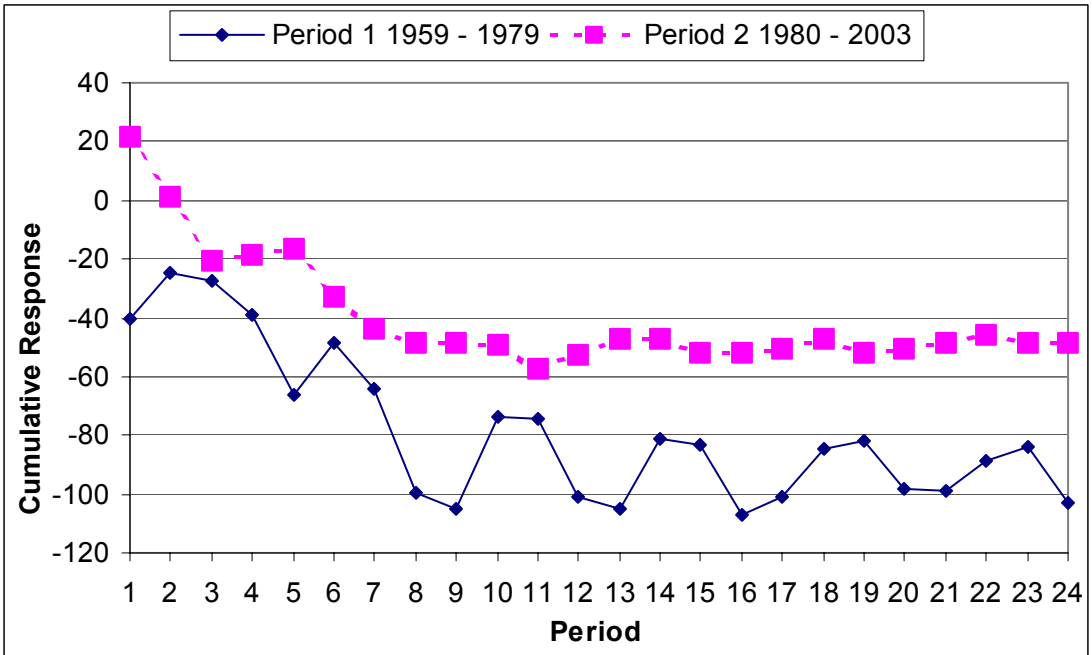

Figure 4.9 Rocky Mountain Responses

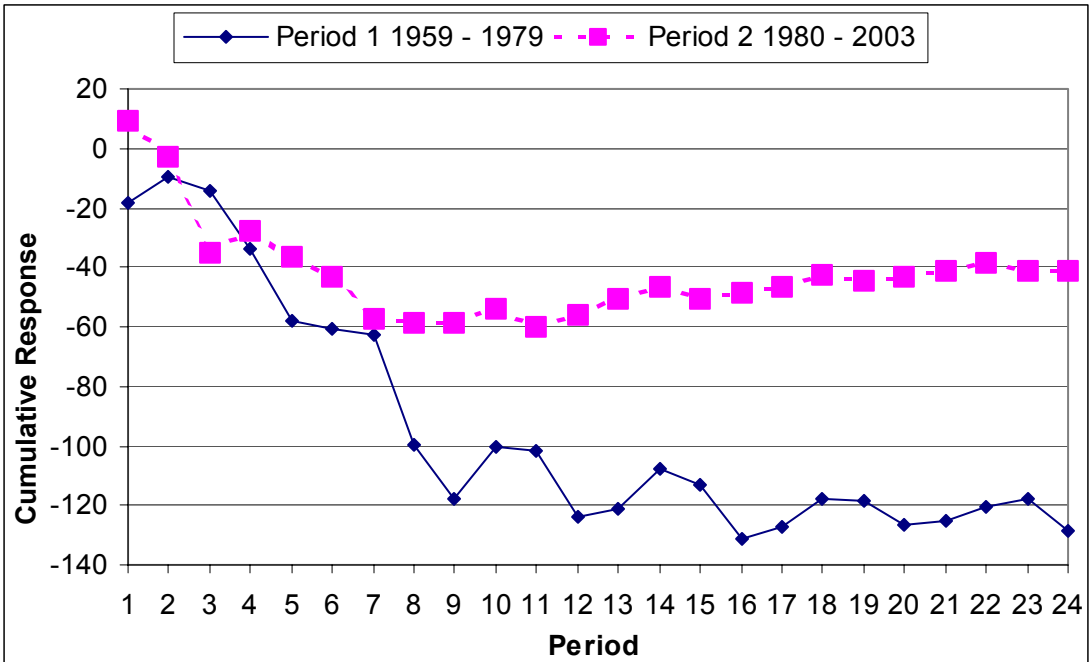

Figure 4.10 Southeast Responses

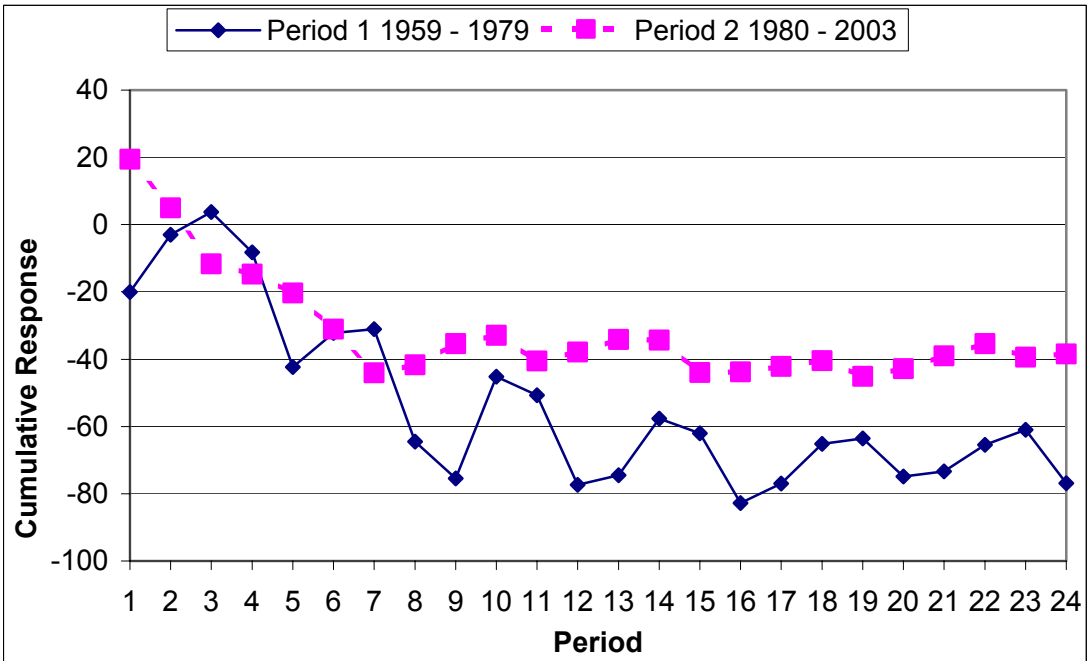

Figure 4.11 Southwest Responses

region were at least twice as large in the first period, as the second period. The regions are affected much less by monetary policy shocks in the second period. Three of the regions, the Plains, Rocky Mountains, and Southwest have a smaller amount of difference in their responses between periods. However, the differences in responses were only about 1.5 times larger in the first period compared to the second period. In addition, the Plains, Rocky Mountains, and Southwest regions had smaller total responses than the average region and therefore, the differences between periods may be muted. The other region, the Far West, had practically no differences in responses to federal funds rate changes between periods. Cumulative responses in both periods reach a maximum near -$120 and level off around -$100. Based on the results, monetary policy should only affect the Far West region the same in both periods. Even though the cumulative responses stay the same for the Far West, its relative position to the other regions changes from the 1959 – 1979 period to the 1980 – 2003 period.

4.6 Summary and Implications

The results from these sections indicate that a rise in the federal funds rate will create a negative impact on real per capita personal income in the regions of the United States. In addition, these impacts differ among the regions. Some regions respond more to a monetary policy shock than other regions. Therefore, the consequences of a change in monetary policy need to be considered for different regions as well as the aggregate economy.

The evidence here indicates notable changes over time in some regions' responses. In general, period two responses are moderated and occur more gradually. From 1959 – 1979 a policy shock would have a large and quick impact on incomes but since 1980 these impacts have been lessened. Responses to a shock in the federal funds rate were much smaller in the sample period from 1980 – 2003 compared to those in the 1959 – 1979 period. The evidence here indicates policymakers need to consider the impacts of policy changes not only across different regions but across time periods as well. With the results indicating changes in responses over time, policymakers need to consider the most recent data and periods when making decisions.

In the current period, to get a desired result, the Federal Reserve may have to move the federal funds rate more than in previous eras. These changes in the economy can be seen by the recent movements in monetary policy. In order to stimulate the economy, the Federal Reserve lowered the federal funds rate to record sustained lows. From 2001 through 2003 the Federal Reserve continued to decrease the federal funds rate to record lows to get the desired change in incomes in the economy. These record lows in the federal funds rate may have been needed to offset the changes that have occurred between earlier periods and the more current period since the 1980s.

Chapter Five

Estimation of State Responses

5.1 Introduction

Chapter four examined regional variation of personal income shocks attributable to changes in the federal funds rate. In this chapter, such variation will be examined across a finer geographical grid, namely states. In this regard, state responses will be regressed against a number of variables selected as proxies for local monetary transmission mechanisms. The goal is to explain as much of the variation in state responses as possible. Table 5.1 shows the 12-quarter cumulative responses for each of the 48 states, as well as the region to which each state belongs. The cumulative responses come from the vector autoregression (VAR) model for states presented in section 3.3. As the table indicates, there are wide differences in the state responses to changes in the federal funds rate, consistent with findings for the BEA regions in chapter four.

In chapter four, cumulative responses were determined for a rise in the federal funds rate. Also, under the VAR methodology (see section 4.1), cumulative responses are symmetric in their interpretation. In this regard, a negative response to a positive one standard deviation shock in the federal funds rate would be reversed in sign for an equivalent negative change in the federal funds rate. With this in mind, the dependent variable (the 12-quarter cumulative response in each state) will be stated in absolute values to make interpretations more straightforward. For

Table 5.1: State 12 Quarter Response (in Absolute Value) by Region

	Period:	(1959 – 2003)	(1959 – 1979)	(1980 – 2003)
Far West:	California	162.472	104.425	146.863
	Nevada	165.640	60.841	84.188
	Oregon	157.113	106.440	105.689
	Washington	139.204	239.903	121.588
	Average	156.107	127.902	114.582
	Standard Deviation	11.806	77.574	26.420
Great Lakes:	Illinois	146.701	215.407	78.609
	Indiana	163.329	165.963	90.994
	Michigan	227.595	411.149	117.984
	Ohio	139.792	105.740	111.865
	Wisconsin	137.049	128.315	55.413
	Average	166.941	202.792	94.064
	Standard Deviation	42.121	141.109	28.239
Mideast:	Delaware	122.524	134.381	92.174
	Maryland	132.439	73.818	75.199
	New Jersey	121.227	148.483	14.220
	New York	133.602	56.805	71.277
	Pennsylvania	120.749	69.680	70.032
	Average	127.004	87.197	57.682
	Standard Deviation	6.966	41.495	29.058
Rocky Mountains:	Colorado	110.131	121.671	80.108
	Idaho	103.530	148.032	73.152
	Montana	51.052	74.171	39.408
	Utah	83.188	69.142	66.878
	Wyoming	146.361	186.220	65.059
	Average	96.033	119.391	61.124
	Standard Deviation	39.906	57.319	14.887
	Southwest:			
	Arizona	126.497	36.168	107.127
	New Mexico	80.972	61.832	52.883
	Oklahoma	27.411	76.191	14.568
	Texas	71.286	94.867	57.558
	Average	76.542	67.265	58.034
	Standard Deviation	40.647	24.753	37.974

Table 5.1: Continued

	Period:	(1959 – 2003)	(1959 – 1979)	(1980 – 2003)
New England:	Connecticut	149.854	113.689	67.989
	Maine	101.203	3.988	60.615
	Massachusetts	128.220	137.499	88.085
	New Hampshire	150.679	135.556	120.739
	Rhode Island	107.431	128.787	61.645
	Vermont	115.997	73.571	43.486
	Average	125.582	118.853	78.489
	Standard Deviation	18.781	30.418	33.596
Plains:	Iowa	118.503	126.291	74.189
	Kansas	99.578	126.364	63.595
	Minnesota	147.540	138.813	96.182
	Missouri	130.295	108.571	104.199
	Nebraska	99.925	87.193	54.442
	North Dakota	71.281	53.917	83.130
	South Dakota	135.250	26.483	133.566
	Average	109.188	69.041	93.834
	Standard Deviation	29.707	36.203	33.428
Southeast:	Alabama	84.686	17.477	68.453
	Arkansas	94.727	98.549	62.045
	Florida	124.232	134.005	46.205
	Georgia	129.822	144.508	132.490
	Kentucky	99.163	91.214	59.300
	Louisiana	22.729	128.514	68.241
	Mississippi	79.268	141.494	40.518
	North Carolina	115.219	19.757	80.821
	South Carolina	103.070	135.647	77.969
	Tennessee	117.568	171.425	91.562
	Virginia	119.563	124.056	58.333
	West Virginia	80.980	92.972	39.981
	Average	105.295	131.025	66.961
	Standard Deviation	17.799	32.404	22.574

convenience to the reader, Appendix C gives the absolute values of each state's response (listed in alphabetical order by state) for each period.

5.2 Variable and Data Specification

Several variables were selected to represent monetary transmission mechanisms at the state level, and are similar to those described in chapter two. These variables will be employed to examine variation in state real per capita personal income responses to the federal funds rate. As noted above, the dependent variable is the 12-quarter cumulative response for each of the 48 contiguous states.[8] The 12-quarter response duration was chosen to capture impacts at or near the maximum level of the response function.[9] In this regard, the dependent variable describes how each state's real per capita personal income responds to a one standard deviation change in the federal funds rate. On the other hand, the independent variables represent potential local channels through which national monetary policy operates. Three monetary transmission channels are examined, and include the interest rate channel, two potential credit channel variables, and two potential consumption channel variables. This will provide for additional potential transmission mechanisms beyond those used in Carlino and Defina. Table 5.2 provides a list of the variables that are used in the estimation with a description, listed below, to relate each variable to a potential transmission mechanism.

[8] The equation estimated for each state is listed in the econometrics section in chapter three.
[9] The results of the estimation are robust against different quarters chosen for the response value.

Table 5.2: Variable Representation

Variable	Definition
State	The State Cumulative Response at 12-quarters
Firm	Percentage of a State's Employment that is Accounted for by Small Firms. (Firms with less than 250 employees)
Man	Percentage of State Gross Product that is Accounted for by Manufacturing.
Tax	The Tax Burden in each State. The tax burden comes from the total amount of state and local taxes in a state.
Urban	Percentage of a State's Population that is Urban
Loan	The Average Total Loans per Bank in each State. Calculated by taking totals loans by commercial banks divided by the total number of institutions in each state.
C	Constant
FW	Dummy Variable to represent the Far West Region. FW = O if the state is not in the region and FW = 1 if the state is in the region
GL	Dummy Variable to represent the Great Lakes Region. GL = O if the state is not in the region and GL = 1 if the state is in the region
ME	Dummy Variable to represent the Mideast Region. ME = O if the state is not in the region and ME = 1 if the state is in the region
NE	Dummy Variable to represent the New England Region. NE = O if the state is not in the region and NE = 1 if the state is in the region
PL	Dummy Variable to represent the Plains Region. PL = O if the state is not in the region and PL = 1 if the state is in the region
RM	Dummy Variable to represent the Rocky Mountains Region. RM = O if the state is not in the region and RM = 1 if the state is in the region
SW	Dummy Variable to represent the Southwest Region. SW = O if the state is not in the region and SW = 1 if the state is in the region
SE	Dummy Variable to represent the Southeast Region. SE = O if the state is not in the region and SE = 1 if the state is in the region

The first variable included is the percentage of gross state product (GSP) that is accounted for by the manufacturing sector. This variable is used to capture the potential interest rate channel. The manufacturing sector tends to be very interest rate sensitive.[10] As interest rates increase, manufacturing activity in the economy decreases. Therefore, the amount of output and employment in the manufacturing sector will decrease. By including the percentage of GSP accounted for by manufacturing, this interest rate sensitivity should be captured. In this regard, as the local presence of manufacturing increases, one would expect the state to become more sensitive to interest rate movements. Therefore, the state cumulative income responses should be a positive function of the percent manufacturing in a state's GSP.[11] Past work by Carlino and Defina (1998a, 1998b, 1999a, 1999b) found this variable to be positive and significant in their estimations.

Two other variables are included to account for credit channel mechanisms: the percentage of total state employment accounted for by small firms and average loans per bank in each state. In the credit channel, the ability to borrow and lend funds should become more difficult as the cost of funds increase. The first variable represents the firm's ability to acquire funds. As interest rates rise, the cost of funds to many firms may increase and/or the sources of such funds may become limited. Meanwhile, other firms may have greater access to such funds, and thus not feel as burdened.[12] Generally, smaller firms have fewer credit options than larger firms, and

[10] Haimowitz (1996) and Chiodo and Owyang (2003)
[11] Recall the symmetrical property of the VAR estimation is being used in this chapter. Therefore, the sign interpretation, of state personal income responses, is now positive in chapter five.
[12] For example see Gertler and Gilchrist (1994)

as a consequence should feel greater burden when interest rates rise. To account for this type of credit channel, the percent of state employment accounted for by small firms (under 250 employees) is included.[13] If small firms have a more difficult time acquiring necessary funds as interest rates increase, then the incomes in states with larger shares of small firms may see a greater impact. Therefore, some of the difference in state responses to the federal funds rate may be attributed to the local relative presence of small firms.

The other credit channel variable, the average total loans per bank in each state, will examine the bank-lending channel in the economy. Many papers, for example Bernanke and Blinder (1992) and Romer and Romer (1990), provide evidence of a monetary transmission mechanism that works through the ability of banks to make loans. Some banks may have a greater ability to generate deposits and continue to make loans in the presence of higher interest rates. Typically, larger banks tend to have more access to deposit sources than small banks. As interest rates increase, larger banks are able to use a variety of sources to maintain deposits and continue to make loans. On the other hand, smaller banks may see additional deposits dry up, and thus must curtail additional lending. Local enterprises that rely solely on bank loans will experience greater difficulty in acquiring funds from smaller banks. Therefore, states with a greater presence of smaller banks are likely more responsive to interest rate movements. In turn, as the federal funds rate increases, the cumulative income response in such states would be greater than in otherwise equivalent states

[13] This variable was also included in Carlino and Defina's estimation.

characterized by larger banks. In order to capture these effects, the amount of total loans made by commercial banks divided by the total number of commercial banks in each state will be included in the estimation. As the average loans per bank increase, so does the implied proportion of larger banks. Thus, as the federal funds rate increases, states with higher average loans per bank should experience smaller responses in real per capita personal income.

The last monetary transmission mechanism is the consumption channel. In this channel, changes in monetary policy or interest rates affect the level of household consumption. In this regard, when interest rates increase, personal consumption decreases for two reasons. In the first, termed the wealth effect, household wealth is decreased through a reduction in asset values. When wealth decreases people have less paper wealth, and consequently reduce their consumption. Under the second reason (the general interest rate channel), the cost of funds rise with the interest rate, and thus people spend less on consumption, particularly consumer durables.

To capture potential consumption mechanisms, an urban population variable will be included in the estimation. The variable will measure the percentage of a state's population that is urban. Urban areas tend to have higher consumption and more spending relative to rural areas. If a state has a higher percentage of urban areas, income in that state should experience a greater effect from reductions in consumption. Therefore, if a consumption channel exists, an increase in the federal funds rate should cause a greater negative response to real per capita personal incomes in states that are more urbanized. Either through the wealth or general

interest rate effects, consumption, and ultimately, incomes should be impacted more in states characterized by greater urbanization.

Another variable representing the consumption channel is the state tax burden. All else held constant, disposable income should decrease with higher levels of state and local taxation. As more income is applied to taxes, people have less income to allocate between consumption and savings bundles. When interest rates increase, one expects individuals with less disposable income, from the higher taxes, to experience greater difficulty offsetting higher interest, as well as interest-induced, costs out of current consumption and/or savings. Consequently, states with a higher tax burden should be more responsive to increases in the federal funds rate.

The data for this analysis are drawn from a variety of sources. The dependent variable (12-quarter cumulative income response) is determined from the VAR estimation on each state. For the independent variables, the data was obtained from the Bureau of Economic Analysis, the US Census Bureau, the Federal Deposit Insurance Corporation, and the Tax Foundation. The tables in Appendix B provide the source for each variable as well as their average values across each time period under investigation. A quick examination of these tables indicates that characteristics (independent variables) vary greatly among states. For example, the percent of GSP accounted for by manufacturing (Table B.1) ranges from a low of less than 5% to a high of greater than 30%. Given this and other variation in determining variables, one would expect states to vary somewhat in their response to federal funds rate shocks. Finally, notice in Appendix B that averages are based upon the available data, and consequently differ in the years used to compute the averages.

5.3 Model Specification

The state-level model discussed above will be estimated by Ordinary Least Squares (OLS) Regression. OLS methods are appropriate here, since the data used in this estimation (which are now cross section data) will not suffer from the non-stationary problems seen in the earlier time series data. In the OLS model, the dependent variable is linearly regressed against the set of independent variables. The dependent variable is the state cumulative income response at 12-quarters whereas the list of independent variables appear in Table 5.2. The general model to be estimated is:

$$State = C + ß_1Firm + ß_2Man + ß_3Tax + ß_4Urban + ß_5Loan + error \quad \ldots 5.1$$

In addition, to account for the possibility of omitted determining factors that vary spatially, the model will also be estimated with regional dummy variables. These variables are set to zero or one depending on whether or not a specific state appears in a given BEA region. Correspondence between states and BEA regions is provided in Appendix A. If the state is in a given region, then the value of the dummy variable is set to unity (and to zero otherwise). Such variables should capture regional effects not otherwise controlled by the state-level independent variables. In the model, dummy variables are included for seven of the eight regions, with the eighth BEA region (Southeast) excluded. With this in mind, the second model to be estimated is:

$$State = C + ß_1Firm + ß_2Man + ß_3Tax + ß_4Urban + ß_5Loan + ß_6FW + \ldots + ß_{12}SW + error \quad \ldots 5.2$$

where FW, SW, etc. are the BEA regions delineated in Appendix A. Each of the two

models was estimated for all three sample periods: 1959 – 2003, 1959 – 1979, and 1980 – 2003.[14]

5.4 Results

The previous sections identify potential ways in which monetary policy actions could affect states differently. Here, each of the factors will be evaluated to identify whether it can account for differing state responses. To conduct this assessment, the absolute values of the state responses (taken at 12 quarters) are regressed against the independent variable, which represents different state characteristics. These results should identify the potential monetary transmission channels causing the differences in state cumulative responses.

The results are presented for each of the two sub-sample periods as well as the entire sample. In addition, the results will be shown for two model specifications to account for the potential differences in state responses not captured by the transmission mechanism variables. In this regard, Model 1 excludes regional dummy variables, while Model 2 includes regional dummy variables to control for potential regional factors not captured in the chosen independent variables. In the later model, the Southeast region is excluded.

Table 5.3 presents the results for the entire sample period. Since the variables in this period are averaged over 40 years, some the results may be muted. For the first model, with only the independent state characteristics, the tax burden and percent

[14] The model was run with the White heteroskedasticity correction. (EVIEWS, version 4) Based upon the correlation coefficients, multicollinearity does not appear to be a problem within either model or time period.

Table 5.3: OLS Results for the Entire Sample Period (1959 – 2003)

	Model 1		Model 2	
Variable (Abbreviation)	Coefficient	t-statistic	Coefficient	t-statistic
Firm	-80.956	-0.993	-57.257	-1.056
Manufacturing (Man)	161.409	1.409	60.726	0.767
Tax	980.738	2.036**	277.097	0.614
Urban	84.827	2.66***	45.568	1.14
Loan	-1.12E-05	-1.77*	-4.68E-06	-0.554
Far West (FW)			48.317	2.695***
Great Lakes (GL)			48.064	2.294**
Mideast (ME)			17.855	1.093
New England (NE)			22.751	1.391
Plains (PL)			17.935	1.168
Rocky Mountains (RM)			4.792	0.225
Southwest (SW)			-23.266	-0.903
Constant (C)	-11.681	-0.11	71.196	0.925
Adjusted R^2	0.221		0.372	

***Test significant at the 1% level **Test significant at the 5% level *Test significant at the 10% level

urban variables both have positive and significant impacts. As these variables rise in value, the response from a federal funds rate shock will increase. The signs on both of the variables match the predicted effects in section 5.2. However, none of the other variables in the estimation had significant coefficients.

When the regional dummy variables are included in the model (model 2), the significance of the tax burden and percent urban variables disappear. In this model, no state transmission mechanism variable has a significant impact on the state responses. However, two of the regional dummy variables (the Great Lakes and Far West) are significant in model 2. This indicates that there are state characteristic differences not captured by the continuous transmission mechanism variables. It is important to remember that the variables are averaged over a long period, and thus

they may not represent state characteristics very well. Therefore, it is even more important to break the entire sample into the two sub-sample periods.

As was shown in chapter four, a one standard deviation shock to the federal funds rate creates differences in responses, not only across regions, but also over different time periods. Due to these differing effects across time, the sample is bifurcated into two sub-samples. The results for the first sub-sample period (1959 - 1979) are shown in Table 5.4. In the first model specification, three variables have significant impacts: the percent of a state's GSP accounted for by manufacturing, the percent of a state's population that is urban, and the average total loan size. This indicates that states with higher percentages manufacturing and urban populations will be more interest rate sensitive. Therefore, as the percentages of these variables rise, a state's response to a federal funds rate shock will increase. The average total loans variable had a negative sign indicating that the responses will become smaller as a state's average total loans rise. This suggests that as the number of larger banks increase in a state, the state will become less sensitive to monetary policy changes, because larger banks likely have more ways to adjust to changes in interest rates. This effect demonstrates the large bank versus small bank issue in the credit channel.

For the first sub-period, when the regional dummy variables are included (model 2), two of the independent variables (the percent urban and the average total loans) remain significant above the 90% confidence level. The significance of the percent of manufacturing in GSP falls slightly below the 90% confidence level, but the results still suggest that this variable could have important impacts. The signs on the variables remain consistent with model 1 and therefore the results for the 60s and

Table 5.4: OLS Results for Sample Period 1 (1959 – 1979)

	Model 1		Model 2	
Variable (Abbreviation)	Coefficient	t-statistic	Coefficient	t-statistic
Firm	-34.059	-0.39	22.619	0.188
Manufacturing (Man)	239.286	2.088**	252.254	1.465
Tax	879.7	1.012	943.908	0.782
Urban	180.182	3.053***	183.884	2.978***
Loan	-0.000353	-2.652***	-0.000029	-2.004**
Far West (FW)			19.278	0.478
Great Lakes (GL)			37.51	0.668
Mideast (ME)			-39.085	-1.503
New England (NE)			-42.124	-1.178
Plains (PL)			-17.195	-0.874
Rocky Mountains (RM)			9.314	0.264
Southwest (SW)			-37.3365	-2.085**
Constant (C)	-100.008	-0.995	-142.616	-0.742
Adjusted R^2	0.157		0.187	

***Test significant at the 1% level **Test significant at the 5% level

70s are consistent with the theory (above) pertinent to local mechanisms. In this regard, states with less interest rate sensitive characteristics and larger banks demonstrate smaller responses to national monetary policy (increased federal funds rate). It is also noted that the Southwest regional dummy variable was significant and had a negative sign. Thus, states in the Southwest were less responsive to federal funds rate shocks than were other regions due to region specific characteristics.

The results for the second sub-period (1980 – 2003) are presented in Table 5.5. In this period, none of the state characteristic variables are significant in either of the model specifications. However, in model 2, the Far West and Plains regional dummy variables are significant. This indicates that there may be regional characteristics creating differences in responses, and that such effects dominate state specific independent variables included in the models. Therefore, the results again

Table 5.5: OLS Results for Sample Period 2 (1980 – 2003)

	Model 1		Model 2	
Variable (Abbreviation)	Coefficient	t-statistic	Coefficient	t-statistic
Firm	-100.476	-1.301	-103.106	-1.602
Manufacturing (Man)	52.534	0.583	86.093	0.932
Tax	-88.118	-0.178	-651.681	-1.276
Urban	21.025	0.514	-15.793	-0.312
Loan	-6.13E-07	-0.16	5.72E-06	0.933
Far West (FW)			67.476	2.583***
Great Lakes (GL)			31.323	1.452
Mideast (ME)			14.13	0.563
New England (NE)			21.593	1.091
Plains (PL)			43.829	1.96**
Rocky Mountains (RM)			33.575	1.302
Southwest (SW)			9.085	0.24
Constant (C)	124.3	1.179	175.388	1.741*
Adjusted R^2	0.0323		0.094	

***Test significant at the 1% level **Test significant at the 5% level

demonstrate that the second period has very different responses than the first, and that the monetary transmission mechanisms may no longer operate the same as they did in the earlier period.[15]

Also, the state responses are very different between the two sub-sample periods (values are provided in Appendix C). In these periods, the values of the second period responses are smaller and the variation between state responses is not as great as the earlier period. The average response and standard deviation for the states are 113.54 and 65.02, respectively, in period one. However, in period two, the average and standard deviations fall to 76.47 and 28.79, respectively. In addition, the range between the largest and smallest response narrows notably across periods (407

[15] For example, Walsh (2003) indicates that evolution in financial markets, through the credit channel, can change the way in which monetary policy affects the economy.

in the first period and only 133 in the second period). The state responses indicate that the impacts from a federal funds rate shock are much smaller and create much less variation in the second sub-sample period. Therefore, characteristics that act as transmission mechanisms have the potential of changing over time. This again indicates the importance for policymakers to examine the current period relationships instead of viewing long sample period relationships.

Appendix D provides the results of an estimation of the above models using interaction variables. In this type of estimation, the two sub-samples are combined and are estimated together using a dummy variable to represent the different periods. In Table D.1, the first part of the table shows the results for the first period. Note that these coefficient results are the same as those found in Table 5.4, for the second model specification. The second part of Table D.1 lists the variables in the interaction form, in which the results are adjusted for the second sub-sample. The benefit of this model is that if any of the interaction variables are significant, then the estimates on that characteristic must vary between the two time periods. Three of the interaction variables' (the percent of a state's population that is urban, average total loans, and the Plains regional variable) coefficients are significant at 95 percent or better. From this, it is shown that the period two results are statistically different from the results found in period one.

5.5 Summary and Implications

The results from the previous sections examine the potential transmission mechanisms for monetary policy. Of the mechanisms examined, the percent of gross

state product accounted for by manufacturing, the percent of a state that is urban, and the average total loan size by banks appear to be the mechanisms most conducive for monetary policy to affect the economy. These variables raise a state's interest rate sensitivity and make a state more vulnerable to monetary policy shocks. The results also support the conclusion from chapter four, which showed that the impacts from monetary policy have changed significantly over time. The transmission mechanisms and channels for federal funds rate shocks appear to have changed across periods. This was supported with the interaction variables used to test the significance of explanatory variables across time.

Results from the first period indicate the chosen transmission mechanism variables perform well in explaining the causes of the cumulative responses. All three of the mechanisms discussed above had significant effects in the model. However, in the second sub-period, none of the transmission mechanism variables had significant values. Only the regional dummy variables had significant explanatory power. This indicates that the path monetary policy takes to affect the economy has shifted from period one to period two.

These results support several monetary policy implications. In this regard, policymakers need to focus on current data trends and more recent models. By using older data or data averaged over long periods, the true relationships among variables may not be captured. In addition, the types of transmission mechanisms may have changed. Older models and explanations of the path money travels through the economy may not be accurate. If a policymaker solely examines older models, estimation results may be incorrect and lead to faulty policy decisions. Also, research

needs to address recent trends in the economy. Based on the results from the previous sections, future research projects should continue to examine new and potentially different monetary transmission mechanisms. Thus, standard or traditional models may need to be updated with the discovery of new monetary channels.

Chapter Six

Summary and Conclusions

Monetary policy and its impacts are important issues in many macroeconomic models. The way in which money affects the economy has been at the heart of many debates in macroeconomics. Several studies, such as Gali (1992) and many others, have shown that monetary policy can lead to effects on real variables in the economy. The previous studies examine the impacts of money in the aggregate economy but miss effects on regional economic activity. However, in an economy as large and diverse as the United States, the aggregate effects of monetary policy may not represent the outcomes occurring in different regions. Aggregate effects may be dominated by one region and if policymakers only examine aggregate data, then the true consequences of policy may be misrepresented. In addition, the impacts that occur may not be stable over time as the economy grows and advances.

The current literature on the differing affects monetary policy has on regions is very limited. One of the objectives of this research was to add a significant amount of information to this literature. Carlino and Defina (1998a, 1998b, 1999a, 1999b) provide much of the current literature on this topic. They estimated regional affects from monetary policy using the structural vector autoregression (VAR). In their papers they found that monetary policy had differing impacts across regions in the economy. By using the federal funds rate as the monetary policy variable, if the

federal funds rate was raised, then the incomes of regions would decrease, although the magnitudes of these shocks were very different between regions.

The VAR methodology is the appropriate technique to use since there is a lack of consensus on how to appropriately model the economy. While Carlino and Defina used a structural VAR, this paper used an unrestricted VAR that allows for estimation without imposing exogenous assumptions. Instead of imposing a large amount of structure on the model, the VAR lets each variable be endogenous. In addition, the VAR corrects problems that can occur with time series data, such as spurious correlation problems when using ordinary least squares estimation. By using VAR estimation, the impacts monetary policy has on the economy can be traced using dynamic impulse response functions. Thereby, the results are traced out over a number of periods showing the affects on different regions of the economy.

The results from the estimation were shown for a one standard deviation rise in the federal funds rate. As the federal funds rates increased, the real per capita personal income in the regions decreased. In addition, the results supported those found by Carlino and Defina by showing that regions differed in their responses to a monetary policy shock. Some regions, such as the Great Lakes, responded more than other regions, like the Southwest. This indicates that the average response may not represent all regions in the economy equally well. A policy designed to change the aggregate economy may impact one region by a large amount, while impacting most regions by a small amount. Therefore, the aggregate economy response, shown by a combined averaged effect, may show a result consistent with the goals of the policy. This would give a false impression that the whole economy changed, while in reality,

most of the economy remained the same with one region bearing the weight of a policy decision.

The results found in Carlino and Defina and supported by the whole sample results in this study, show the negative impacts from an increase in the federal funds rate. However, these impacts may not be stable over time and could change as the economy expands. This issue is taken up by splitting the whole sample into two sub-samples. This study also shows results for the impulse responses that occur in an early and later period with the split occurring at 1980, while earlier papers fail to examine the potential differences across periods. The results indicated that monetary policy not only has impacts that are different across regions, but these impacts are also different across periods. In period one (1959 – 1979), the responses from a shock were very large and had a magnitude much larger then the whole sample. Meanwhile, the period two (1980 – 2003) responses were moderated and much less then the whole sample period. These results show that monetary policy no longer has the same types of impacts as it once did. In order to move the economy to a desired level, a policymaker would now need to change a policy tool by a larger amount than in the past, since a bigger shock would be needed to get the same type of impact. Therefore, the results indicate that policymakers should examine impacts based on the most current period data instead of only longer-term data sets because the implications may not be correct or muted from the length of the data set.

Besides examing the impacts from a monetary policy shock, this study examined the potential transmission mechanisms that money may use to create the responses previously found. The transmission mechanisms are the paths used to

move monetary shocks through the economy. The results from estimating the transmission mechanisms imply that the impacts of monetary policy differ across periods. This again shows the importance of using current data to examine effects in the economy because the consequences of monetary shocks are not stable over time. The results from the period one estimation show that the three most important mechanisms were the percent of gross state product accounted for by manufacturing, the percent of a state that was urban, and the average size of bank loans in a state. These variables could make a state more interest rate sensitive, and thus more vulnerable to monetary policy shocks. However, the transmission mechanisms may have changed over time because the only variables significant in period two were the regional dummy variables. None of the chosen transmission mechanisms variables were significant in this period. These results indicate that the traditional channels may no longer be operative or they may have changed. With the expansion and innovation in the financial markets, the paths money takes through the economy may not be what they once were. It is important that policymakers recognize these changes so they can gain a better understanding on how their policies move through and affect the economy.

The evidence provided here points to the difficulties faced in a large and ever changing economy. Policymakers need to be aware of the impacts of policies, not only on the aggregate economy, but on different regions of the economy as well. A policy designed to help the whole economy may in fact have little effect on most of the economy while impacting one particular region by a large amount. In addition, with the economy constantly changing, policymakers need to keep up with the most

recent trends, data, and models. Early period results matched up well with predictions from older established economic models, in which, interest rate shocks should have fairly strong negative impacts in the economy by moving through the most interest sensitive parts of the economy. Since more recent data suggest that the economy has changed significantly, and monetary policy shocks no longer have the same quick and powerful impacts, policy may have to be stronger in magnitude in order to move the economy in the desired direction. In summary, regional economies demonstrate very different responses to monetary policy; therefore it is important to examine regional effects from policy in addition to the aggregate economy.

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Appendices

Appendix A

Definitions of Regions

New England
Connecticut
Maine
Massachusetts
New Hampshire
Rhode Island
Vermont

Mideast
Delaware
Maryland
New Jersey
New York
Pennsylvania

Great Lakes
Illinois
Indiana
Michigan
Ohio
Wisconsin

Plains
Iowa
Kansas
Minnesota
Missouri
Nebraska
North Dakota
South Dakota

Southeast
Alabama
Arkansas
Florida
Georgia
Kentucky
Louisiana
Mississippi
North Carolina
South Carolina
Tennessee
Virginia
West Virginia

Southwest
Arizona
New Mexico
Oklahoma
Texas

Rocky Mountains
Colorado
Idaho
Montana
Utah
Wyoming

Far West
California
Nevada
Oregon
Washington

Appendix B

Table B.1: Percent of Gross State Product Accounted for by Manufacturing

	Averaged from (1977 - 2001)	Averaged from (1977 - 1980)	Averaged from (1980 - 2001)
Alabama	22.9%	25.4%	22.6%
Arizona	14.0%	13.7%	14.0%
Arkansas	24.2%	25.1%	24.0%
California	15.5%	18.0%	15.2%
Colorado	12.4%	14.0%	12.2%
Connecticut	21.7%	29.6%	20.7%
Delaware	25.5%	35.0%	24.1%
Florida	9.3%	10.8%	9.1%
Georgia	19.5%	22.7%	19.1%
Idaho	18.3%	17.8%	18.3%
Illinois	20.3%	26.3%	19.4%
Indiana	31.8%	35.7%	31.2%
Iowa	24.4%	25.3%	24.3%
Kansas	18.3%	19.5%	18.1%
Kentucky	27.2%	28.7%	26.9%
Louisiana	15.2%	15.6%	15.1%
Maine	20.0%	24.2%	19.4%
Maryland	10.7%	15.1%	10.1%
Massachusetts	19.6%	25.7%	18.8%
Michigan	30.5%	36.0%	29.5%
Minnesota	20.8%	21.7%	20.6%
Mississippi	23.3%	24.2%	23.1%
Missouri	21.7%	24.0%	21.3%
Montana	8.0%	9.8%	7.6%
Nebraska	14.3%	14.4%	14.3%
Nevada	4.5%	5.1%	4.4%
New Hampshire	24.1%	29.6%	23.4%
New Jersey	18.4%	25.9%	17.4%
New Mexico	10.3%	5.6%	10.9%
New York	14.5%	19.7%	13.7%
North Carolina	29.4%	33.2%	28.8%
North Dakota	6.6%	5.4%	6.7%
Ohio	29.2%	34.5%	28.3%
Oklahoma	16.0%	15.0%	16.2%
Oregon	22.3%	24.5%	21.9%
Pennsylvania	22.5%	28.9%	21.6%
Rhode Island	21.0%	29.2%	19.8%

Table B.1: Continued

	Averaged from (1977 - 2001)	Averaged from (1977 - 1980)	Averaged from (1980 - 2001)
South Carolina	26.6%	30.6%	26.0%
South Dakota	10.9%	8.8%	11.3%
Tennessee	24.3%	27.2%	23.9%
Texas	15.1%	17.6%	14.8%
Utah	14.4%	14.9%	14.3%
Vermont	21.1%	24.8%	20.7%
Virginia	16.3%	19.4%	15.8%
Washington	15.8%	18.7%	15.4%
West Virginia	17.3%	20.7%	16.7%
Wisconsin	28.9%	32.4%	28.4%
Wyoming	4.7%	4.8%	4.6%
Average	18.8%	21.6%	18.4%
Standard Deviation	6.8	8.6	6.6

Source: Bureau of Economic Analysis

Table B.2: Share of Total State Employment Accounted for by a State's Small Firms

	Averaged from (1977 - 2001)	Averaged from (1977 - 1980)	Averaged from (1980 - 2001)
Alabama	63.0%	62.3%	63.1%
Arizona	67.1%	67.6%	66.9%
Arkansas	66.1%	68.3%	65.8%
California	48.2%	44.2%	49.3%
Colorado	68.1%	67.3%	68.2%
Connecticut	58.9%	54.1%	59.5%
Delaware	52.0%	47.6%	52.6%
Florida	71.8%	73.9%	71.5%
Georgia	65.0%	64.8%	65.1%
Idaho	70.0%	71.8%	69.7%
Illinois	59.1%	57.1%	59.4%
Indiana	58.5%	52.5%	59.3%
Iowa	65.2%	64.1%	65.3%
Kansas	68.2%	68.8%	68.1%
Kentucky	64.3%	62.4%	64.6%
Louisiana	68.0%	66.7%	68.2%
Maine	66.2%	64.5%	66.3%

Table B.2: Continued

	Averaged from (1977 - 2001)	Averaged from (1977 - 1980)	Averaged from (1980 - 2001)
Maryland	66.4%	63.5%	66.8%
Massachusetts	59.9%	58.2%	60.1%
Michigan	56.6%	50.4%	57.5%
Minnesota	61.8%	63.0%	61.7%
Mississippi	66.5%	66.9%	66.5%
Missouri	61.9%	61.0%	62.0%
Montana	84.6%	81.6%	84.9%
Nebraska	68.0%	71.0%	67.6%
Nevada	60.6%	61.7%	60.3%
New Hampshire	68.5%	65.7%	68.8%
New Jersey	64.3%	64.0%	64.4%
New Mexico	74.0%	73.7%	74.1%
New York	52.6%	51.1%	52.5%
North Carolina	60.7%	58.5%	61.0%
North Dakota	81.8%	87.7%	81.0%
Ohio	59.3%	54.0%	60.1%
Oklahoma	69.2%	68.5%	69.2%
Oregon	73.0%	74.0%	72.8%
Pennsylvania	77.5%	54.8%	80.6%
Rhode Island	67.0%	64.1%	67.4%
South Carolina	58.5%	53.1%	59.2%
South Dakota	77.5%	81.4%	76.8%
Tennessee	62.8%	61.0%	63.1%
Texas	66.4%	60.9%	66.7%
Utah	66.2%	67.6%	65.9%
Vermont	70.5%	66.4%	71.1%
Virginia	64.6%	64.9%	64.6%
Washington	65.5%	66.9%	65.2%
West Virginia	65.5%	58.7%	66.5%
Wisconsin	62.8%	59.9%	63.2%
Wyoming	81.9%	79.7%	82.2%
Average	65.8%	64.0%	66.0%
Standard Deviation	7.3	8.9	7.3

Source: Bureau of Economic Analysis

Table B.3: Percent of a State's Population that is Urban

	Averaged from (1977 - 2001)	Averaged from (1977 - 1980)	Averaged from (1980 - 2001)
Alabama	57.8%	57.8%	58.6%
Arizona	82.7%	79.3%	86.5%
Arkansas	50.1%	48.1%	52.5%
California	91.1%	89.5%	92.8%
Colorado	79.9%	77.6%	82.5%
Connecticut	80.5%	78.5%	81.9%
Delaware	72.3%	69.5%	74.6%
Florida	82.8%	80.0%	86.1%
Georgia	62.6%	59.3%	65.7%
Idaho	55.9%	51.9%	59.3%
Illinois	83.9%	82.4%	85.2%
Indiana	65.4%	63.8%	66.6%
Iowa	58.1%	56.3%	60.1%
Kansas	66.9%	64.6%	69.1%
Kentucky	51.1%	49.2%	52.8%
Louisiana	67.8%	66.1%	69.8%
Maine	46.9%	49.9%	44.1%
Maryland	79.4%	76.5%	82.6%
Massachusetts	85.5%	84.0%	86.5%
Michigan	72.7%	72.7%	72.0%
Minnesota	67.3%	65.2%	69.2%
Mississippi	45.1%	43.2%	47.7%
Missouri	68.6%	68.3%	68.7%
Montana	52.6%	52.2%	53.2%
Nebraska	62.9%	59.6%	66.3%
Nevada	83.3%	78.9%	88.4%
New Hampshire	55.4%	55.6%	54.2%
New Jersey	90.1%	88.8%	90.9%
New Mexico	71.2%	69.3%	73.4%
New York	85.5%	85.2%	85.5%
North Carolina	48.7%	44.3%	52.9%
North Dakota	47.5%	42.8%	52.7%
Ohio	74.7%	74.0%	74.9%
Oklahoma	66.2%	66.1%	66.8%
Oregon	69.3%	65.7%	72.4%
Pennsylvania	71.7%	70.8%	71.8%
Rhode Island	87.5%	86.8%	88.0%
South Carolina	51.7%	47.9%	56.4%
South Dakota	46.4%	43.4%	49.4%

Table B.3: Continued

	Averaged from (1977 - 2001)	Averaged from (1977 - 1980)	Averaged from (1980 - 2001)
Tennessee	59.3%	57.3%	61.6%
Texas	79.4%	78.1%	80.8%
Utah	83.0%	79.9%	86.5%
Vermont	35.0%	34.8%	34.7%
Virginia	65.4%	61.6%	69.5%
Washington	74.7%	71.7%	77.3%
West Virginia	39.1%	37.8%	39.5%
Wisconsin	65.6%	64.6%	66.1%
Wyoming	62.0%	60.0%	64.3%
Average	66.7%	64.8%	68.6%
Standard Deviation	14.4	14.4	14.6

Source: Bureau of Economic Analysis

Table B.4: Combined State and Local Tax Burden in each State

	Averaged from (1977 - 2001)	Averaged from (1977 - 1980)	Averaged from (1980 - 2001)
Alabama	8.6%	8.4%	8.4%
Arizona	10.7%	11.0%	11.0%
Arkansas	9.1%	8.3%	8.3%
California	10.4%	11.0%	11.0%
Colorado	9.8%	9.9%	9.9%
Connecticut	10.0%	9.5%	9.5%
Delaware	8.4%	8.5%	8.5%
Florida	8.9%	8.6%	8.6%
Georgia	9.7%	9.1%	9.1%
Idaho	9.8%	9.2%	9.2%
Illinois	9.9%	9.9%	9.9%
Indiana	9.5%	9.2%	9.2%
Iowa	10.6%	10.2%	10.2%
Kansas	9.9%	9.5%	9.5%
Kentucky	9.4%	8.8%	8.8%
Louisiana	8.9%	8.3%	8.3%
Maine	11.7%	11.0%	11.0%
Maryland	10.2%	10.2%	10.2%
Massachusetts	10.7%	11.7%	11.7%
Michigan	10.3%	10.1%	10.1%

Table B.4: Continued			
	Averaged from (1977 - 2001)	Averaged from (1977 - 1980)	Averaged from (1980 - 2001)
Minnesota	11.4%	11.0%	11.0%
Mississippi	9.7%	9.7%	9.7%
Missouri	9.0%	8.8%	8.8%
Montana	10.2%	10.3%	10.3%
Nebraska	10.4%	10.1%	10.1%
Nevada	9.6%	9.8%	9.8%
New Hampshire	8.3%	8.5%	8.5%
New Jersey	10.2%	9.7%	9.7%
New Mexico	9.9%	9.4%	9.4%
New York	13.3%	13.5%	13.5%
North Carolina	9.4%	9.0%	9.0%
North Dakota	9.5%	9.4%	9.4%
Ohio	9.4%	8.3%	8.3%
Oklahoma	8.8%	7.9%	7.9%
Oregon	10.2%	9.8%	9.8%
Pennsylvania	9.5%	9.4%	9.4%
Rhode Island	10.6%	10.2%	10.2%
South Carolina	9.5%	8.9%	8.9%
South Dakota	9.9%	10.6%	10.6%
Tennessee	8.3%	8.4%	8.4%
Texas	8.7%	8.1%	8.1%
Utah	10.6%	10.1%	10.1%
Vermont	11.8%	12.2%	12.2%
Virginia	9.3%	9.0%	9.0%
Washington	10.7%	10.3%	10.3%
West Virginia	10.2%	10.1%	10.1%
Wisconsin	11.8%	11.5%	11.5%
Wyoming	10.8%	10.8%	10.8%
Average	10.0%	9.7%	10.0%
Standard Deviation	1.0	1.1	1.0

Source: Bureau of Economic Analysis

Table B.5: Total Loans and Leases by Commercial Banks divided by the Number of Institutions

	Averaged from (1977 - 2001)	Averaged from (1977 - 1980)	Averaged from (1980 - 2001)
Alabama	164606	16232	255377
Arizona	447280	242593	575800
Arkansas	37692	11816	53901
California	470049	295801	585632
Colorado	46617	16941	65154
Connecticut	185010	70007	257326
Delaware	962516	59056	1514236
Florida	117968	19117	178977
Georgia	96021	16760	144711
Idaho	146800	61763	200643
Illinois	101502	31240	145625
Indiana	117730	23303	175979
Iowa	26735	9339	37656
Kansas	22807	7178	32575
Kentucky	59458	15012	87128
Louisiana	76921	24400	109817
Maine	167517	28769	252734
Maryland	204114	47977	301212
Massachusetts	489912	65239	751294
Michigan	211006	51737	309132
Minnesota	58715	11842	87700
Mississippi	75932	16622	112741
Missouri	51049	13515	74315
Montana	29788	10462	41868
Nebraska	25426	7531	36559
Nevada	391119	133675	552648
New Hampshire	182878	14099	286166
New Jersey	296369	60556	442175
New Mexico	61502	20218	87272
New York	1677236	415923	2478560
North Carolina	1476266	77355	2331334
North Dakota	27209	7850	39270
Ohio	314400	37489	484532
Oklahoma	32841	11420	46379
Oregon	187004	74551	256403
Pennsylvania	285267	69401	419536
Rhode Island	2439744	161744	3832078
South Carolina	108574	23387	161298

Table B.5: Continued

	Averaged from (1977 - 2001)	Averaged from (1977 - 1980)	Averaged from (1980 - 2001)
South Dakota	105397	9765	164008
Tennessee	101786	21663	151154
Texas	60034	19908	85354
Utah	224429	32457	342050
Vermont	118043	27227	174534
Virginia	156992	31498	234636
Washington	175528	70979	242503
West Virginia	54738	12297	80954
Wisconsin	57996	14115	85122
Wyoming	35857	10584	51525
Average	270091	52759	404533
Standard Deviation	460391	78366	713946

Source: Bureau of Economic Analysis

Appendix C

Table C.1: State 12 Quarter Response (in Absolute Value) by Period

	(1959 – 2003)	(1959 – 1979)	(1980 – 2003)
Alabama	84.686	17.477	68.453
Arizona	126.497	36.168	107.127
Arkansas	94.727	98.549	62.045
California	162.472	104.425	146.863
Colorado	110.131	121.671	80.108
Connecticut	149.854	113.689	67.989
Delaware	122.524	134.381	92.174
Florida	124.232	134.005	46.205
Georgia	129.822	144.508	132.490
Idaho	103.530	148.032	73.152
Illinois	146.701	215.407	78.609
Indiana	163.329	165.963	90.994
Iowa	118.503	126.291	74.189
Kansas	99.578	126.364	63.595
Kentucky	99.163	91.214	59.300
Louisiana	22.729	128.514	68.241
Maine	101.203	3.988	60.615
Maryland	132.439	73.818	75.199
Massachusetts	128.220	137.499	88.085
Michigan	227.595	411.149	117.984
Minnesota	147.540	138.813	96.182
Mississippi	79.268	141.494	40.518
Missouri	130.295	108.571	104.199
Montana	51.052	74.171	39.408
Nebraska	99.925	87.193	54.442
Nevada	165.640	60.841	84.188
New Hampshire	150.679	135.556	120.739
New Jersey	121.227	148.483	14.220
New Mexico	80.972	61.832	52.883
New York	133.602	56.805	71.277
North Carolina	115.219	19.757	80.821
North Dakota	71.281	53.917	83.130
Ohio	139.792	105.740	111.865

Table C.1: Continued

	(1959 – 2003)	(1959 – 1979)	(1980 – 2003)
Oklahoma	27.411	76.191	14.568
Oregon	157.113	106.440	105.689
Pennsylvania	120.749	69.680	70.032
Rhode Island	107.431	128.787	61.645
South Carolina	103.070	135.647	77.969
South Dakota	135.250	26.483	133.566
Tennessee	117.568	171.425	91.562
Texas	71.286	94.867	57.558
Utah	83.188	69.142	66.878
Vermont	115.997	73.571	43.486
Virginia	119.563	124.056	58.333
Washington	139.204	239.903	121.588
West Virginia	80.980	92.972	39.981
Wisconsin	137.049	128.315	55.413
Wyoming	146.361	186.220	65.059
Average	116.597	113.541	76.471
Standard Deviation	35.961	65.017	28.785
Range	204.866	407.161	132.642

Note: The values come from the vector autoregression model for states presented in section 3.3.

Appendix D

Table D.1: OLS Results for the Estimation of Interaction Variables

Variable	Coefficient	t-Statistic
Firm	22.619	0.188
Man	252.254	1.464
Tax	943.908	0.782
Urban	183.884	2.978***
Loan	-0.0003	-2.004**
FW	19.278	0.478
GL	37.510	0.668
ME	-39.085	-1.503
NE	-42.124	-1.178
PL	-17.195	-0.874
RM	9.314	0.264
SW	-37.365	-2.085**
Firm * Interaction Variable	-125.725	-0.920
Man * Interaction Variable	-166.160	-0.850
Tax * Interaction Variable	-1595.589	-1.217
Urban * Interaction Variable	-199.676	-2.502**
Loan * Interaction Variable	0.0003	2.042**
FW * Interaction Variable	48.198	1.003
GL * Interaction Variable	-6.187	-0.103
ME * Interaction Variable	53.215	1.472
NE * Interaction Variable	63.717	1.558
PL * Interaction Variable	61.024	2.043**
RM * Interaction Variable	24.261	0.555
SW * Interaction Variable	46.450	1.108
Dummy Variable to Indicate Period 1 or 2	318.005	1.466
C	-142.616	-0.742
Adjusted R^2	0.264	

***Test significant at the 1% level **Test significant at the 5% level

VITA

Christopher D. Kauffman was born in Ashland, Ohio on August 26, 1975. He attended Ashland City Schools and graduated from Ashland High School, Ashland, OH. in June 1994. In August of 1994 he entered Muskingum College and graduated from Muskingum College in May 1998 with a B.A. in Economics, Accounting, and Business. He joined the Doctoral program in Economics at the University of Tennessee, Knoxville in August 1998. Throughout his time in the Ph.D. program, he worked as a graduate teaching assistant and graduate teaching associate. He defended his dissertation in August 2004 and received his doctoral degree in December 2004.

Christopher currently lives in Knoxville with his wife, Sarah, and their daughter, Maria. He currently has a position as an Assistant Professor at Tusculum College, in Greenville/Knoxville, Tennessee.