

# **The Impact of Monetary Policy: Evidence of Differential State Impacts?**

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## **I. Introduction**

Students enrolled in a beginning macroeconomics course are introduced to some version of the monetary transmission mechanism. They are taught that if the Federal Reserve changes the money supply, interest rates are affected and economic activity will change, at least in the short run, if not the long run. However, few of these students are taught that the effectiveness of monetary policy may differ across the states. Past papers analyzing geographical differences in the effectiveness of monetary policy have used quarterly, regional, multiple-state data that has concentrate mainly on the growth in state personal income. This paper uses monthly data to investigate whether monetary policy affects a state's unemployment rate and level of employment and whether that effect is the same across states.

Using monthly data from January 1976 to April 2010, the impact of monetary policy on state employment and unemployment rates is investigated using two different techniques. First, the causal relationship between the federal funds rate and state employment levels and between the federal funds rate and state unemployment rates are analyzed using Granger causality tests. Second, a VAR model is estimated for each state. The model assumes that state employment levels and unemployment rates are endogenous while the federal funds rate is exogenous. The estimates of the VAR are used to simulate future employment conditions over the next 36 months under two assumptions. The first simulation assumes the effective federal funds rate remains constant at the value observed in April 2010, 0.20%. In the second simulation, the effective federal funds rate is assumed to increase fifty basis points to 0.70. The results of the two simulations are compared to assess how changes in the federal funds rate affect state employment levels and unemployment rates.

The Granger causality tests show that there is unidirectional causality from the federal funds rate to state employment levels in only 24 of the states. The multiple F tests also reveal that there is unidirectional causality from the federal funds rate to the unemployment rate in only 25 of the states. That is, the federal funds rate was found to Granger cause employment and unemployment rates in only half of the states. However, the simulations of the VAR models show a more robust effect.

Comparing the two simulations in every state, an increase in the federal funds rate leads to a higher unemployment rate in every state. Given a fifty basis point increase in the federal funds rate, state unemployment rates increased an average of almost 19 basis points. In regards to the impact of the federal funds rate on employment levels, the higher federal funds rate caused lower employment levels in 48 of the states. However, the effect is relatively small. In those states, an increase in the federal funds rate of fifty basis points caused employment to fall an average of 0.28%.

In analyzing the impact of national monetary policy on the various states, this paper is organized as follows. Following this introduction, the second section of the paper contains a review literature dealing with differential effects of U.S. monetary policy at the state or regional level. The third section of the paper describes the data and summarizes the results of the Granger causality tests. Estimation of the VAR, simulations of the future forecasts and comparison of the forecasts under the different federal funds rates are discussed in the fourth section of the paper. The fifth and final section of the paper summarizes the results and offers suggestions for future work.

## **II. Literature Review**

In discussing whether monetary policy has a different effect on each state, two distinct areas of literature have to be reviewed. First, one has to address the theoretical issues why the

impact of monetary policy may differ across states. Having addressed the theoretical discussion, the next step discusses the empirical literature that tests whether monetary policy indeed has a differential effect.

### **Theoretical issues**

The reasons why the effects of monetary policy may vary across states depend on the geographical distribution of firms, differences in the firms' interest sensitivities and their access to credit markets, differences in transaction and information costs, the firms need to use financial intermediaries to find necessary funding and how banks' ability to alter their balance sheets may differ across regions. The geographical distribution of firms includes several dimensions. There are concerns about the size of the firm, whether they are large or small, and the type of firms, whether they are engaged in manufacturing or services.

One reason why the effectiveness of monetary policy may vary across states rest with differences in the distribution of the various types of firms across the country. For example, one state may have a larger percentage of manufacturing firms than another state. For example, Michigan has a greater percentage of manufacturing firms than Nevada. While the geographic distribution of the type of firms may differ across the sates, so too will the interest elasticities of the various firms. Those states with a greater concentration of manufacturing and construction activity have firms whose spending is much more interest-sensitive than other firms in the state; hence, the differences in the effect of monetary policy across states.

Regional differences in the distribution of firm sizes may also affect the impact of monetary policy across the various states. Papers similar to Bernanke and Blinder (1988) argue that monetary policy affects banks' willingness to make loans which will affect economic activity in a given state. Because of differences in information and transactions costs, small

firms may more dependent on banks for sources of funding while larger firms are less dependent on bank financing as they have easier access to the money and capital markets. Therefore, states with a higher concentration of smaller firms may be more sensitive to changes in monetary policy.

The impact of monetary policy may vary across states because the geographic distribution of bank sizes is not the same in every state. The key idea here is that monetary policy's impact on the ability of a bank to make loans depends on the size of the bank. Kashyap and Stein (1995) argue that when the Federal Reserve adopts a tighter monetary policy, larger banks have more sources of funding compared to smaller banks. For example, if the Fed reduces the availability of reserves, larger banks can attract new sources of funds by offering new, larger denomination certificates of deposits, a source of funds that is often precluded from small banks. Therefore, a state with a greater percentage of large banks will react differently to a change in monetary policy than a state with a greater percentage of small banks.

### **The empirical literature**

Given theoretical justifications that the effect of monetary policy may vary across states, other papers have attempted to empirically test that hypothesis. Early research by Miller (1978) and Bias (1992) show that regional bank flows respond differently to monetary policy. Other empirical studies analyzed the impact of monetary policy on regional personal income using a reduced-form, St. Louis-type model. These models assume that personal income is a function of different measures of national fiscal and monetary policy.<sup>1</sup>

Carlino and Defina (1998) examined whether the effect of monetary policy was the same across the eight Bureau of Economic Analysis regions of the United States. Using quarterly data between 1958 and 1992, they estimated a three-equation VAR model describing the growth rate

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<sup>1</sup> See Garrison and Kort (1983) as the most recent example of this approach.

in real personal income, the relative price of energy and a variable measuring monetary policy. Impulse response functions indicated that five of the eight regions - - New England, the Midwest, the Plains, the Southeast and the Far West - - had a response to changes in monetary policy that were approximately similar to the average response of the entire nation to changes in monetary policy. They concluded that the Great Lakes region was much more sensitive to changes in monetary policy while the two other regions, the Southwest and the Rocky Mountains, were much less sensitive to changes in monetary policy.

They demonstrated that their findings were robust. Similar results were found with different measures monetary policy such as nonborrowed reserves or the federal funds rate. The results were invariant to different measures of economic activity which included real personal income growth and employment growth. Similar results were obtained when Carlino and DeFina used variables expressed in level terms or in growth rates. They also analyzed VAR models for the 48 continental states. They found states with a larger concentration of industries in manufacturing were more responsive to changes in monetary policy. There was mixed evidence showing that states with a larger percentage of smaller firms were also more responsive to changes in monetary policy.

In a study to determine whether monetary policy had different effects on regional housing markets, Fratantoni and Schuh (2003) applied a heterogeneous-agent VAR model to a panel data set consisting of 27 MSA regions over 40 quarters of data between 1986 and 1996. They structured their model so that inflation and nominal interest rates were determined at the national level by the Federal Reserve and the financial markets. However, they assumed income, housing prices and the investment in housing were determined at the regional level. The mortgage rate was the channel of monetary policy and the link between the national and regional markets.

Their model exhibited “long and variable lags in monetary policy” and they found that tight monetary policy was less effective when the eastern and western coastal regions of the United States are experiencing housing booms.

### III. The Data and Granger Causality Tests

In a first pass of analyzing the data, Granger causality test were used to determine the causal relationship between state unemployment rates, state employment levels and the federal funds rate. To perform these tests, four separate regressions were estimated for each of the fifty states. Let  $U_{it}$  denote the unemployment rate in state  $i$  during month  $t$ ,  $E_{it}$  represent the number of people employed in state  $i$  in month  $t$  and  $F_t$  denote the effective federal funds rate in month  $t$ . The four sets of equations that were estimated are below.

$$E_{it} = \alpha_1 + \sum_{j=1}^m \beta_j E_{it-j} + \sum_{j=1}^m \delta_j F_{t-j} + \varepsilon_{1t} \quad (1)$$

$$F_t = \alpha_2 + \sum_{j=1}^m \gamma_j E_{it-j} + \sum_{j=1}^m \lambda_j F_{t-j} + \varepsilon_{2t} \quad (2)$$

$$U_{it} = \alpha_3 + \sum_{j=1}^m \mu_j U_{it-j} + \sum_{j=1}^m \varphi_j F_{t-j} + \varepsilon_{3t} \quad (3)$$

$$F_t = \alpha_4 + \sum_{j=1}^m \theta_j U_{it-j} + \sum_{j=1}^m \nu_j F_{t-j} + \varepsilon_{4t} \quad (4)$$

In the above equations,  $\alpha_1$ ,  $\alpha_2$ ,  $\alpha_3$  and  $\alpha_4$  are the unknown regression intercepts. The eight sets of unknown slope coefficients are the  $\beta_j$ ,  $\delta_j$ ,  $\gamma_j$ ,  $\lambda_j$ ,  $\mu_j$ ,  $\varphi_j$ ,  $\theta_j$  and  $\nu_j$ . In Equations (1) – (4),  $\varepsilon_{1t}$ ,  $\varepsilon_{2t}$ ,  $\varepsilon_{3t}$  and  $\varepsilon_{4t}$  are the random, white noise.

All the state unemployment rates and employment levels come from the local area unemployment statistics published by the Bureau of Labor Statistics. For each of the fifty states,

the two data series are monthly data from January 1976 to April 2010.<sup>2</sup> The data series for the monthly, effective federal funds rate comes from the ‘Federal Reserve Economic Data’ on the website for the Federal Reserve Bank of St. Louis.<sup>3</sup> This monthly data series is available from July 1954 but only data after January 1976 are needed.

All four of the above equations include  $m$  lagged variables of two of the data series. The number of lags to include is often an important consideration and the detection and direction of causality in these statistical tests are sensitive to the number of lags chosen. In the causality tests that follow, the value of  $m$  that was selected for each state was the number of lags that minimized the Schwarz Information criterion for the vector autoregressive model that included two endogenous variables, state employment levels and the state unemployment rates, and the exogenous data series of the federal funds rate.<sup>4</sup> For most of the states,  $m$  was found to be equal to the past 13 months of data.

### **The relationship between state employment levels and the federal funds rate**

Equations (1) and (2) test the relationship between the federal funds rate and the state employment levels. The federal funds rate is said to ‘‘Granger cause’’ state employment levels if the number of people employed in the state is a function of past values of the federal funds rate. Referring to Equation (1), past values of  $F_t$  will Granger cause the current value of  $E_{it}$  if the values of  $\delta_j$  are not all simultaneously equal to zero. Consequently, Granger causality tests are an example of classical statistical hypothesis testing and they consist of a series of  $F$  tests with null and alternative hypotheses. Define Null Hypothesis I or  $H_0^I$  as  $H_0^I: \delta_1 = \delta_2 = \dots = \delta_m = 0$ .

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<sup>2</sup> See <http://data.bls.gov/cgi-bin/surveymost?la>.

<sup>3</sup> See <http://research.stlouisfed.org/fred2/>.

<sup>4</sup> The value of  $m$  for each state is reported in Table 6.

Past values of the federal funds rate will affect the current employment level in a given state, or equivalently, the federal funds rate will Granger cause state employment levels if  $H_0^I$  is rejected.

Some are concerned that changes in a state's employment level might ultimately lead to the changes in the federal funds rate target. Equation (2) examines whether the past values of employment in a given state affect the federal funds rate. While it is dubious that the Federal Reserve would change the targeted federal funds rate for the whole nation because of changes in the employment in just one state, Equation (2) tests whether the current federal funds rate is affected by previous employment levels in a given state. Past employment levels will Granger cause the current level of the federal funds rate if not all the values of  $\gamma_j$  are not simultaneously equal to zero, implying the rejection of Null Hypothesis II or  $H_0^{II}$ , which is

$$H_0^{II}: \gamma_1 = \gamma_2 = \dots = \gamma_m = 0.$$

If there is feedback or bilateral causality between state employment levels and the federal funds rate, then lagged values of one variable affect the current value of the other and both  $H_0^I$  and  $H_0^{II}$  are rejected. If the current values state employment levels and the federal funds rate are independent of the lagged variables of the other variable then both  $H_0^I$  and  $H_0^{II}$  cannot be rejected. The four possible outcomes when using Granger causality tests to analyze the relationship between the federal funds rate and the state unemployment levels are summarized in Table 1.

### **The relationship between state unemployment rates and the federal funds rate**

To determine the causal relationship between state unemployment rates and the federal funds rate, Granger causality test are applied to the regressions in Equations (3) and (4). To determine whether causality is unidirectional, bilateral or nonexistent, F tests and hypothesis testing are performed in a similar fashion as was done earlier with state employment levels and

the federal funds rate. If there is unidirectional causality from the federal funds rate to state unemployment rates then Null Hypothesis III or  $H_0^{III}: \phi_1 = \phi_2 = \dots = \phi_m = 0$ , is rejected while Null Hypothesis IV, which is  $H_0^{IV}: \theta_1 = \theta_2 = \dots = \theta_m = 0$ , cannot be rejected. If, on the other hand, there is unidirectional causality from state unemployment rates to the federal funds rate, then  $H_0^{IV}$  is rejected while  $H_0^{III}$  cannot be rejected.

Bilateral causality or feedback implies that both  $H_0^{III}$  and  $H_0^{IV}$  can be rejected. If state unemployment rates and the federal funds rate are independent of each other, then both  $H_0^{III}$  and  $H_0^{IV}$  cannot be rejected. The four possible outcomes of these Granger causality tests and the corresponding decisions regarding the null hypotheses of the statistical test are summarized in Table 2.

### **Results of the Granger causality tests**

The F tests associated with the Granger casualty tests are reported in Table 3 and the results are summarized in Tables 4 and 5. Table 4 shows that there is unidirectional causality from the federal funds rate to state employment levels in 24 states. In only three states - - Arizona, Oklahoma and Texas - - did the Granger causality tests indicate there was unidirectional causality from the state employment levels to the federal funds rate, a weak confirmation of the argument that, from the perspective of an individual state, the federal funds rate should be exogenous. There was evidence of bilateral causality between state employment levels and the federal funds rate in only two states: Illinois and New Jersey. But the finding that the federal funds rate and the state employment level are independent in 21 states, including California, would not comfort the proponents of monetary policy.

Reviewing the outcomes in Table 5, the analysis of the causal relationship between the federal funds rate and the unemployment rate in a given state also results in mixed findings. In 25 of the fifty states, there is unidirectional causality from the federal funds rate to the unemployment rate in a given state. In five states, the state unemployment rate Granger causes the federal funds direction and the causality is only in that direction. Ten states exhibit a feedback relationship or bilateral causality between the unemployment rate and the federal funds rate. Finally, in ten or one-fifth of the states, both null hypotheses could not be rejected and the federal funds rate and the unemployment rate in a particular state are independent.

Comparing the results for employment and the unemployment rate, the results are not always internally consistent. There are five states - - Alabama, Alaska, Hawaii, Kentucky and Maine - - where there is statistical evidence that the federal funds rate affects the unemployment rate in the state; but, there is no statistical evidence that the employment level in the same states is affected by the federal funds rate. Likewise, there are three states - - Kansas, Massachusetts and Rhode Island - - where there is no statistical evidence that the federal funds rate and state unemployment rates are related; but, there is statistical evidence that the federal funds rate Granger causes state employment levels in those states.

#### **IV. Using a VAR Models to Estimate the Effect of the Federal Funds Rate on States**

Given the mixed results of the Granger causality tests, the impact of the federal funds rate on state employment rates and state unemployment rates were analyzed using a vector autoregressive model (VAR) of the monthly data. For each state, the first step was to estimate the following three-equation model.

$$E_{it} = \alpha_1 + \sum_{j=1}^m \beta_{1j} E_{it-j} + \sum_{j=1}^m \gamma_{1j} U_{it-j} + \sum_{j=1}^m \delta_{1j} F_{t-j} + \varepsilon_{1t}$$

$$E_{it} = \alpha_2 + \sum_{j=1}^m \beta_{2j} E_{it-j} + \sum_{j=1}^m \gamma_{2j} U_{it-j} + \sum_{j=1}^m \delta_{2j} F_{t-j} + \varepsilon_{2t}$$

$$F_t = \alpha_3 + \sum_{j=1}^m \beta_{3j} E_{it-j} + \sum_{j=1}^m \gamma_{3j} U_{it-j} + \sum_{j=1}^m \delta_{3j} F_{t-j} + \varepsilon_{3t}$$

As was done earlier, the Greek intercept and slope parameters in the above equations denote the unknown parameters that were estimated using regression techniques. The optimal value of m was determined by choosing the amount of lags that minimized the Schwarz information criterion. The values of m for each state are listed in Table 6 and, for the overwhelming majority of the states, the optimal lag was 13 months. For other states the value was either 14 or 8.

Next, given the optimal lag determined by the Schwarz information criterion, a two-equation VAR model was estimated. The model assumed that the state unemployment rates and the number of people employed in the state are endogenous while the federal funds rate is exogenous. The regressions are specified in equations (5) and (6) below.

$$E_{it} = v_1 + \sum_{j=1}^m \theta_{1j} E_{it-j} + \sum_{j=1}^m \pi_{1j} U_{it-j} + \sum_{j=1}^m \tau_{1j} F_{t-j} + \mu_{1t} \quad (5)$$

$$U_{it} = v_2 + \sum_{j=1}^m \theta_{2j} E_{it-j} + \sum_{j=1}^m \pi_{2j} U_{it-j} + \sum_{j=1}^m \tau_{2j} F_{t-j} + \mu_{2t} \quad (6)$$

Once the VAR model was estimated for each state, using a technique similar to impulse response functions, each equation was simulated for 36 months into the future. In the baseline simulation, the effective federal funds rate was assumed to be the last value in April 2010 or 0.20 percent. In the alternative scenario, the model was simulated assuming that the effective federal funds rate increases 50 basis points to 0.70 percent. The results of the baseline simulation and the simulation of the alternative scenario are reported in Table 6. The two regression equations in the VAR models do a reasonable job capturing the variation in the data. The values of the R<sup>2</sup> of

the employment regressions range from a minimum of 0.9962 to a maximum of 0.9988 while the  $R^2$  values of the unemployment rate regression range from a low of 0.9424 to a high of 0.9915.<sup>5</sup>

With the exception of Alaska and Oklahoma, the simulation data show that, three years after an increase in the federal funds rate of fifty basis points, the level of employment in the other 48 states will fall. The simulation data also shows that if there is a fifty basis point increase in the federal funds rate, after three years, the unemployment rate in every state will increase. In regards to the change in the state's unemployment rate three years after a fifty basis point increase in the federal funds rate, the minimum change was the increase in 0.2 basis points in the Alaskan unemployment rate, a value that probably is not statistically different from zero. The largest change in the unemployment rate was the increase of in the unemployment rate of 44.3 basis points observed in Michigan. The simulations reveal that, on average, a fifty basis point increase in the federal funds rate will cause an increase in a state's unemployment rate of 18.9 basis points within three years.

Excluding the simulations results for Alaska and Oklahoma, over a three year period, a fifty basis point increase in the federal funds rate will cause, on average, a decline in state employment of 0.28% - - a rather inelastic result. The smallest fall occurred in South Dakota (-0.04%) and the largest fall occurred in Massachusetts (-0.70%).

Table 6 reveals the lags in monetary policy may be long and variable. In some of the states, the change in employment may have been positive in the first year with an ultimate negative change in the third year of the simulation. Likewise, for some of the states, the unemployment rate may have had a perverse fall during the first year of the simulation; but, it ultimately fell by the third year of the simulation.

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<sup>5</sup> The estimates of the VAR model for each of the fifty states are available upon request.

## V. Conclusions and Suggestions for Future Research

Using Granger causality tests to determine the causal relationship between the federal funds rate and the state employment data generates mixed results. The series of simultaneous F tests on different regressions indicate that the federal funds rate Granger causes state employment levels in only half the states. Likewise, the federal funds rate was found to Granger cause the unemployment rate in only half the states. Equally troubling was that the two sets of states where the Granger causality was found were not improper subsets.

Simulations of state-level VAR models result in more encouraging findings. Simulations of the models found that in 48 of the states, a fifty basis point increase in the federal funds rate resulted in lower employment levels. The response was relatively inelastic, resulting in an average decline in employment equal to 0.28%. Likewise, simulations showed that a fifty basis point increase in the federal funds rate would increase state unemployment rates. The average increase in state unemployment rates was almost 19 basis points.

The small response of employment levels and unemployment rates to a change in monetary policy begs the question on whether the change is statistically different from zero. The next step of this research is to determine whether standard errors can be calculated for the forecasts and whether confidence intervals can be calculated. Being able to determine whether the forecasted differences are statistically different from zero would place additional confidence in the model and the validity of its results.

Additional estimation needs to be done to verify the robustness of the results. While the goal of the paper was to focus on the effect of monetary policy on state employment variables such as the number of people employed and the unemployment rate, there are other measures of monetary policy such as nonborrowed reserves. The robustness of the results can be verified by

performing similar analyses with the alternative measures of monetary policy. Finally, the number of lags to include was determined by the Schwarz information criterion. There are several other criteria to use such as the Akaike and Hannan-Quinn information criterion. The optimal number of lags can also be determined with successive likelihood ratio tests. Sometimes the predictions of simulations and impulse response functions may differ upon the lag chosen. The optimal number lags can be determined by using a different criteria and the robustness of the results can be verified.

But the lessons from the simple simulations in this paper are clear. While the lags of monetary policy are long and variable and while the effect of monetary policy differs across states, there is relatively strong evidence that employment levels are inversely related to the federal funds rate and there is a direct relationship between the federal funds rate and state unemployment rates.

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Table 1  
Granger Causality Tests: Federal Funds Rate and State Employment Levels

Underlying Regressions	$E_{it} = \alpha_1 + \sum_{j=1}^m \beta_j E_{it-j} + \sum_{j=1}^m \delta_j F_{t-j} + \varepsilon_{1t}$ $F_t = \alpha_2 + \sum_{j=1}^m \gamma_j E_{it-j} + \sum_{j=1}^m \lambda_j F_{t-j} + \varepsilon_{2t}$	
Null Hypothesis	Null Hypothesis I = $H_0^I$ $H_0^I: \delta_1 = \delta_2 = \dots = \delta_m = 0$	Null Hypothesis II = $H_0^{II}$ $H_0^{II}: \gamma_1 = \gamma_2 = \dots = \gamma_m = 0$
Unidirectional Causality from the Federal Funds Rate to State Employment Levels	Reject	Fail to Reject
Unidirectional Causality from State Employment Levels to the Federal Funds Rate	Fail to Reject	Reject
Feedback or Bilateral Causality	Reject	Reject
Independence	Fail to Reject	Fail to Reject

Table 2  
Granger Causality Tests: Federal Funds Rate and State Unemployment Rates

Underlying Regressions	$U_{it} = \alpha_3 + \sum_{j=1}^m \mu_j U_{it-j} + \sum_{j=1}^m \varphi_j F_{t-j} + \varepsilon_{3t}$ $F_t = \alpha_4 + \sum_{j=1}^m \theta_j U_{it-j} + \sum_{j=1}^m \nu_j F_{t-j} + \varepsilon_{4t}$	
Null Hypothesis	Null Hypothesis III = $H_0^{III}$ $H_0^{III}: \varphi_1 = \varphi_2 = \dots = \varphi_m = 0$	Null Hypothesis IV = $H_0^{IV}$ $H_0^{IV}: \theta_1 = \theta_2 = \dots = \theta_m = 0$
Unidirectional Causality from the Federal Funds Rate to State Employment Levels	Reject	Fail to Reject
Unidirectional Causality from State Employment Levels to the Federal Funds Rate	Fail to Reject	Reject
Feedback or Bilateral Causality	Reject	Reject
Independence	Fail to Reject	Fail to Reject

Table 3  
Granger Causality Results

State	Null Hypotheses			
	Federal Funds Rate Does Not Granger Cause State Employment	Federal Funds Rate Does Not Granger Cause State Unemployment Rate	State Employment Level Does Not Granger Cause Federal Funds Rate	State Unemployment Rate Does Not Granger Cause Federal Funds Rate
Alabama	1.531	2.513*	1.195	1.091
Alaska	0.376	3.233*	1.080	1.530
Arizona	1.288	1.194	1.691***	3.680*
Arkansas	1.575***	1.661***	1.450	0.927
California	0.759	2.245*	1.379	1.942**
Colorado	1.477	1.986**	1.388	2.988*
Connecticut	0.872	1.370	1.023	1.308
Delaware	0.522	0.834	1.016	1.483
Florida	1.227	1.418	1.443	1.796**
Georgia	1.096	1.481	1.334	3.042*
Hawaii	0.610	1.626***	1.241	1.428
Idaho	1.558	4.205*	1.230	3.786*
Illinois	4.752*	2.224*	1.725***	1.433
Indiana	4.789*	2.854*	1.126	1.279
Iowa	3.259*	1.611***	0.731	0.697
Kansas	4.423*	1.098	1.379	1.103
Kentucky	1.460	2.353*	1.465	0.869
Louisiana	0.794	1.462	1.225	0.741
Maine	1.443	2.000**	1.311	1.413
Maryland	0.977	0.834	1.299	1.042
Massachusetts	1.827**	1.485	1.178	1.063
Michigan	4.705*	3.097*	0.906	0.989
Minnesota	3.500*	3.304*	0.812	0.790
Mississippi	0.666	1.287	1.027	0.798
Missouri	2.810*	1.677***	1.226	1.000
Montana	1.791**	3.587*	1.363	3.284*

See the footnotes the conclusion of Table 3.

Table 3 (Continued)  
Granger Causality Results

State	Null Hypotheses			
	Federal Funds Rate Does Not Granger Cause State Employment	Federal Funds Rate Does Not Granger Cause State Unemployment Rate	State Employment Level Does Not Granger Cause Federal Funds Rate	State Unemployment Rate Does Not Granger Cause Federal Funds Rate
Nebraska	2.455*	1.943**	0.826	0.660
Nevada	0.932	2.281*	1.103	1.797**
New Hampshire	1.673***	1.880**	1.022	0.992
New Jersey	2.025**	1.136	1.544***	1.435
New Mexico	1.298	2.872*	1.178	2.847*
New York	2.379*	1.404	1.270	1.634***
North Carolina	2.398*	4.564*	1.119	1.138
North Dakota	1.828**	3.127*	0.806	0.393
Ohio	5.682*	3.825*	0.996	1.305
Oklahoma	1.512	5.378*	1.985**	1.935**
Oregon	1.656***	2.471*	1.245	2.308*
Pennsylvania	2.152**	2.907*	1.131	1.162
Rhode Island	2.113**	0.991	1.335	0.636
South Carolina	0.677	1.411	1.190	1.256
South Dakota	2.759*	2.933*	0.725	0.274
Tennessee	1.766**	2.134**	1.286	0.807
Texas	1.177	1.438	1.712***	1.553***
Utah	1.132	3.156*	1.016	2.289*
Vermont	1.698***	2.615*	1.340	1.153
Virginia	1.541	2.077**	1.154	1.297
Washington	1.111	2.531*	1.521	2.215*
West Virginia	2.402*	3.755*	1.165	0.752
Wisconsin	4.553*	4.701*	1.410	0.621
Wyoming	2.548*	2.151*	1.306	0.687

\*, \*\* and \*\*\* denote the null hypothesis is rejected at the 1%, 5% and 10% level, respectively.

Table 4

The Federal Funds Rate and State Employment Levels: Summary of Granger Causality Results

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Unidirectional Granger Causality from Federal Funds Rate to State Employment Levels

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Arkansas***	Indiana*	Iowa***	Kansas*	Massachusetts**
Michigan*	Minnesota*	Missouri*	Montana**	Nebraska*
New Hampshire***	New York*	North Carolina*	North Dakota**	Ohio*
Oregon***	Pennsylvania**	Rhode Island**	South Dakota*	Tennessee**
Vermont***	West Virginia*	Wisconsin*	Wyoming*	

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Unidirectional Granger Causality from State Employment Levels to Federal Funds Rate

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Arizona***	Oklahoma**	Texas***		
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Feedback or Bilateral Causality between the Federal Funds Rate and State Employment Levels

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Illinois**	New Jersey**			
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Federal Funds Rate and State Employment Levels are Independent of Each Other

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Alabama	Alaska	California	Colorado	Connecticut
Delaware	Florida	Georgia	Hawaii	Idaho
Kentucky	Louisiana	Maine	Maryland	Mississippi
Nevada	New Mexico	South Carolina	Utah	Virginia
Washington				

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\*, \*\*, and \*\*\* imply the relevant null hypothesis was rejected at the 1%, 5% or 10% level, respectively.

Table 5

The Federal Funds Rate and State Unemployment Rates: Summary of Granger Causality Results

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Unidirectional Granger Causality from Federal Funds Rate to State Unemployment Rates

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Alabama*	Alaska*	Arkansas***	Hawaii***	Illinois*
Indiana*	Iowa***	Kentucky*	Maine **	Michigan*
Minnesota*	Missouri***	Nebraska**	New Hampshire**	North Carolina*
North Dakota*	Ohio*	Pennsylvania*	South Dakota*	Tennessee**
Vermont*	Virginia*	West Virginia*	Wisconsin*	Wyoming*

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Unidirectional Granger Causality from State Unemployment Rates to Federal Funds Rate

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Arizona*	Florida**	Georgia*	New York***	Texas***
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Feedback or Bilateral Causality between the Federal Funds Rate and State Unemployment Rates

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California**	Colorado**	Idaho*	Montana*	Nevada**
New Mexico*	Oklahoma**	Oregon*	Utah*	Washington*

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Federal Funds Rate and State Unemployment Rates are Independent of Each Other

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Connecticut	Delaware	Kansas	Louisiana	Maryland
Massachusetts	Mississippi	New Jersey	Rhode Island	South Carolina

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\*, \*\*, and \*\*\* imply the relevant null hypothesis was rejected at the 1%, 5% or 10% level, respectively.

Table 6  
The Effect of a 50 Basis Point Increase in the Federal Funds Rate on State Employment Levels and Unemployment Rates

State	Employment							Unemployment Rate				Lags	Schwarz Information Criterion
	Percentage Change			Change in Level Values			R <sup>2</sup>	Basis Point Change			R <sup>2</sup>		
	1 year	2 years	3 years	1 year	2 years	3 years		1 years	2 years	3 years			
AL	-0.08%	-0.26%	-0.47%	-1,456	-5,257	-9,993	0.9990	0.047	0.163	0.289	0.9898	13	23.758
AK	0.02%	0.07%	0.13%	81	232	440	0.9997	-0.011	-0.014	0.002	0.9781	13	19.824
AZ	0.02%	-0.05%	-0.11%	475	-1,516	-3,340	0.9998	-0.008	0.067	0.100	0.9424	8	24.646
AR	-0.06%	-0.20%	-0.34%	-798	-2,627	-4,554	0.9988	0.028	0.095	0.164	0.9837	13	22.398
CA	-0.10%	-0.27%	-0.45%	-16,480	-44,500	-75,870	0.9995	0.080	0.213	0.331	0.9847	13	27.449
CO	-0.02%	-0.14%	-0.31%	-376	-3,517	-7,800	0.9997	0.003	0.085	0.159	0.9641	14	23.985
CT	-0.03%	-0.08%	-0.12%	-508	-1,352	-1,977	0.9977	0.066	0.114	0.132	0.9847	13	22.472
DE	-0.03%	-0.16%	-0.33%	-125	-602	-1,278	0.9992	0.056	0.114	0.188	0.9839	13	20.804
FL	-0.03%	-0.14%	-0.25%	-2,736	-12,076	-22,291	0.9997	0.055	0.172	0.285	0.9819	13	25.971
GA	-0.05%	-0.20%	-0.37%	-2,007	-8,586	-16,915	0.9997	0.051	0.129	0.205	0.9677	13	24.852
HA	-0.01%	-0.05%	-0.10%	-64	-273	-613	0.9992	-0.002	0.043	0.089	0.9746	13	21.201
ID	0.00%	-0.11%	-0.23%	-8	-851	-1,827	0.9996	0.045	0.124	0.207	0.9876	14	21.202
IL	0.03%	-0.10%	-0.27%	2,045	-6,220	-17,679	0.9978	0.001	0.096	0.218	0.9803	13	26.102
IN	-0.17%	-0.42%	-0.65%	-4,844	-12,770	-20,615	0.9987	0.085	0.197	0.286	0.9847	13	24.625
IA	-0.07%	-0.22%	-0.36%	-1,147	-3,425	-5,772	0.9971	0.011	0.059	0.119	0.9876	13	22.805
KS	0.01%	-0.12%	-0.24%	193	-1,704	-3,517	0.9982	0.023	-0.026	0.071	0.9452	13	22.802
KY	-0.04%	-0.14%	-0.26%	-665	-2,641	-5,037	0.9985	0.004	0.082	0.175	0.9828	13	23.578
LA	0.00%	-0.05%	-0.13%	88	-954	-2,594	0.9926	0.111	-0.033	0.039	0.9573	13	25.971
ME	-0.01%	-0.09%	-0.16%	-75	-562	-1,074	0.9991	0.004	0.082	0.175	0.9788	13	21.293

Table 6 (Continued)  
The Effect of a 50 Basis Point Increase in the Federal Funds Rate on State Employment Levels and Unemployment Rates

State	Employment						Unemployment Rate					Lags	Schwarz Information Criterion
	Percentage Change			Change in Level Values			R <sup>2</sup>	Basis Point Change			R <sup>2</sup>		
	1 year	2 years	3 years	1 year	2 years	3 years		1 years	2 years	3 years			
MD	-0.06%	-0.19%	-0.32%	-1,776	-5,359	-9,234	0.9992	0.004	0.119	0.164	0.9722	13	23.887
MA	-0.03%	-0.10%	-0.15%	-932	-3,278	-4,952	0.9982	0.060	0.122	0.158	0.9915	13	23.269
MI	-0.02%	-0.47%	-0.70%	-8,904	-21,904	-34,880	0.9981	0.147	0.302	0.443	0.9890	13	25.910
MN	-0.01%	-0.08%	-0.18%	-205	-2,381	-5,116	0.9992	0.003	0.084	0.159	0.9757	13	24.013
MS	0.00%	-0.07%	-0.17%	57	-836	-1,995	0.9980	-0.056	0.002	0.066	0.9648	13	23.990
MO	-0.02%	-0.15%	-0.29%	-641	-4,229	-8,514	0.9989	0.000	0.090	0.177	0.9720	13	24.546
MT	-0.01%	-0.11%	-0.25%	-40	-537	-1,191	0.9983	0.055	0.119	0.187	0.9849	14	20.505
NE	0.00%	-0.09%	-0.18%	-30	-852	-1,757	0.9985	0.05	0.064	0.102	0.9633	13	21.754
NV	-0.01%	-0.10%	-0.26%	-75	-1,179	-3,040	0.9999	0.085	0.197	0.311	0.9858	13	22.004
NH	-0.04%	-0.12%	-0.18%	-290	-864	-1,285	0.0997	0.066	0.141	0.180	0.9901	13	20.041
NJ	-0.11%	-0.24%	-0.35%	-4,553	-10,286	-15,294	0.9984	0.017	0.088	0.151	0.9832	13	24.752
NM	-0.02%	-0.08%	-0.14%	-149	-712	-1,278	0.9995	0.046	0.107	0.162	0.9784	13	21.825
NY	-0.08%	-0.20%	-0.33%	-6,784	-18,189	-30,517	0.9980	0.002	0.071	0.135	0.9768	13	26.236
NC	0.00%	-0.12%	-0.24%	36	-5,522	-11,184	0.9992	0.053	0.179	0.282	0.9794	13	25.382
ND	0.00%	-0.10%	-0.19%	-5	-358	-704	0.9962	-0.015	0.028	0.060	0.9615	13	20.531
OH	-0.09%	-0.24%	-0.40%	-4,928	-13,456	-22,789	0.9984	0.091	0.229	0.356	0.9840	13	25.446
OK	0.05%	0.05%	0.02%	880	759	316	0.9985	-0.073	0.007	0.087	0.9733	14	23.099
OR	-0.09%	-0.26%	-0.44%	-1,609	-4,782	-8,269	0.9995	0.107	0.236	0.331	0.9818	14	23.401
PA	-0.08%	-0.22%	-0.37%	-4,835	-13,256	-22,328	0.9968	0.048	0.164	0.273	0.9863	13	25.690

Table 6 (Continued)  
The Effect of a 50 Basis Point Increase in the Federal Funds Rate on State Employment Levels and Unemployment Rates

State	Employment						Unemployment Rate					Lags	Schwarz Information Criterion
	Percentage Change			Change in Level Values			R <sup>2</sup>	Basis Point Change			R <sup>2</sup>		
	1 year	2 years	3 years	1 year	2 years	3 years		1 years	2 years	3 years			
RI	-0.12%	-0.32%	-0.52%	-595	-1,656	-2,736	0.9969	0.078	0.205	0.326	0.9823	14	21.582
SC	-0.04%	-0.14%	-0.22%	-882	-2,796	-4,576	0.9992	0.074	0.182	0.244	0.9757	13	24.060
SD	-0.03%	-0.14%	-0.26%	-111	-616	-1,137	0.9990	0.024	0.066	0.097	0.9658	13	19.557
TN	-0.02%	-0.17%	-0.33%	-566	-4,971	-10,062	0.9992	0.031	0.134	0.251	0.9895	13	24.083
TX	0.01%	-0.01%	-0.04%	1,470	-600	-4,200	0.9997	-0.032	0.006	0.073	0.9685	13	26.237
UT	0.00%	-0.08%	-0.22%	46	-1,060	-2,732	0.9998	0.036	0.139	0.229	0.9797	14	22.069
VT	0.00%	-0.06%	-0.12%	6	-217	-429	0.9990	0.021	0.056	0.084	0.9763	13	19.932
VA	-0.08%	-0.17%	-0.26%	-3,164	-6,905	-10,445	0.9994	0.055	0.117	0.165	0.9746	13	24.445
WA	-0.08%	-0.24%	-0.39%	-2,772	-8,218	-13,499	0.9994	0.60	0.177	0.265	0.9813	14	24.815
WV	-0.01%	-0.19%	-0.41%	-61	-1,350	-3,062	0.9969	-0.033	0.152	0.328	0.9900	13	22.085
WI	-0.08%	-0.21%	-0.36%	-2,130	-5,925	-10,647	0.9993	0.081	0.163	0.245	0.9807	13	24.216
WY	0.07%	0.02%	-0.10%	197	59	-263	0.9983	-0.019	0.062	0.145	0.9755	14	20.148