Do States Respond Differently To Changes in Monetary Policy?

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In earlier research we found that monetary policy affects real income quite differently in each of the eight major U.S. regions as defined by the Bureau of Economic Analysis (BEA).[1] In this article, we extend our analysis of the effects of monetary policy to the state level. Extending the evidence to the state level is important for two reasons. First, states within a region may have quite varied responses to monetary policy actions: responses different from one another and from the region's overall response. For example, we found that five of the seven states in the Plains region show an effect below the regional average, and two states, Missouri and Minnesota, show an above-average impact. Missouri and Minnesota account for more than one-half of the personal income in the Plains region.

Second, a state-level study provides 48 individual responses to monetary policy actions, not just the eight responses in our regional study.[2]

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[1]See the 1996 article by Gerald A. Carlino and Robert DeFina.

The states, therefore, provide a richer testing ground for determining the sources of the differential responses. Our analysis indicates that state economies with a large proportion of the interest-sensitive industries—construction and durable goods manufacturing—are more responsive to changes in monetary policy than the more industrially diverse states. Our earlier study showed the same is true for regional economies as well. While our earlier analysis indicated that a region's concentration of small firms possibly has an effect on a region's response to changes in policy, no such association was evident for states. Finally, as in our regional study, a greater concentration of small banks is found to decrease a state's sensitivity to monetary policy shocks, contrary to predictions of some economists.

WHAT IS THE EVIDENCE?

Individual States' Responses. We used a statistical technique known as vector autoregression (VAR) to estimate the effects of *changes in monetary policy* on real personal income growth at the state level.[3] The variables in our model included real personal income growth for the state under consideration as well as real personal income growth in each of the eight major regions defined by the BEA.[4] Including income growth in the regions permits feedback effects. The model also included the change in the relative price of energy to account for the effects of oil-price shocks, the change in core CPI to capture underlying trends in the aggregate price level, the change in the index of leading indicators as a parsimonious way to summarize a variety of macroeconomic variables, and the change in the federal funds rate as a measure of changes in monetary policy.[5] The study employed quarterly data for the period 1958-92.

A typical way to summarize the impact of monetary policy on personal income growth is to show how the level of real personal income in a state changes over time because of monetary policy surprises, or shocks. Such shocks are measured by unanticipated changes in the federal funds rate. For example, in the fall of 1994, Fed actions raised the federal funds rate 0.75 percentage point. Shortly before, forecasters had been publicly predicting an increase of 0.25 percentage point. Thus, the additional 0.50 percentage point represented a policy shock.[6] The im-

[2]Since Alaska and Hawaii do not share common borders with any other state, we limited our study to the 48 contiguous states.

[3]See Gerald Carlino and Robert DeFina (1999). A VAR is a widely used modeling technique for gathering evidence on business-cycle dynamics. VARs typically rely on a small number of variables expressed as past values of the dependent variable and past values of the other variables in the model. See Theodore Crone's article for a discussion of VARs as applied to regional analysis.

[4]More precisely, we included the seven regions not containing the state under study, plus the personal income from the region containing the state less that state's income.

[5]The core CPI is the CPI minus food and energy. The change in core CPI and the change in the index of leading indicators are two variables that did not appear in the list of variables for our earlier regional study.

[6]An important part of our study requires the separation of changes in the funds rate that are predictable responses to important indicators of the economy's health from changes in the funds rate that cannot be systematically predicted (policy shocks). The model includes an equation that predicts changes in the federal funds rate on the basis of a year's worth of *past* data for each of the variables in the model (including change in core CPI and the change in the index of leading indicators). Unexpected changes in the federal funds rate are measured by taking the difference between the actual and predicted change. Unexpected changes in the federal funds rate are used to measure monetary policy shocks in the policy simulations that follow. The analysis assumes that unexpected changes in the federal funds rate arise only from policy shocks. Some economists believe that only unanticipated changes in monetary policy affect real eco-

pact of this unanticipated change in monetary policy is measured by the gap between the model's estimate of what real personal income in a state would have been without the monetary policy action and what it turned out to be with it.[7]

We found that an unexpected one-percentage-point increase in the federal funds rate generally reduces real *income growth* temporarily and, thus, leaves the *level* of real personal income below what it otherwise would have been.[8] The model treats tightening and easing of the fed funds rate symmetrically, so that an unexpected cut in the funds rate temporarily raises real personal income growth relative to what it otherwise would have been.

The greatest response to an unanticipated change in monetary policy is not immediate. In fact, real income at the state level is essentially unchanged for two quarters after an unanticipated one-percentage-point increase in the federal funds rate, but then real income declines substantially in most states. The maximum gap between actual personal income and what it would be without the change in monetary policy occurs, on average, about eight to 10 quarters following the policy shock. This general profile is similar to the estimated impact of monetary policy changes on the U.S. economy as reported in other studies.[9] If we look at real personal income's response to an unexpected increase of one percentage point in the federal funds rate, income in the nation falls 1.16 percent (compared with what it would have been) eight quarters after the increase (Figure).

nomic variables. See Shaghil Ahmed's article for a fuller discussion of the distinction between unanticipated and anticipated changes in monetary policy and their effects on real activity.

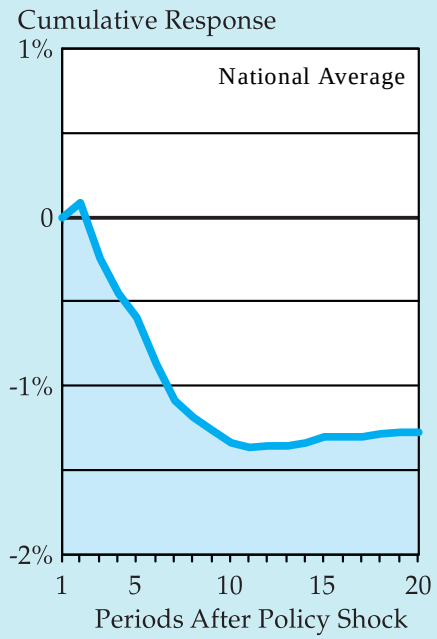
[7]The gap in each period is called the cumulative impulse response.

[8]The question of how monetary policy affects real personal income in the long run remains open. We did not conduct formal statistical tests on the significance of the long-run response and so cannot shed light on the issue. While the graph presented in the text suggests a sustained impact, the effects of policy shocks over long horizons are estimated with less statistical precision than those estimated over short horizons. Since the estimates become less precise, statements about policy's long-term impact become more tenuous.

[9]See, for example, the 1996 study by Eric Leeper, Christopher Sims, and Tao Zha.

FIGURE

Response of Real Personal Income to an Unexpected One-Percentage-Point Increase in the Fed Funds Rate



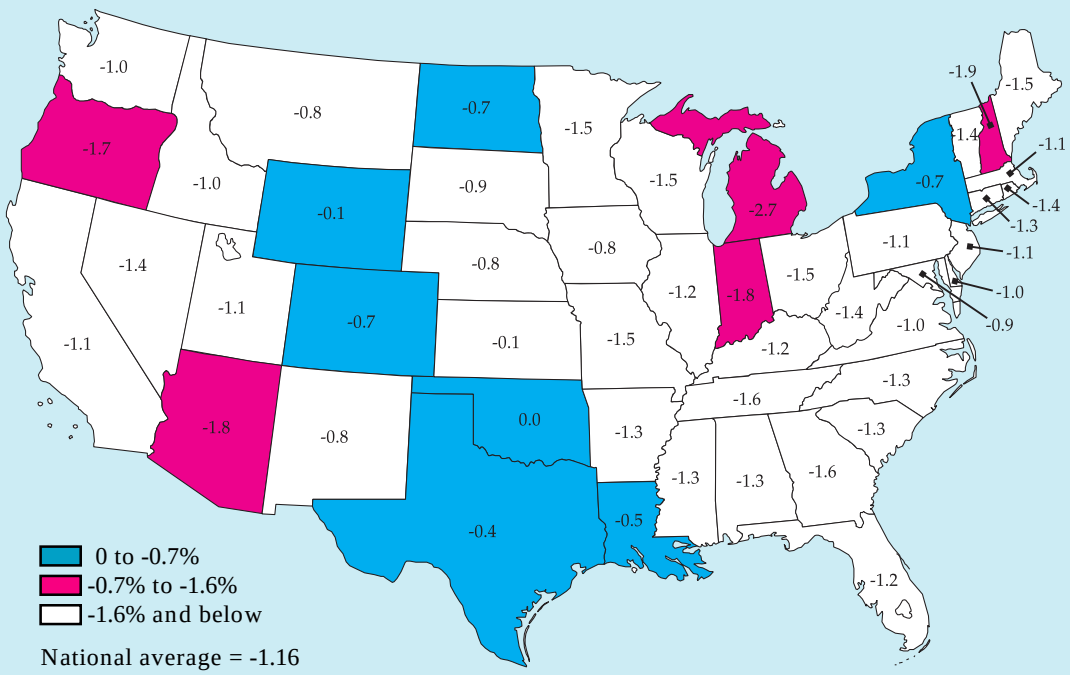
Graph shows the percent difference in real personal income from what it would have been without the unanticipated increase in the fed funds rate.

While the vast majority of state responses follow the general pattern demonstrated by the national average, not all states respond by the same magnitude (see map).[10] Michigan has the largest response: real income fell 2.7 percent eight quarters after a one-percentage-point increase in the federal funds rate. Seven states (Arizona, Georgia, Indiana, Michigan, New Hampshire, Oregon, and Tennessee) respond at least 38 percent again as much as the national average.[11] Possible explanations for this high response include the fact that four of these states (Indiana, Michigan, New Hampshire, and Oregon) have a relatively high concentration of durable goods manufacturing, an interest-sensitive industry. One state (Arizona) has a much higher than average concentration of construction, another interest-sensitive industry. While Georgia and Tennessee do not have an especially high concentration of interest-sensitive industries, they

[10]The cumulative impulse response functions for individual states are shown in our 1999 article on the Internet at www.phil.frb.org/econ/wps/1997/wp97-12.pdf.

[11]The average state response was 1.16 percent with a standard deviation of 0.4684. The seven most responsive states are at least one standard deviation above the average state response.

Response of Personal Income to a One-Percentage-Point Increase in the Fed Funds Rate*



*Eight-quarter cumulative impulse response of personal income

may have large markets for their products in the states that *are* highly responsive to monetary policy shocks; if so, Georgia and Tennessee would tend to be more sensitive to monetary policy actions than their own industrial structures would indicate.[12]

Seven states (Colorado, Louisiana, Oklahoma, New York, North Dakota, Texas, and Wyoming) are the least sensitive to monetary policy shocks, responding no more than 60 percent as much as the national average.[13] Interestingly, the total output of four of these states (Louisiana, Oklahoma, Texas, and Wyoming) includes a high concentration in the extractive industries (drilling and mining). Although these states are found to be the four least sensitive to monetary policy actions, they are buffeted by other types of shocks, particularly shocks to the price of energy. For example, a one-percentage-point decrease in the growth rate of the relative price of energy leaves real personal income in the four states between 1.6 percent (Oklahoma) to 3.2 percent (Wyoming) lower than otherwise after two years. (Personal income fell 1.9 percent in Texas and 2.8 percent in Louisiana in response to this energy price shock.)

By contrast, New Jersey, an energy-consuming state, experiences a rise in personal income of about 2 percent two years after a one-percentage-point decrease in the growth rate of the relative price of energy. We also found that Colorado, New York, and North Dakota tend to be less responsive to monetary policy shocks than the national average. One reason is that production in these states involves relatively small shares of interest-sensitive industries.

Responses of States Within a Region. By using a weighted average of the responses of states within a region, we can form an average response for each of the eight major regions (*Table of Regional Summaries*). The absolute value of these responses ranges from 0.52 in the Southwest to 1.72 in the Great Lakes; in terms of absolute value the national average is 1.16.[14]

Comparisons of states' responses to monetary policy actions reveal that an individual state's response is often quite different from the average response of its region and from the response of the other states in that region. For example,

[12]Since we used broad regional aggregates to capture these spillovers in our model, we are unable to shed any light on the extent to which trade among individual states influences their responsiveness to monetary policy actions.

[13]States were placed in this grouping if their policy response was at least one standard deviation below that of the average state.

[14]Real personal income growth in the Rocky Mountain region also has a relatively small response to monetary policy shocks. Thus, our findings match up well relative to those reported in our earlier article, which found the largest response to monetary policy actions in the Great Lakes region and the least response in the Southwest and Rocky Mountain regions.

Table of Regional Summaries

Region	Average Response*
New England	-1.26
Mideast	-0.91
Great Lakes	-1.72
Plains	-1.14
Southeast	-1.23
Southwest	-0.52
Rocky Mountain	-0.80
Far West	-1.16
All Regions	-1.16

*Eight-quarter cumulative impulse response of real personal income. The regional responses are computed as weighted averages of the individual state responses; the weights reflect each state's share of its region's personal income.

we found that real personal income in the Far West region fell 1.16 percentage points following a one-percentage-point increase in the fed funds rate, matching the average national response. However, two of the four states that make up the Far West region (Oregon and Nevada) are considerably more responsive to monetary policy shocks.

Being part of a region that has a low response to monetary policy actions is no guarantee that each state in the region will respond similarly. Arizona responds more than half again as much as the U.S. average, despite being part of the least responsive Southwest region. In general, there is much less variation in regional responses to monetary policy shocks than in state responses.[15]

WHAT CAUSES THE DIFFERENTIAL STATE RESPONSES TO MONETARY POLICY ACTIONS?

In our regional study, we showed that a region's response to monetary policy is related to its mix of interest-sensitive industries and possibly to its mix of large and small firms. Because small businesses typically have banks as their sole sources of credit they might be considered more sensitive to Fed policy. Our regional study found only slight evidence that economic activity in regions that have high concentrations of small firms was more sensitive to changes in Fed policy. Similarly, some researchers believe that the effects of monetary policy would be greater in regions with a large share of small banks. But our regional study found that the mix of small and large banks has the opposite effect. In another recent study, we looked at how important these factors are in accounting for the different state responses to monetary policy shocks (Appendix).[16] The individual state responses (the estimated values of the cumulative responses shown on the map) were systematically related to variables capturing two of these three factors.

The interest sensitivity of a state's industries is likely to rise with the percent of a state's total gross state product accounted for by construction or durable goods manufacturing. Studies have shown that consumer spending on housing and manufactured goods, especially durable goods, tends to be interest sensitive. Spending on services, in contrast, tends to vary little with interest rates.[17] Our analysis indicates that state economies with a large proportion of construction or manufacturing of durable goods are more responsive to changes in monetary policy than the more industrially diverse states.

On the other hand, the analysis found that states with relatively large shares of output accounted for by the extractive industries and by the finance, insurance, and real estate industries are less sensitive to changes in monetary policy than the more industrially diverse states. This finding suggests that differences in interest-rate sensitivities across industries are one reason for different state responses.[18] Differences in the mix of interest-sensitive industries may explain why the states that make up the Third Federal Reserve District (Pennsylvania, New Jersey, and Delaware) respond somewhat more to monetary policy shocks than other states in the Mideast region. (See *Monetary Policy and the Third District States.*)

[15]The standard deviation of the regional responses is 0.3574; state responses show a considerably larger standard deviation of 0.4684.

[16]See Gerald A. Carlino and Robert DeFina (1998b).

[17]See Paul Bennett's article for a survey of relevant studies.

[18]The finding of high interest-rate sensitivity for states that depend heavily on durable goods manufacturing is consistent with our findings for regions. However, unlike the state-level findings, our regional results did not offer significant evidence that regions that depend on the construction industry have greater responsiveness to monetary policy initiatives. The state-level findings are likely to be more reliable, since they are based on a much larger sample.

Monetary Policy and the Third District States

The responses of the states of the Third Federal Reserve District to monetary policy shocks are similar to one another and to the national average response.[a] The states of the Third District have a somewhat stronger response, however, than the other two states in the Mideast region—Maryland and New York. This stronger response can be attributed, at least in part, to differences in the mix of interest-sensitive industries. For example, New York has a much higher concentration of finance, insurance, and real estate industries (24.3 percent) compared with the average state (14.9 percent), which tends to reduce New York's responsiveness (see the Table). Also limiting New York's responsiveness is its relatively low fraction of construction and durable goods manufacturing.

Share of Total Output Attributable To Selected Interest-Sensitive Industries[b]

State	Construction	Durable Goods	Finance, Insurance, and Real Estate	Policy Response[c]
Delaware	5.0	9.8	19.8	-1.00
Maryland	5.9	7.1	18.1	-0.92
New Jersey	4.4	9.6	18.4	-1.06
New York	3.4	9.4	24.3	-0.72
Pennsylvania	4.5	14.8	15.6	-1.14
U.S. Average	**4.7**	**11.5**	**14.9**	**-1.16**

While Maryland has a somewhat higher share of interest-sensitive construction, Maryland's responsiveness tends to be limited by its relatively low share of interest-sensitive durable goods manufacturing and its relatively high concentration of income from the finance, insurance, and real estate sector. By contrast, Pennsylvania has a relatively high share of durable goods manufacturing and only a slightly above-average share of income from the finance, insurance, and real estate sector. Thus, among the states of the Mideast region, Pennsylvania tends to be the most responsive to monetary policy actions.

Because the policy responses (impulse responses) were estimated over a long period, the industry mix variables given in the table are averaged over 1977-90. However, states have experienced changes in their mix of industries over time, so that long-run averages may not be representative of a state's current industrial structure. Therefore, we also looked at the 1996 share of each state's personal income accounted for by the industries given in the table and found that conclusions based on 1996 shares are consistent with those based on shares averaged over the period 1977-90.

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[a]The Third District covers the eastern two-thirds of Pennsylvania, southern New Jersey, and Delaware.

[b]Shares are averaged over the period 1977-90.

[c]Eight-quarter cumulative impulse response in real personal income that results from an unanticipated one-percentage-point increase in the federal funds rate.

At the state level we find no evidence that states containing a larger concentration of small firms tend to be more responsive to monetary policy shifts than states containing small concentrations of small firms.[19] In addition, we found that a region becomes less sensitive to an increase in the federal funds rate as the percentage of small banks in that region increases. This result is inconsistent with the view espoused by Anil Kashyap and Jeremy Stein that small banks do not have as many alternative sources of funds and are therefore affected more by changes in monetary policy.[20] One possibility for the inconsistency is that a bank's asset size may be a poor indicator of its ability to adjust its balance sheet to monetary policy actions. In a study at the Federal Reserve Bank of Boston, Joe Peek and Eric Rosengren suggested that bank capital is a better indicator—better capitalized banks have more and cheaper alternative sources of funds available. Using data for New England banks during the late 1980s and early 1990s, the authors found that the number of loans made by banks that were under regulatory pressure to raise their capital levels did not increase in response to a lower federal funds rate.

[19]According to one theory, Fed actions affect economic activity by altering banks' ability to provide loans. Large firms usually have greater access to alternative, nonbank sources of funds, such as issuing corporate stocks and bonds or commercial paper. We found no evidence, however, that activity in states that have high concentrations of small firms was especially sensitive to changes in Fed policy.

[20]This contrary effect was also found in our regional study.

CONCLUSION

Does monetary policy have differential effects across states? The answer clearly is yes. Comparisons of states' responses to monetary policy actions reveal that an individual state's response is often quite different from the average response of its region and from the response of the other states in that region.

We provided some reasons for the differential policy response across states. The size of a state's response to a monetary policy shock is positively related to its share of construction and durable goods manufacturing and negatively related to its share of extractive industries and the finance, insurance, and real estate industries. A state's concentration of small firms has no significant effect on the size of the state's policy response. Finally, a greater concentration of small banks decreases a state's sensitivity to monetary policy shocks, contrary to the predictions of Kashyap and Stein.

Appendix

The absolute value of the estimated state cumulative responses shown in Table A (and summarized in the map) are used as dependent variables in a cross-state regression equation to explain the differential state responses to monetary policy shocks. An eight-quarter horizon was chosen for the cumulative response because this is generally when Fed policy has its maximum cumulative impact. The independent variables in the model are designed to account for the three reasons given to explain why state responses to monetary policy innovations differ. The shares of a state's gross state product (GSP) accounted for by each of eight major industry groupings are included to capture the effect of monetary policy as a result of the policy's effect on interest rates. The percent of a state's firms (establishments) that are small, defined as the percent of a state's firms with fewer than 250 employees, is included to capture the possible effects of firm size. Two alternative variables are used to capture the effects of bank size—the percent of a state's total loans made by the state's banks at or

Appendix (continued)

TABLE A

Eight-Quarter Cumulative Responses to a One-Percentage-Point Fed Funds Rate Increase (response in percentage points; weight is the state's share of regional personal income.)

New England	Response	Weight
Connecticut	1.2678	0.29
Massachusetts	1.0712	0.47
Maine	1.5099	0.07
New Hampshire	1.9264	0.07
Rhode Island	1.4391	0.07
Vermont	1.4246	0.03

Mideast	Response	Weight
Delaware	1.0018	0.01
Maryland	0.9174	0.10
New Jersey	1.0607	0.20
New York	0.7176	0.44
Pennsylvania	1.1379	0.25

Great Lakes	Response	Weight
Illinois	1.2351	0.30
Indiana	1.8345	0.12
Michigan	2.6634	0.22
Ohio	1.5378	0.25
Wisconsin	1.4604	0.11

Plains	Response	Weight
Iowa	0.8278	0.16
Kansas	0.9653	0.14
Minnesota	1.1982	0.25
Missouri	1.5282	0.29
Nebraska	0.8216	0.09
North Dakota	0.7427	0.03
South Dakota	0.8695	0.04

Southeast	Response	Weight
Alabama	1.3261	0.07
Arkansas	1.3443	0.04
Florida	1.154	0.22
Georgia	1.6084	0.11
Kentucky	1.1599	0.06
Louisiana	0.4935	0.07
Mississippi	1.3004	0.04
North Carolina	1.3404	0.11
South Carolina	1.2816	0.05
Tennessee	1.5632	0.08
Virginia	1.022	0.12
West Virginia	1.3803	0.03

Southwest	Response	Weight
Arizona	1.8006	0.13
New Mexico	0.8182	0.05
Oklahoma	-0.0741	0.13
Texas	0.361	0.69

Rocky Mountain	Response	Weight
Colorado	0.7134	0.50
Idaho	0.9573	0.13
Montana	0.8469	0.11
Utah	1.1396	0.19
Wyoming	0.1109	0.07

Far West	Response	Weight
California	1.1305	0.79
Oregon	1.7168	0.07
Washington	0.9757	0.12
Nevada	1.4356	0.03

below the 90th percentile in assets nationally, and the percent of a state's total loans made by the state's banks at or below the 90th percentile in assets nationally and not part of a bank holding company. Because the estimated long-run responses represent average behavior during the sample period, averaging the data for the explanatory variables is appropriate. Averaging also minimizes the chance that the results depend on the data for a particular year and helps control for business-cycle dynamics. (Data availability limited averaging to the period from the mid-1970s to the early 1990s.)

Two versions of the model are presented in Table B, depending on which of the alternative small-bank variables is used. In model 1, the all-small-banks variable is included, whereas model 2 uses only small banks that are not members of a bank holding company. The results for models 1 and 2 pre-

sented in Table B explain between 61 to 62 percent of the cross-state variation in cumulative responses. The percent of a state's GSP accounted for by the manufacture of durable goods and by construction is positively and significantly related to the size of a state's long-run response to Fed policy shocks; the percent of a state's GSP accounted for by its extractive industries and by the finance, insurance, and real estate industries is negatively and significantly related to its long-run response to Fed policy. These results appear quite reasonable and do not depend on the choice of the loan variable. The importance of the shares of durable goods manufacturing and construction can be interpreted as evidence that monetary policy affects total output because higher interest rates are likely to have profound effects on people's ability to buy houses and other big ticket items, such as autos.

We find no evidence that cross-state variation in the mix of small versus large firms matters. States containing large concentrations of small firms tend to be no more responsive to monetary policy shifts than states containing small concentrations of small firms. In contrast, we find some evidence that a state becomes more sensitive to a monetary policy shock as the percentage of small banks in the state goes down. The estimated coefficients on the small-bank variables are negative in both models 1 and 2 and negative and significant in model 2.

TABLE B
Explaining Cross-State Variation in Policy Responses[a]

Variable[b]	Model 1	Model 2
Intercept	0.2179 (1.5218)	0.3194 (1.4867)
% Agriculture	-0.5071 (1.4005)	-0.3359 (1.3818)
% Mining	-3.4785 (1.7354)**	-3.2890 (1.7157)*
% Construction	20.9681 (8.2570)**	19.5034 (8.1240)**
% Durables Mfg.	5.5628 (1.4791)***	5.5225 (1.4374)***
% Nondurable Mfg.	-0.1964 (1.5781)	-0.0639 (1.5585)
% Transportation	3.4391 (4.4016)	3.3139 (4.2550)
% Wholesale Trade	-0.6849 (4.9399)	-0.3864 (4.8691)
% Retail Trade	-3.0018 (7.6550)	-1.6932 (7.5837)
% FIRE	-5.0091 (2.7362)*	-5.2696 (2.7047)*
% Small Firm	0.0064 (0.0109)	0.0047 (0.0107)
% Small Bank Loans (all banks)	-0.0044 (0.0031)	
% Small Bank Loans (no holding co.)		-0.0076 (0.0042)*
Adjusted R^2	0.6070	0.6191

[a]The dependent variable is the absolute value of the estimated state cumulative responses shown in the table. Standard errors in parentheses. *, **, and *** indicate that a null hypothesis of zero is rejected at the 10%, 5%, and 1% levels, respectively.

[b]Variables are averaged over 1977-90.

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