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THE DIFFERENTIAL REGIONAL EFFECTS OF MONETARY POLICY: EVIDENCE FROM THE U.S. STATES

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Abstract

This paper uses time-series techniques to examine whether monetary policy had symmetric effects across U.S. states during the 1958:1-1992:4 period. Impulse response functions from estimated structural vector autoregression models reveal differences in policy responses, which in some cases are substantial. The paper also provides evidence on the reasons for the measured cross-state differential policy responses. The size of a state's response is significantly related to industry-mix variables, providing evidence of an interest rate channel for monetary policy, although the state-level data offer no support for recently advanced credit-channel theories.

1. INTRODUCTION

This paper examines empirically how economic activity in each of the 48 contiguous states responds to monetary policy actions. The idea that policy changes affect states differently is intuitive given the heterogeneity of state economies and their financial networks. At a deeper level, cross-state variation in a state's response to Fed actions can be deduced from traditional and new credit-based theories [Bernanke and Blinder (1988); Kashyap, Stein, and Wilcox (1993); Kashyap and Stein (1994)] of the monetary policy transmission mechanism. Still, evidence on the nature and extent of such differences is limited, in part because of the simplified way in which policy and regional economic activity have been modeled. Specifically, previous studies have failed to account for inter-relationships among sub-national economies and associated feedbacks from policy shocks. Moreover, existing studies have been restricted to particular regions within the U.S. or Canada, and no comprehensive look at state responses to a policy change is available. Also lacking is a systematic analysis of why state economies can respond differently to policy. Existing studies typically focus on identifying differential responses, but the reasons for any measured differences are unaddressed or explained heuristically as a function of industry mix. Nonetheless, state-level data offer a rich avenue for exploring the empirical significance of possible transmission mechanisms for monetary policy. Finally, the manner by which existing studies identify monetary policy shocks and, more generally, control for the influences of macroeconomic developments appears lacking. This study contributes to the debate about policy's sub-national effects by applying a statistical methodology that handles these important issues neglected in earlier work.

The effects of monetary policy on real personal income in each of the 48 contiguous states are studied using structural vector autoregression models (SVARs) estimated over the period 1958:1

to 1992:4. Impulse response functions from the estimated SVARs reveal a broad pattern in which state real personal income tends to fall after an unanticipated increase of one percentage point in the federal funds rate. The maximum effect on income levels occurs about eight quarters after the policy shock. Nonetheless, differences in state responses are evident and, in some cases, substantial. The largest response among states (Michigan) exceeded the smallest (Oklahoma) by 2.73 percentage points. This compares with an average state response of 1.09 percentage points. States within the Great Lakes region are found to be the most sensitive to monetary policy changes, responding one-and-a-half times as much as the nation, on average. States within the Southwest region, by contrast, are found to be the least sensitive, responding half as much as the nation, on average.

The study then examines which attributes of state-level economies underlie their different responses to monetary policy shocks. Several theoretically motivated variables are investigated and, of these, measures capturing differences in share of gross state product accounted for by a state's manufacturing sector are significantly correlated with a state's response to monetary policy shocks This finding is taken as evidence for the traditional interest rate channel for monetary policy. Two other variables, which proxy for the so-called credit channel of monetary policy, either have no significant correlation or one opposite to that predicted by theory. Thus, we find no evidence that a credit channel for monetary policy operates at the state level, despite their possible importance for individual firms.

2. SOURCES OF STATE DIFFERENCES IN THE EFFECTS OF MONETARY POLICY

Monetary theory suggests several reasons why Fed policy actions can have different sub-national effects. These include state differences in the mix of industries, in the number of large versus small firms, and in the number of large versus small banks.

The Role of Industry Mix. At the national level, both the timing and impact of monetary policy actions differ across industries. In part, these differences arise because of varying interest sensitivities in the demand for products. Housing, cars, and other durable manufactured goods have historically been more responsive to interest rate changes than, say, consumer services. In a similar vein, differences in an industry's response can depend on whether its output constitutes a necessity or a luxury, and the extent to which demand for the industry's output is linked to foreign trade and, thus, the health of foreign economies.

These varying industry responses together with differing industry mixes across states provide a natural way for monetary policy to have differential state effects.[1] As Table 1 shows, industry mix differs widely across states. For example, manufacturing, which is thought to be an interest-sensitive sector, accounted for about 34 percent of real gross state product (GSP) in Michigan, on average, during the 1977-90 period, but less than 4 percent of Wyoming's real GSP. These state shares can be compared with an overall average state manufacturing share of 20 percent.

Possible Credit Channels. Recent theoretical work on possible credit channels for the transmission of monetary policy actions to economic activity suggests that state differences in the mix of large versus small firms and large versus small banks could lead to different state responses to monetary policy.[2] Concerning firm size, Bernanke and Blinder (1988), Bernanke (1993), and Gertler and Gilchrist (1993) argue that monetary policy affects economic activity by directly affecting banks' abilities to provide loans. Moreover, significant information costs and transaction costs often require small firms to deal with financial intermediaries, primarily banks, to meet their credit needs. Large firms, by contrast, usually have greater access to external, nonbank sources of funds. Consequently, activity in a state that has a high concentration of small firms could be especially sensitive to Fed policy. It is also possible that the greater uncertainty about the health and prospects of small firms means that they face relatively greater volatility in the costs of all forms of finance (bank loans, trade credit, commercial paper, etc.) in light of Fed actions [Gertler and Gilchrist (1993); Oliner and Rudebusch (1995)]. If so, state-level differences in mix of firm size will imply state-level differences in responses to policy actions.

As Table 2 shows, the percentage of small firms (defined as state firms with fewer than 250 employees averaged over the 1976 to 1992 period) varies widely across states. It ranges from a low of about 49 percent in Connecticut to a high of about 89 percent in Montana. The average state share is 72 percent.

A potential role for bank size in the monetary transmission mechanism has been developed by Kashyap and Stein (1994), who suggest that Fed policy actions can have varied effects on different banks' abilities to make loans. During periods of tight monetary policy when bank reserves are restricted, some banks can find alternative sources of funding for deposits and loans (by issuing large denomination CDs, for example) more cheaply and easily than others. Such lending by banks will be less sensitive to monetary policy changes. Kashyap and Stein (1994) propose that bank size largely explains differences in financing abilities, with large banks having more funding options available than small banks. Thus, states in which a disproportionately large share of bank loans is made by small banks might respond more to monetary policy shifts than states in which a large share of loans is made by the nation's large banks.[3]

Kashyap and Stein (1994) define small banks as those with total assets at or below a given percentile--they use, alternatively, the 75th, 90th, 95th, or 98th percentile. Table 3 shows the state distribution of loans for the nation's banks that are at or below the 90th percentile in terms of total assets averaged for the period 1976 to 1992. Whether we look at all small banks or only small banks that are <u>not</u> members of a bank holding company, the state distribution of loans by small banks appears highly unequal, suggesting that monetary policy could have differential state effects for the reasons proposed by Kashyap and Stein (1994).[4]

3. LITERATURE REVIEW

Some researchers have investigated the effects of monetary policy on interregional banking flows as opposed to economic activity. Studies by Miller (1978) and Bias (1992) have found that Fed policy actions do affect regional banking flows differentially. More typical of earlier studies is the use of a reduced-form, St. Louis-type equation in which personal income, earnings, or employment is regressed on the high-employment federal government revenues, high-employment federal government expenditures, and the national money supply. These models are applied at the regional level to test the monetarist proposition that monetary policy has an important impact on nominal income [Toal (1977); Garrison and Chang (1979); Beare (1976), Mathur and Stein (1980); Garrison and Kort (1983)].[5]

Garrison and Chang (1979) study regional manufacturing earnings in the eight major BEA regions during the 1969-76 period and find that monetary policy has differential effects across regions, with an especially large impact in the Great Lakes region and a rather small impact in the Rocky Mountain region. Like Garrison and Chang (1979), Toal (1977) concludes that differences in regional responses to monetary policy changes existed in the 1952 to 1975 period, with relatively larger responses in the Mideast, Great Lakes, and Southeast regions, and relatively weak responses in the Rocky Mountain and New England regions. Carlino and DeFina (1998) study whether monetary policy has similar effects across BEA regions in the United States. Impulse response functions from a structural vector autoregression estimated over the period 1958:1 to 1992:4 revealed a core of regions--New England, Mideast, Plains, Southeast, and the Far West--that respond to monetary policy changes in ways that closely approximate the U.S. average response. Of the three non-core regions, one (Great Lakes) is noticeably more sensitive to monetary policy changes, and two (Southwest and the Rocky Mountain) are found to be much less sensitive. Thus, most past studies find that the states comprising the Great Lakes region are generally the most responsive to changes in the money supply, while states in the Rocky Mountain region are least responsive.[6]

4. EMPIRICAL APPROACH

The Model. Economic activity in the 48 contiguous states is modeled using structural vector autoregressions (SVARs), a methodology that accounts for feedbacks between all system variables in describing the effects of policy shocks. Formally, we study the dynamic behavior of 48 state-level, 13 x 1 covariance-stationary vectors:

$$Z_{s,t} = (\Delta x_{s,t},\ \Delta x_{r-s,t},\ \Delta x_{r2,t},\ldots,\ \Delta x_{r8,t},\ \Delta c_{1,t}\ \Delta c_{2,t},\ \Delta c_{3,t},\ \Delta m_t)',$$

where t indexes time, Δx_s is real income growth in state s, Δx_{r-s} is growth of real income in the BEA region containing the state less the state's real income, Δx_{r2} through Δx_{r8} are growth in the real incomes of the other seven major BEA regions, Δc_1 through Δc_3 are three macroeconomic control variables, and Δm is a measure of monetary policy actions.

The dynamics of $Z_{s,t}$ are represented by:

(1) $$AZ_{s,t} = B(L)Z_{s,t-1} + e_{s,t}\ ,$$

where A is a 13 x 13 matrix of coefficients describing the contemporaneous correlations among the variables; B(L) is a 13 x 13 matrix of polynomials in the lag operator, L; and $e_{s,t} = [\varepsilon_{1,t}, \varepsilon_{2,t}, \cdots, \varepsilon_{13,t}]'$ is a 13 x 1 vector of structural disturbances, or primitive shocks, for each state. Thus, each of the system's variables, including the state's real income, can be influenced by its own idiosyncratic shocks and by shocks to all other variables. The matrices A and B(L) determine how shocks to each variable are transmitted through the system, both contemporaneously (the A matrix) and in subsequent periods (the B(L) matrix). To see this more explicitly, rewrite (1) as a reduced-form:

(2) $$Z_{s,t} = C(L)Z_{s,t-1} + u_{s,t} \ ,$$

where $C(L) = A^{-1}B(L)$ is an infinite-order lag polynomial, and $u_{s,t} = A^{-1}e_{s,t}$ describes the relationship between the model's reduced-form residuals and the model's structural residuals.[7]

*Impulse Response Functions***.** The standard way to summarize the dynamic impact of policy shocks on personal income growth is the cumulative impulse response function.[8] Assuming the system's primitive innovations, e_t, are identified, impulse response functions, Z_t, are calculated directly from (1) as

(3) $$Z_{s,t} = [I - C(L)]^{-1}A^{-1}e_{s,t} = \theta(L)e_{s,t}$$

(4) $$where: \quad \Theta(L) = \sum_{l=0}^{L} \Theta_l L^{\,l},$$

and Θ_l is a k x k matrix of structural parameters. It is evident from (3) and (4) that the impulse responses reflect the dynamic interaction of all model parameters subsequent to a policy shock, $e_{s,t.}$

Estimation Procedure and Identification Restrictions. The elements of B(L) and A are estimated using Bernanke's (1986) two-step procedure. In the first step, OLS estimates of the reduced-form errors $u_t = A^{-1}e_t$ are obtained for the dynamic simultaneous equation model (2). Sufficient restrictions are then placed on the variance-covariance matrix of structural errors and on the matrix of contemporaneous correlations, A, to achieve identification. Given estimates of A, estimates of B(L) are derived from the relationship, $C(L) = A^{-1}B(L)$, where C(L) comes from the estimated reduced-form (2). Estimates of A also allow estimates of the structural errors, e_t, as implied by the relationship, $u_t = A^{-1}e_t$.

Two sets of standard restrictions are placed on the structural variance-covariance matrix:

- Structural shocks are assumed to be orthogonal (zero contemporaneous covariance).
- Variances of the structural shocks are normalized to unity.

These restrictions constrain the structural variance-covariance matrix to be an identity matrix.

Three sets of restrictions are placed on the matrix A. Each is motivated by practical consideration of time lags in the transmission of economic changes through sub-national and national economies:

- A state-specific shock affects only the state of origin contemporaneously, although it can spill over into other regions with a one-quarter lag.[9]
- Fed policy actions, shocks to core inflation, changes in the leading indicators, and changes in the relative price of energy are assumed to affect state income growth no sooner than with a one-quarter lag.

- Neither state income growth nor Fed policy actions contemporaneously affect changes in core inflation, in the leading indicators, or in the relative price of energy.

Residual changes in the federal funds rate represent the exogenous policy innovations (the $\varepsilon_{m,t}$), which are needed to compute the impulse responses. Four lags of each variable are used in the estimation, a sufficient number to eliminate serial correlation in the errors.[10] Given these estimates, impulse responses are calculated using (3).

Variable Selection. State-level economic activity is measured using real personal income, calculated by deflating quarterly data on nominal personal incomes for each state during the period 1958:1 to 1992:4 with the national Consumer Price Index (CPI-U).[11] Use of the national CPI-U is forced by unavailability of state price indices.[12]

Which variable best serves as an indicator of monetary policy has been long debated, both inside and outside the Fed. The debates have identified several possibilities, including reserve aggregates (such as non-borrowed reserves), monetary aggregates, interest rates (in particular, the federal funds rate and the three-month Treasury bill rate), and so-called "narrative" policy indicators derived from the official Federal Open Market Committee minutes. Among the available choices, the case for using an interest rate appears most convincing both in light of actual Fed operating procedures and the most recent empirical evidence [see, for example, Leeper, Sims, and Zha (1996)]. Thus, we select the federal funds rate as the policy measure.[13]

Three variables are employed to control for macroeconomic influences on state economies and Fed policy decisions. The Bureau of Labor Statistics' "core" CPI (the official index less the effects of food and energy prices) captures underlying trends in the aggregate price level. The BEA index of leading indicators is employed as a parsimonious way to include a variety of macroeconomic real-sector variables. Finally, to account for aggregate supply shocks, an energy price variable is included in the system. This variable is calculated as the Producer Price Index for fuels and related products and power relative to the total Producer Price Index. It is especially important to account for energy price shocks given the large changes that occurred during period studied.

Unit Root Tests. The variables used in the estimation must be stationary so that standard statistical theory applies. We conducted augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests applied to the levels and first-differences of the system's variables [Hamilton (1994)]. All variables except the federal funds rate are expressed in logs. The unit root null cannot be rejected at conventional significance levels for any of the data series (in levels) using either the ADF or PP tests, although stationarity is achieved by first-differencing. Thus, first-differences of all variables are used to estimate the models.

5. EMPIRICAL RESULTS

Impulse Response Functions. Figure 1 shows the cumulative impulse responses for each state resulting from a one-percentage-point increase in the federal funds rate.[14] State responses are grouped by major BEA region and the weighted average of the state responses, labeled U.S., is included in each regional grouping as a benchmark.

Concerning the average response, real income exhibits a slight initial rise, followed by a substantial decline, subsequent to the policy shock. The maximum cumulative, or long-run, response occurs, on average, about eight quarters following the policy shock.[15] This general profile is similar to the estimated impact of monetary policy changes on the U.S. economy as reported in other studies [see, for example, Leeper, Sims and Zha (1996)].

The estimated state responses exhibit noticeable within-region and between-region variation at various horizons. For example, in the one to two quarters immediately following the policy shock, many states respond in ways that closely mirror the average response. Still, responses in a number of states, ones mainly located in the Plains and the Rocky Mountain regions, show considerable dispersion around the average. As the period after the shock lengthens, both within-region and between-region variation rise as the dynamics fully work through the system. In the long run, the real incomes in individual states generally settle down as they approach their new lower levels.

Table 4 contains these long-run, state responses (i.e., cumulative eight-quarter response), expressed in percentage points.[16] Each state's relative importance in its region's income (denoted "weight") is provided to help illuminate how a state's response affects its region's income growth and, ultimately, the nation's. Related data for the regional aggregates are shown in the lower part of the figure.

Among the states, Michigan has the largest response (2.7 percent), while five states (Arizona, Indiana, Michigan, New Hampshire, and Oregon) respond at least one-and-a-half times as much as the nation, on average. By contrast, four states (Louisiana, Oklahoma, Texas, and Wyoming) are found to be least sensitive, responding no more than half as much as the nation, on average. Moreover, across all states, the largest response (Michigan) exceeds the smallest (Oklahoma) by 2.73 percentage points.

Turning to regional differences, the regional responses (equal to a weighted average of component state responses) range from a low of 0.52 in the Southwest to a high of 1.72 in the Great Lakes, compared with a national average of 1.09. 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 earlier studies that found the largest response to monetary policy actions was in the Great Lakes region and the least response in the Southwest and Rocky Mountain regions.

The high responsiveness of the Great Lakes economy is due both to the generally high responsiveness of its component states and the relatively large contribution of each state to regional income. For the Southwest, Arizona has a sizable response but a relatively low share in regional income, which helps limit the region's overall response. The Southeast region has the least within-region variation as measured by the coefficient of variation, while the Far West region has the most within-region variation. The coefficient of variation also indicates that between-region variation is generally much greater than within-region variation. This can be seen by comparing the regional coefficients of variation to the coefficient of variation for the U.S. With the exception of the Far West region, the coefficient of variation (0.31) for the U.S. (average of all regions) exceeds the coefficient of variation within any of the individual regions.[17]

6. WHAT CAUSED THE DIFFERENTIAL STATE RESPONSES TO MONETARY POLICY ACTIONS?

Section 2 identified three possible ways by which monetary policy actions could differentially affect state economies, including differences in the mix of industries, firm size, and bank size. How important are these factors in accounting for the different state responses to monetary policy innovations?

To answer the question, absolute values of the long-run state responses (the estimated cumulative responses about eight quarters following a policy shock) are regressed on state-level independent variables that proxy for the hypothesized explanatory factors. Two industry-mix variables are used -- the percent of a state's GSP accounted for by manufacturing (taken from Table

1) and that accounted for by extractive industries.[18] The percent of a state's firms that are small, defined as the percent of a state's firms with fewer than 250 employees (taken from Table 2), captures the possible effects of firm size. To account for the bank size effects, we use two alternative variables: the percent of a state's total loans made by the state's banks at or 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 (taken from Table 3). The latter variable is used to control for the possibility that a bank can use its parent corporation as an alternative funding source during periods of tight credit. Because the estimated long-run responses represent average behavior during the sample period, averaging the data for the explanatory variables is appropriate. Data availability limited averaging to the period from the mid-1970s to the early 1990s. Averaging also minimizes the chance that the results depend on the data for a particular year and helps control for business-cycle dynamics.

Estimated parameters from four cross-state regressions are presented in Table 5. Models (1) and (2) contain the four explanatory variables described above. The banking variable in Model (1) is measured using all small banks, while the analogous variable in Model (2) excludes banks that are members of a holding company. Models (3) and (4) are similar to Models (1) and (2), respectively, except that dummy variables identifying the region in which a state is located have been included to control for fixed region-specific factors (the Southeast region is excluded).[19]

The results presented in Table 5 reveal that each regression is significant at the 1 percent level, explaining between 42 percent and 49 percent of the cross-state variation in cumulative responses. The percent of a state's GSP accounted for by manufacturing has a positive and significant relationship to the size of a state's long-run response to Fed policy shocks, while the percent of a state's GSP accounted for by its extractive industries has a negative and significant relationship.[20] These results appear quite reasonable and are robust to the choice of the loan variable and to the inclusion of regional dummies. The importance of manufacturing share can be interpreted as evidence of an interest rate channel for monetary policy.

We find no evidence that cross-state variation in the mix of small versus large firms matters. States containing a larger concentration of small firms tend to be no more responsive to monetary policy shifts than states containing smaller concentrations of small firms.[21] In contrast, we find some evidence that a region becomes less sensitive to a monetary policy shock as the percent of small banks in the region increases. The estimated coefficients are negative in all four equations and negative and significant in equations 2 and 4. The finding of a negative sign on the small bank variable is, however, inconsistent with the theory espoused by Kashyap and Stein (1994).[22] 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. For example, Peek and Rosengren (1995) suggest that bank capital is a better indicator--better capitalized banks have more and cheaper alternative sources of funds available. In addition, Kashyap and Stein (1994) point out that regional differences in the types of loans being made might also matter, a factor not controlled for in our study.

7. CONCLUSIONS

This paper uses time-series techniques to examine whether monetary policy had symmetric effects across U.S. states during the 1958:1-1992:4 period. Impulse response functions from estimated structural vector autoregression models reveal long-run differences in policy responses that, in some cases, are substantial. The response of Michigan, the most affected state, to an unanticipated one-percentage-point increase in the federal funds rate was 2.73 percentage points greater than that of Oklahoma, the least affected state. Nonetheless, state real personal income generally falls in the periods following an unanticipated increase in the federal funds rate, with the maximum effect on income levels occurring about eight quarters after the policy shock.

The paper also provides evidence on the reasons for the measured cross-state differential policy responses. We find that the size of a state's long-run response to a monetary policy shock is positively related to the share of manufacturing, evidence of an interest rate channel for monetary policy. 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 is found to decrease the state's sensitivity to monetary policy shocks, contrary to predictions of Kashyap and Stein (1994). Thus, we find no evidence for a credit channel for monetary policy operating at the state level. While credit channels may be important at the firm level, they do not appear to be important in the aggregate.

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Table 1: Percent of Gross State Product Accounted for by Manufacturing
(Averaged over the period 1977-1990)

MICHIGAN	33.5	MINNESOTA	21.9
INDIANA	33.2	GEORGIA	21.6
N. CAROLINA	32.3	KANSAS	19.2
OHIO	31.4	WASHINGTON	18.7
DELAWARE	31.1	VIRGINIA	18.5
WISCONSIN	30.4	NEW YORK	17.8
S. CAROLINA	28.5	W. VIRGINIA	17.8
KENTUCKY	26.4	CALIFORNIA	17.5
CONNECTICUT	26.1	IDAHO	16.9
RHODE ISLAND	25.8	TEXAS	16.7
TENNESSEE	25.6	LOUISIANA	15.5
NEW HAMPSHIRE	25.5	UTAH	15.4
PENNSYLVANIA	25.1	OKLAHOMA	14.9
ARKANSAS	24.7	ARIZONA	14.6
MISSISSIPPI	24.4	NEBRASKA	14.0
ALABAMA	23.9	COLORADO	13.6
IOWA	23.8	MARYLAND	13.2
ILLINOIS	23.1	FLORIDA	10.8
MASSACHUSETTS	23.1	S. DAKOTA	9.0
MISSOURI	22.8	MONTANA	8.8
MAINE	22.7	NEW MEXICO	6.3
NEW JERSEY	22.6	NORTH DAKOTA	5.6
VERMONT	22.4	NEVADA	4.5
OREGON	22.0	WYOMING	3.6

average	20.1
std. dev.	7.7

Source: BEA, Survey of Current Business,
Various Years.

Table 2: Share of Total State Employment Accounted for by a State's Small Firms
(Firms with less than 250 employees, averaged over the period 1976 to 1992)

MONTANA	89.1	MARYLAND	71.8
NORTH DAKOTA	87.8	MAINE	71.7
WYOMING	85.9	KENTUCKY	71.3
S. DAKOTA	84.3	GEORGIA	70.6
NEW MEXICO	82.1	VIRGINIA	70.5
OREGON	79.2	MINNESOTA	70.0
IDAHO	78.3	WISCONSIN	69.9
FLORIDA	77.8	ALABAMA	69.9
VERMONT	77.0	NEW JERSEY	69.4
OKLAHOMA	76.8	RHODE ISLAND	69.2
KANSAS	76.2	MISSOURI	68.9
NEBRASKA	75.6	TENNESSEE	67.6
COLORADO	75.3	INDIANA	66.8
LOUISIANA	75.1	OHIO	65.9
WASHINGTON	74.9	ILLINOIS	65.8
ARIZONA	74.9	N. CAROLINA	65.3
IOWA	74.1	PENNSYLVANIA	65.1
MISSISSIPPI	72.9	MICHIGAN	64.8
ARKANSAS	72.4	MASSACHUSETTS	64.6
UTAH	72.3	NEW YORK	64.1
W. VIRGINIA	72.3	S. CAROLINA	63.4
CALIFORNIA	72.3	DELAWARE	62.7
NEW HAMPSHIRE	72.0	NEVADA	60.7
TEXAS	71.9	CONNECTICUT	48.8
		average	71.9
		std. dev.	7.3

Source: County Business Patterns, Various Years

Table 3: Share of Total Loans Made by a State's Small Banks
(averaged over the period 1976 to 1992)

All Small Banks[a]				Not in Holding Co.[b]			
N. DAKOTA	73.0	VERMONT	28.3	KANSAS	63.6	S. DAKOTA	21.9
KANSAS	72.7	FLORIDA	25.2	NEBRASKA	53.4	S. CAROLINA	17.7
MONTANA	71.1	ILLINOIS	25.0	OKLAHOMA	50.6	ILLINOIS	17.4
IOWA	69.7	MAINE	24.7	ARKANSAS	47.5	MAINE	16.3
NEBRASKA	64.6	VIRGINIA	20.8	N. DAKOTA	46.7	UTAH	15.8
WYOMING	64.2	MICHIGAN	19.1	IOWA	46.3	VIRGINIA	14.6
ARKANSAS	63.8	S. CAROLINA	18.6	W. VIRGINIA	42.4	FLORIDA	12.7
W. VIRGINIA	60.8	UTAH	17.6	MISSISSIPPI	38.1	CONN	11.5
OKLAHOMA	57.6	OHIO	16.6	LOUISIANA	36.7	OHIO	11.1
WISCONSIN	54.9	MARYLAND	16.0	KENTUCKY	36.3	MICHIGAN	11.0
COLORADO	51.3	CONN	12.7	WISCONSIN	34.2	MARYLAND	11.0
NEW MEXICO	48.3	PENN	12.2	MONTANA	33.8	PENN	10.7
MISSOURI	46.5	IDAHO	11.2	WYOMING	32.3	OREGON	9.3
KENTUCKY	45.7	OREGON	10.4	NEW MEXICO	30.5	IDAHO	9.2
MINNESOTA	44.7	NEW JERSEY	10.4	N HAMPSHIRE	29.8	NEW JERSEY	8.6
N HAMPSHIRE	43.9	WASHINGTON	9.6	INDIANA	28.5	WASHINGTON	8.6
MISSISSIPPI	38.6	MASS	8.3	TENNESSEE	27.8	CALIFORNIA	5.6
LOUISIANA	37.6	CALIFORNIA	6.1	MINNESOTA	27.6	N. CAROLINA	5.6
TENNESSEE	36.5	N. CAROLINA	6.0	COLORADO	24.2	MASS	5.5
INDIANA	34.4	DELAWARE	4.8	MISSOURI	23.2	NEVADA	4.1
ALABAMA	33.1	NEVADA	4.7	ALABAMA	23.2	RHODE IS	3.1
TEXAS	32.9	ARIZONA	3.6	GEORGIA	23.2	DELAWARE	3.0
GEORGIA	32.3	RHODE IS	3.2	TEXAS	23.0	ARIZONA	2.9
S. DAKOTA	29.2	NEW YORK	1.2	VERMONT	22.2	NEW YORK	0.9
		average	31.7			average	22.6
		std. dev.	22.0			std. dev.	15.5

[a]The percent of loans made by a state's banks that are at or below the 90th percentile in terms of total assets (compared with all banks in the nation).

[b]The percent of loans made by a state's banks that are at or below the 90th percentile in terms of total assets (compared with all banks in the nation) and are not members of a multi-bank holding company.

Source: Compiled from Federal Reserve Call Reports, Various Years.

FIGURE 1: Cumulative Impulse Response of State Real Personal Income to Funds Rate Shock, Grouped by Major Region.

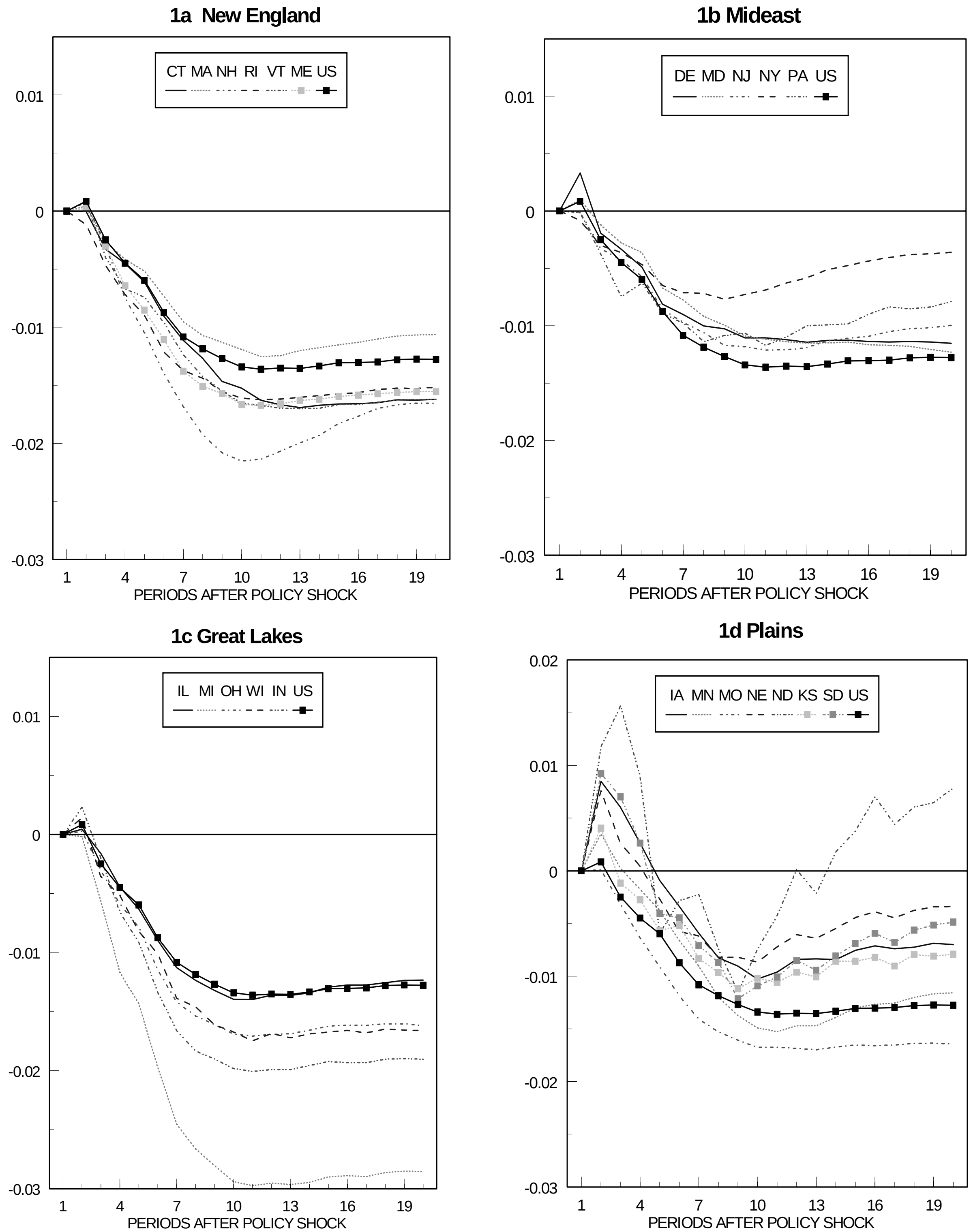

Figure 1: Continued.

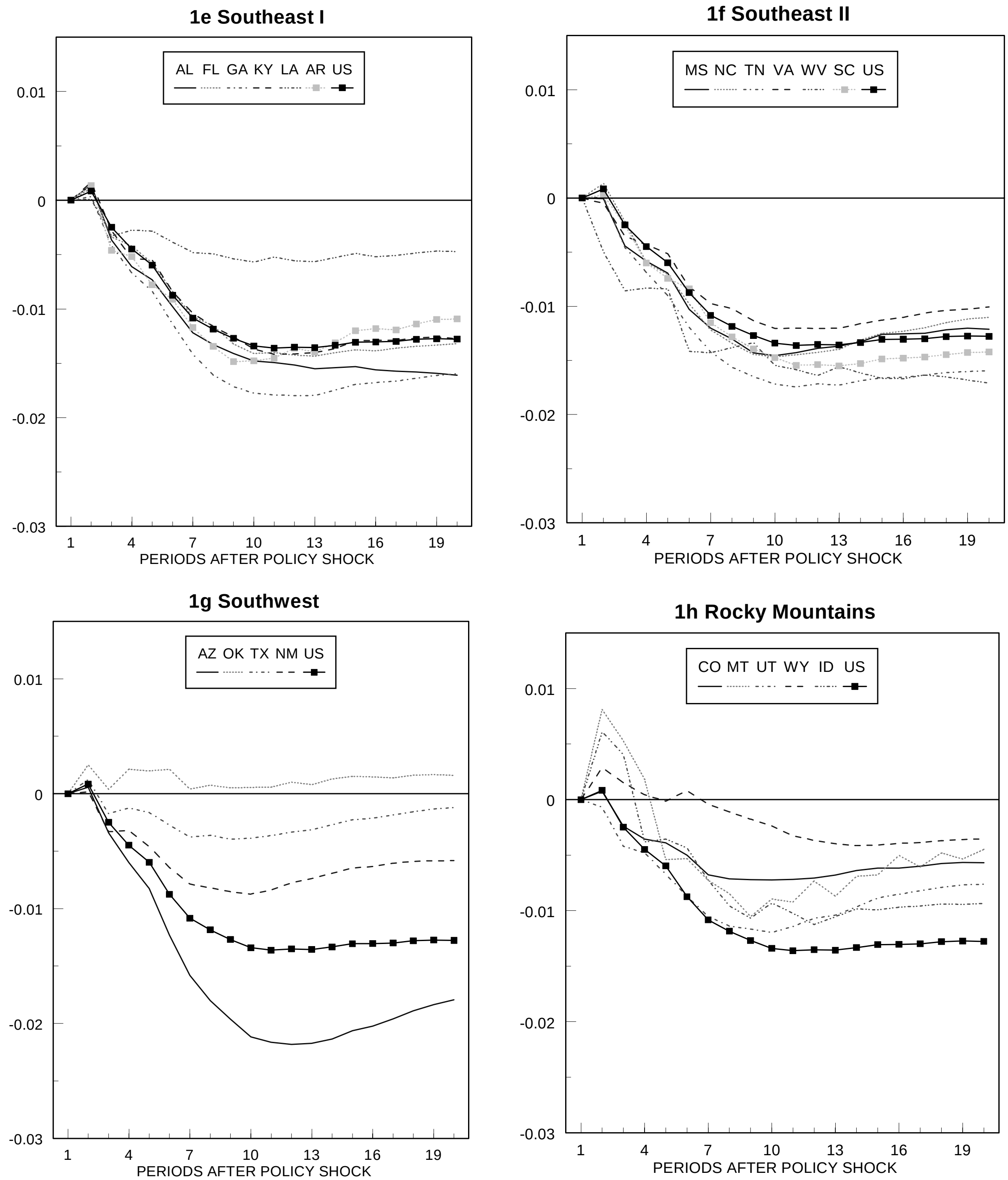

Figure 1: Continued.

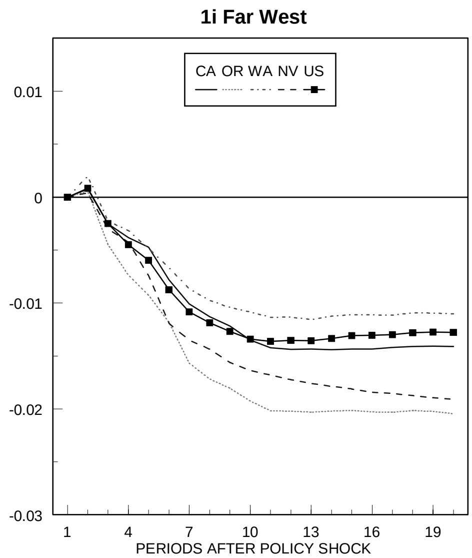

Table 4:
Eight-Quarter Cumulative Responses to a One-Percentage-Point Fed Funds Rate Increase
(response in percentage points; weight is the state's share of regional personal income.)

New England	**Response**	**Weight**	**Southeast**	**Response**	**Weight**
Connecticut	1.2678	0.29	Alabama	1.3261	0.07
Massachusetts	1.0712	0.47	Arkansas	1.3443	0.04
Maine	1.5099	0.07	Florida	1.154	0.22
New Hampshire	1.9264	0.07	Georgia	1.6084	0.11
Rhode Island	1.4391	0.07	Kentucky	1.1599	0.06
Vermont	1.4246	0.03	Louisiana	0.4935	0.07
			Mississippi	1.3004	0.04
Mideast	**Response**	**Weight**	North Carolina	1.3404	0.11
Delaware	1.0018	0.01	South Carolina	1.2816	0.05
Maryland	0.9174	0.10	Tennessee	1.5632	0.08
New Jersey	1.0607	0.20	Virginia	1.022	0.12
New York	0.7176	0.44	West Virginia	1.3803	0.03
Pennsylvania	1.1379	0.25			
			Southwest	**Response**	**Weight**
			Arizona	1.8006	0.13
Great Lakes	**Response**	**Weight**	New Mexico	0.8182	0.05
Illinois	1.2351	0.30	Oklahoma	-0.0741	0.13
Indiana	1.8345	0.12	Texas	0.361	0.69
Michigan	2.6634	0.22			
Ohio	1.5378	0.25	**Rocky Mountain**	**Response**	**Weight**
Wisconsin	1.4604	0.11	Colorado	0.7134	0.50
			Idaho	0.9573	0.13
			Montana	0.8469	0.11
Plains	**Response**	**Weight**	Utah	1.1396	0.19
Iowa	0.8278	0.16	Wyoming	0.1109	0.07
Kansas	0.9653	0.14			
Minnesota	1.1982	0.25	**Far West**	**Response**	**Weight**
Missouri	1.5282	0.29	California	1.1305	0.79
Nebraska	0.8216	0.09	Oregon	1.7168	0.07
North Dakota	0.7427	0.03	Washington	0.9757	0.12
South Dakota	0.8695	0.04	Nevada	1.4356	0.03

Regional Summaries

Region	**Average Response**	**Weight (% of Nation)**	**Coefficient of Variation**	**Max-Min (% Avg)**
New England	1.26	0.06	0.14	0.68
Mideast	0.91	0.21	0.12	0..46
Great Lakes	1.72	0.18	0.09	0.83
Plains	1.14	0.07	0.12	0..69
Southeast	1.23	0.20	0.05	0.91
Southwest	0.52	0.09	0.21	3.60
Rocky Mountain	0.80	0.03	0.15	1.29
Far West	1.16	0.16	0.30	0.64
All Regions	1.09	1.00	0.31	2.51

Table 5: Explaining Cross-State Variation in Policy Responses[a]

Variable	Model (1)	Model (2)	Model (3)	Model (4)
Intercept	0.0494 (0.8817)	-0.0413 (0.8517)	0.3987 (0.8666)	0.3267 (0.8438)
Percent Manufacturing[b]	0.0270 (0.0100)***	0.0287 (0.0099)***	0.0151 (0.0115)*	0.0121 (0.0114)*
Percent Extractive[c]	-0.0264 (0.0102)***	-0.0254 (0.0099)***	-0.0287 (0.0113)**	-0.0261 (0.0109)**
Percent Small Firms[b]	0.0105 (0.0110)	0.0117 (0.0104)	0.0097 (0.0108)	0.0112 (0.0104)
Percent Small Bank Loans (all banks)[b]	-0.0027 (0.0030)		-0.0025 (0.003)	
Percent Small Bank Loans (no holding co.)[b]		-0.0052 (0.0037)*		-0.0062 (0.0046)*
New England[c]			0.0131 (0.1804)	-0.0232 (0.1798)
Mideast[c]			-0.3743 (0.2043)*	-0.4255 (0.2026)**
Great Lakes[c]			0.3458 (0.1986)*	0.3142 (0.1961)
Plains[c]			-0.1758 (0.2029)	-0.1380 (0.1945)
Southwest[c]			-0.2005 (0.1352)	-0.2185 (0.2180)
Rocky Mountain[c]			-0.1642 (0.2164)	-0.2300 (0.2195)
Far West[c]			0.1439 (0.2371)	0.0970 (0.2302)
Adjusted R^2	0.4591	0.4243	0.4734	0.4925

[a]Standard errors in parentheses. *, **, and *** indicates that a null hypothesis of zero is rejected at the 10%, 5%, and 1% levels, respectively.

[b]Null hypothesis is tested against an alternative hypothesis of a theoretically prescribed positive coefficient (one-tailed test).

[c]Null hypothesis is tested against an alternative hypothesis of a non-zero coefficient since an expected sign is unspecified by theory (two-tailed test).

Endnotes

1. Interstate input-output relationships can further complicate a state's response to policy.

2. See Hubbard (1995) for a critical review of the credit channel view of monetary policy.

3. The effect of the differences in states' reliance on small banks will be diluted if bank-dependent borrowers can obtain credit from sources outside their own states. However, there is evidence that banking markets tend to be segmented along state lines. See, for example, Moore and Hill (1982) and Hanson and Waller (1996).

4. As a member of a bank holding company, a small bank can issue large denomination (uninsured) CDs at more favorable rates because it can rely on the financial strength of the larger bank holding company. Note also that although the data indicate the location of the lending bank, they do not specify the location of the borrowers. One reason for focusing on the lending patterns of small banks is that they tend to specialize in loans to local customers. Large banks tend to make loans outside their local market.

5. Mathur and Stein (1980) question the usefulness of reduced-form, St. Louis-type equations for analyzing the effects of policy shocks.

6. Beare (1976) uses data for the predominately agrarian Canadian prairie provinces during the 1956-71 period and finds that different provinces respond differently to money supply changes.

7. The problem of identifying the structural shocks $e_{s,t}$ from the VAR reduced-form residuals $u_{s,t}$ and their variances is taken up below. The solution depends on identification restrictions placed on the A matrix and on the variance-covariance matrix of structural errors.

8. See Sims (1980) for a discussion.

9. This particular identifying restriction effectively deals with issues regarding spatial autocorrelation of the residuals. The restriction on the matrix A ensures that each region's shock is orthogonal to

all other regions' shocks, thus eliminating any simultaneous equation bias. Nonetheless, the model allows for inter-regional feedbacks through the lag structure of the model.

10. Ljung-Box Q test statistics indicate that the null hypothesis of white noise errors cannot be rejected at the 5 percent level of significance for any of the system's equations. The choice of lag length was also addressed in a restricted way using the Akaike and Schwartz information criteria. That is, the number of lags of all variables in a particular equation was sequentially varied from one to eight. These criteria suggested that an optimal lag length was in the neighborhood of two to five quarters, depending on the equation. Thus, the choice of four lags appears appropriate on several grounds.

11. The SVAR is estimated using the growth in real personal incomes because the level of each state's real personal income is non-stationary. This point is addressed more fully below.

12. Consumer price indexes do exist for many of the metropolitan areas in the various states. We found a high degree of correlation in consumer price inflation across these metropolitan areas during the 1958:1 to 1986:4 period. The sample ends in 1986 because the BLS subsequently stopped reporting the CPIs for many MSAs.

13. For discussions of other possible indicators, see Christiano, Eichenbaum, and Evans (1996), Bernanke and Mihov (1995), Strongin (1995), Gordon and Leeper (1994), Bernanke and Blinder (1992), and Todd (1990).

14. The model treats increases and decreases of the federal funds rate symmetrically, so that an unexpected cut in the funds rate temporarily raises real personal income relative to what it otherwise would have been. Moreover, given data limitations, we ignore any possible structural changes that might have occurred during the estimation period.

15. Monte Carlo simulations (500 replications) performed on quarterly changes in each region's income growth indicate that these changes are significantly different from zero for the first eight quarters following a policy shock and insignificant thereafter. This result is also evident in the individual state cumulative responses shown in Figure 1, in that the effects of Fed actions tend to bottom out between 8 and 10 quarters after the shock.

16. Given the short-horizon volatility in many of the responses and the desire to incorporate all system dynamics in the analysis, we focus on the long-run responses in which system dynamics have fully worked through.

17. To examine the robustness of the findings reported in this paper, a number of alternative specifications were estimated at the regional level. The regional findings are robust to alternative measures of monetary policy (nonborrowed reserves and a narrative measure developed by Boschen and Mills [1995]). The findings are also robust to an alternative measure of economic activity (employment growth). Finally, the results are robust whether the variables in the SVAR are expressed in levels or growth rates.

18. Share of manufacturing is employed to capture state differences in interest sensitivity. Share of extractive industries was included to reflect the significant dependence of energy sector production on foreign economic developments. Casual inspection of the estimated long-run responses indicates that states with large shares of extractive activity tend to have relatively small response.

19. White's test revealed no heteroskedasticity in the estimated errors of either version of the model.

20. A one-tailed test is used for percent manufacturing, percent small firm, and percent small bank variables because theory unambiguously predicts positive coefficients. A two-tailed test is used for percent extractive and for regional dummies, since there are no strong prior beliefs about the signs

of these coefficients.

21. At the suggestion of a referee, we investigated the possibility that the findings on firm size could be driven by a failure to account for an independent effect from the importance of the farm sector in each state's economy. The theory is that agriculture has a unique economic role and that states with a greater fraction of small firms also have a larger agricultural component to their economies. Some unique role might be indicated, for example, by the "farm crisis" of the 1980s and, specifically, the Fed's contribution. Thus, our estimates for firm-size effects might be confounded by the omission of a control for the importance of agriculture. In any event, we reran the regression models including two alternative measures of the importance of agriculture in a state's economy – the percent of GSP accounted for by farms and the percent accounted for by agriculture. As with the other variables, these fractions represent averages for the study period. The addition of these variables had no significant impact on the estimated regressions or on the conclusions. Neither of the agriculture variables were statistically significant, nor did the significance or magnitudes of the other coefficients change appreciably.

22. If small banks largely make loans to small firms, this relationship would be captured by the small firm variable. There is moderate correlation between the small firm variable and the small bank variable (simple correlation of 0.5). This correlation helps explain the lack of a positive response of the bank size variable to changes in monetary policy, but not the estimated negative effect.