The Policy Sensitivity of Industries and Regions

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by

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Changes in both fiscal and monetary policy can affect regional growth. Changes in government spending and tax policies influence growth directly by altering factor prices and industry demand. Meanwhile, many economists believe shifts in monetary policy affect growth by temporarily altering real short-term interest rates. The extent to which industries and states are sensitive to changes in interest rates and federal spending helps determine the regional consequences of such policy changes.

There are a number of reasons why sensitivity to fiscal and monetary policy might vary across industries. Some industries (e.g. ordnance manufacturing) benefit more directly from government spending than others (Taylor 1993). Similarly, some industries are more sensitive to interest rate changes than others (Ceglowski 1989, Kretzmer 1985, Taylor and Yucel 1995). Carlino and DeFina (1995) find that manufacturing intensive regions of the United States are more sensitive to monetary policy than construction-intensive regions.

There are also a number of reasons why industry sensitivity to policy may vary from state to state. States rely on a variety of tax instruments to raise revenues and the mix of tax instruments varies substantially across states. States that rely disproportionately on taxes that are not deductible against federal income taxes (like sales taxes) face a differential impact from changes in federal taxes. Differences in taxes, government services and natural amenities can alter the relative prices of labor and capital in a state, leading to potentially different factor price elasticities and policy responses. Similarly, the tax and regulatory environment can affect firm size, which in turn affects policy sensitivity. Gertler and Gilchrist (1994) find that small manufacturing firms contract substantially more than large manufacturing firms following a tightening of monetary policy.

Thus, differences in both industry composition and state-specific industry sensitivity may lead to differences in regional sensitivity to policy shocks. Mathur and Stein (1980) find that monetary policy strongly impacts regional growth in personal income while fiscal policy is generally insignificant. However, using the Mathur and Stein data, Garrison and Kort (1983) find that both monetary and fiscal policy are significant in explaining changes in aggregate state employment.

We contribute to the literature on the regional effects of national policy in two ways. First, we examine industry responses to both monetary and fiscal policy shocks. Second, we examine the extent to which we can use national information about these industry responses to forecast regional employment responses. We find that industry employment is sensitive to both types of policy shocks. We also find that policy sensitivity varies across industries and industry sensitivity varies across states. As such, our analysis suggests that it would be inappropriate to use national estimates to forecast regional employment responses to policy shocks.

Analytical Framework and Estimation

We use a vector autoregressive (VAR) model to assess the policy sensitivity of employment. A VAR model is a system of reduced-form equations wherein the interaction between several variables is used to forecast each individual variable. Each endogenous variable is represented as a function of past values of itself and past values of all the other variables in the system.

The VAR approach is particularly well suited to an analysis of policy sensitivity for a number of reasons. First, the VAR approach imposes no a priori restrictions on the structure of the system. Rather, the approach allows the data to determine the results. Such a non-structural approach is preferable whenever economic theory provides little guidance as to the exact nature of the relationship between the variables in the system. Although the non-structural approach means that one cannot infer causality, it generates reliable estimates of the response of employment to changes in policy variables. Second, because the VAR approach estimates reduced-form relationships, the channels through which policy affects employment need not be explicitly modeled. The VAR approach captures not only the direct effects of policy on employment, but also the indirect effects on employment that arise from the influence of policy on other variables. Finally, estimating the policy sensitivity of employment in a VAR system provides information about the time path of a variable's response to a systemic shock. Therefore, we can examine policy sensitivity in both the short run and the long run.

Our six equation VAR model includes variables designed to capture the major influences on industry employment. These five variables are the nominal price of oil (which reflects a major source of economic shocks), the consumer price index (which reflects inflation shocks), the nominal Federal Funds rate (our measure of monetary policy), federal government spending as a share of gross domestic product (our measure of fiscal policy) and aggregate U.S. employment (which reflects the influence of national business cycles). The sixth variable is employment in the industry of interest.

To examine the relative effects of policy on industries, we repeatedly estimate this model using U.S. and state data for employment in each of the nine industry divisions—mining, construction, manufacturing, TC&PU (transportation, communications and public utilities), wholesale trade, retail trade, FIRE (finance, insurance and real estate), services and government. To evaluate the extent to which U.S. responses can be used to forecast regional employment responses, we compare the U.S. estimates to the state estimates. The state-level data comes from each of the four largest states—California, Florida, New York and Texas.

The Data

The monthly data for this analysis come from a variety of sources and span the period from January 1982 to December 1995. Data on refiner's acquisition cost, which we use to measure oil prices, come from the Department of Energy. The data on federal government purchases and GDP from which we construct our measure of fiscal policy come from the Bureau of Economic Analysis. Data on the federal funds rate come from the Federal Reserve Board. (Charts 1 and 2 illustrate the two policy shock variables). The remaining data come from the Bureau of Labor Statistics. The employment and price data were seasonally adjusted. The remaining variables had no significant seasonal pattern and, therefore, were not seasonally adjusted. With the exception of the federal funds rate, we logarithmically transformed all of the data series. Augmented Dickey-Fuller tests indicated that many of the data series were not stationary in levels, although all of the transformed series were stationary in first or second differences.[1]

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[1] The construction employment series for Texas, Florida and the U.S. were not stationary even with second differencing. However, when we restrict the sample to the period after 1985, the logarithmic series were first-difference stationary for the U.S. and all four states under evaluation. Given the dramatic effects on the construction industry of the Tax Reform Act of 1986, it seems plausible to so restrict the sample. Therefore, the sample used

There are two approaches for using nonstationary data in a VAR model. One is to formulate an error-correction model in differences with cointegrating terms. Alternatively, one can estimate the VAR in levels with sufficient lags to yield white noise residuals but without explicitly modeling the cointegrating relationships.

A solid case exists for examining the model in levels. The shortness of our sample period reduces the already low power of cointegration tests.[2] Furthermore, the large number of variables in our VARs introduces uncertainty about the specification and number of cointegrating vectors. Therefore, it would be difficult to identify the appropriate set of cointegrating vectors. In contrast, estimates from a levels model are not conditional upon the estimated number of cointegrating relationships and their estimated values. For these reasons, we selected a VAR model in log levels.

The appropriate specification of the VAR system in levels depends critically on the number of lags. If the system has too few lags, the researcher has omitted valuable information and the estimation may be biased. If the system has too many lags, the researcher has included avoidable noise and the estimation will be inefficient (but should be unbiased). We use the Akaike information criterion (AIC) and the Schwarz criterion (SC) to suggest the appropriate lag length for the national industry models.[3] The AIC indicates that the appropriate specification would include either 5 or 6 lags of the variables in the system,

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for analyses of the construction industry spans the period from January 1986 to December 1995.

[2] The short time frame is dictated by our interest in using a consistent proxy for the stance of monetary policy.

[3] For a further discussion of the model selection criteria, see Mills (1990) or Kennedy (1992).

depending on the industry; the SC consistently indicates that no more than 2 lags would be necessary. Because a likelihood ratio test consistently favors the six-lag specification over the two-lag specifications, all variables in each system are estimated as a function of 6 lags of themselves and 6 lags each of the other variables.[4] In the interests of comparability with the national analysis, we use a 6-lag specification for all of our VARs.

Assessment Strategies

We use two strategies to assess the relationship between policy shocks and industry employment. The first strategy is to examine impulse response functions for the two policy variables. Impulse response functions trace over time how an independent and unexpected shock to one variable in the VAR system affects another. The second strategy is to examine variance decompositions. Variance decompositions apportion the variance of forecast errors in a given variable to shocks to itself and shocks to the other variables. They allows us to compare the relative importance of fiscal and monetary policy shocks.

We use a Choleski decomposition to construct the impulse responses and variance decompositions. The Choleski technique decomposes the residual (μ_i) from each of the equations in the VAR system into a linear combination of the residuals from the other equations (μ_j) and an orthogonal element (ν_i). We specified a decomposition that allows a

[4] Because the construction industry is evaluated over a shorter time period, it may require a different lag structure than the rest of the analysis. The AIC indicates that at least 12 lags would be necessary for analysis of the construction industry: the SC indicates that only 2 lags are necessary. Because the lag length favored by the AIC consumes virtually all of our degrees of freedom, we use the lag length recommended by the SC and estimate construction industry employment as a function of two lags of itself and two lags each of the other variables.

one-way contemporaneous relationship between the policy and employment variables.[5] The structure is as follows:

$$\begin{aligned}
\mu_{oil} &= \nu_{oil} \\
\mu_{i} &= c_{21}\mu_{oil} + \nu_{i} \\
\mu_{m} &= c_{31}\mu_{oil} + c_{32}\mu_{i} + \nu_{m} \\
\mu_{f} &= c_{41}\mu_{oil} + c_{42}\mu_{i} + c_{43}\mu_{m} + \nu_{f} \\
\mu_{US} &= c_{51}\mu_{oil} + c_{52}\mu_{i} + c_{53}\mu_{m} + c_{54}\mu_{f} + \nu_{US} \\
\mu_{ind} &= c_{61}\mu_{oil} + c_{62}\mu_{i} + c_{63}\mu_{m} + c_{64}\mu_{f} + c_{65}\mu_{US} + \nu_{ind}
\end{aligned}$$

where μ_{oil} represents the residual from the oil price equation, μ_{i} represents the residual from the consumer price index equation, μ_{m} represents the residual from the monetary policy equation, μ_{f} represents the residual from the fiscal policy equation, μ_{US} represents the residual from the aggregate U.S. employment equation and μ_{ind} represents the residual from either the industry employment equation.

The decomposition structure implies that unexpected changes in oil prices (μ_{oil}) do not contemporaneously arise from any of our specified variables. Similarly, unexpected changes in inflation (μ_{i}) do not arise contemporaneously from any of the employment or policy variables, but can be contemporaneously affected by innovations in oil prices (μ_{oil}). Unexpected changes in oil prices and inflation contemporaneously affect unexpected changes in the federal funds rate (μ_{m}), but μ_{m} only affects oil prices and inflation in subsequent

[5] If the covariance among the residuals is sufficiently high, the ordering of the dependent variables can affect the results. In our opinion, the ordering employed here reflects a plausible transmission relationship among the variables. Furthermore, exploratory analysis suggests that variations in ordering have little qualitative impact on the results.

periods. Similarly, unexpected changes in oil prices, inflation and monetary policy contemporaneously affect unexpected changes in fiscal policy (μ_f), but μ_f only affects oil prices, inflation and monetary policy in subsequent periods. Unexpected changes in industry employment can arise contemporaneously from unexpected changes in any of the other variables in the system but can affect those variables only with a lag.

We used the estimated coefficients of the VAR system of equations and Monte-Carlo integration with 1000 replications to compute one-standard-deviation confidence bands for the impulse response functions of the variables in the model.[6] These confidence bands can be used to distinguish where the impulse response functions differ significantly from zero. Whenever the lower bound on the impulse response function is positive, we consider the impulse to be significantly positive. Whenever the upper bound on the impulse response is negative, we consider the impulse to be significantly negative. Rather than show the confidence bands directly, for simplicity we report significant point estimates for an average one-standard-deviation initial impulse.[7]

The Monte-Carlo integration also generates a distribution of variance decompositions. If the variance decomposition share for the monetary policy variable is greater than the variance decomposition share for the fiscal policy variable in at least 90 percent of these replications, then we conclude that employment is more sensitive to monetary policy than to

[6]The methodology follows Kloek and Van Dijk (1978) with the coefficient draws taken directly from the estimated posterior distribution of the coefficients.

[7] For all industries and states, we calculate one-standard-deviation impulses and then standardize them so that the initial impulse is equivalent to the mean initial impulse across U.S. industries.

fiscal policy. On the other hand, if the variance decomposition share for the monetary policy variable is greater than the variance decomposition share for the fiscal policy variable in no more than 10 percent of the replications, we conclude that employment is more sensitive to fiscal policy than to monetary policy.

Results

The impulse response functions reveal a number of interesting patterns in the employment data. First, the significant responses to a fiscal policy shock are overwhelmingly negative. As chart 3 illustrates, significant decreases in U.S. employment follow soon after increases in federal government spending (as a share of GDP) for construction, TC&PU, retail trade and services, while mining turns negative after two years. However, the responses become insignificant after 40 months for all industry divisions except TC&PU. The employment responses are insignificant for manufacturing, wholesale trade, FIRE and government.

The significant responses to a monetary policy shock also tend to be negative. As chart 4 illustrates, significant decreases in U.S. employment follow increases in the federal funds rate for TC&PU, retail trade, services and government. Furthermore, while mining, manufacturing, wholesale trade and FIRE seem to add jobs immediately following an increase in the federal funds rate, the effect turns negative after a year for wholesale trade and FIRE (chart 5). We were unable to detect a response to changes in monetary policy for the construction industry.[8]

For two of the four industries wherein both types of policy shocks generate significant impulses—TC&PU and retail trade— the employment responses are similar in magnitude. However, employment in the services and mining industries appears to respond much more to a monetary policy shock than to a fiscal policy shock. Evaluated at the peak, the impulse responses to a change in monetary policy are roughly 60 percent greater than the impulse responses to a change in fiscal policy.

The state-level data generally support the national conclusions, but they also illustrate the risks involved in using U.S. estimates of industry response to forecast regional industry responses. For example, the construction industry is the only one to respond to a fiscal policy shock significantly and in the same direction across the four states and the nation. In contrast, manufacturing employment decreases following an increase in government spending in Texas and New York, changes insignificantly in Florida and the U.S. and increases in California (chart 6). Employment in California's retail trade, services and government industries appears to respond positively to a fiscal policy shock, while it responds negatively, if at all, in the other three states and the nation.

A monetary policy shock also elicits widely divergent impulse responses across states within the same industry. As was the case for a fiscal policy shock, employment in California's retail trade, services and government industries appears to respond positively to a monetary policy shock while it responds negatively, if at all, in the other three states and

[8] This finding is consistent with work by Carlino and DeFina (1996) who found that increases in the share of construction in GSP reduced a region's sensitivity to movements in the nominal federal funds rate.

the nation. Texas differs from the rest with a long-run negative response for manufacturing employment (chart 7). Similarly, New York differs from the rest with an positive response for transportation employment. While the U.S., New York and Texas responses are insignificant, construction employment increases significantly in California and Florida following an increase in the federal finds rate. There is no industry division for which the impulse responses following a monetary policy shock are equal in sign and significance across the U.S. and all four states.

A more formal analysis of the forecasting power of the U.S. impulses also reveals significant variations between the states and the nation. Simple regression analysis shows that the national fiscal policy responses are not a good predictor for the states. There are only four industries which do a reasonable job of forecasting state level responses. The national construction industry response can explain more than 90 percent of the construction employment responses in Florida, New York and Texas. Similarly, the national services industry is a good predictor of the service-sector response in California, Florida and Texas. The only other national industries which are good predictors for the industry at the state level are TC&PU for California and Florida and retail trade for New York and Texas. All others are either insignificant (at either the national or state level) or not good predictors.

The aggregate industry response to a monetary policy shock is a better predictor of the state-level industry responses that the aggregate response to a fiscal policy shock. The U.S. responses to a change in monetary policy are an especially good predictor for industries in California and Florida. With the exception of the mining and construction industries, the U.S. industry response explained more than 90 percent of the state level industry responses.

The U.S. responses are also good predictors for New York. The U.S. response explained more than 90 percent of all nine New York industry divisions, although construction, retail trade and FIRE were insignificant. However, U.S. impulse responses are not a good predictor for the Texas industries. The only industries in which U.S. responses which can be used to confidently forecast Texas employment responses are mining, TC&PU and retail trade.

As another check on the ability of the aggregate industry responses to predict the state industry response, we calculated Pearson correlation coefficients between the industry response at the national and state level. The results supply further evidence that it would not be appropriate to use the US responses to forecast the regional response to a policy shock, especially with a fiscal policy shock. There are only five out of 36 industries (of the 4 state/9 industry combinations) which correlate more than 90 percent with the national in response to a fiscal policy shock The correlation is somewhat higher with a monetary policy shock, with 13 out of 36 industries correlating better than 90 percent.

The variance decomposition data provide additional insight into the differential industry responses across states. Table 1 presents the variance decomposition results for both the short run (one year after the shock) and the long run (five years after the shock). At the national level, these variance decompositions reveal two interesting regularities. First, the point estimates suggest that the share of forecast error arising from national policy shocks tends to grow over time. With the exception of manufacturing, both monetary and fiscal policy shocks are much greater sources of national volatility after five years than after one year. For manufacturing, the impact of fiscal policy shocks also grows over time, while the impact of monetary policy shocks decays. Second, the distributions of variance decompositions indicate that fiscal policy tends to dominate monetary policy as a source of short-run employment volatility in construction and TC&PU, but not in any other industry division. In the long run, the variance decomposition data do not distinguish which of the two policy shocks is a greater source of volatility at the national level.

There is not much consistency with the national results at the state level. The results are mixed in the short run, while fiscal policy is a greater source of volatility in the long run. In the short run we find that monetary policy is a larger source of volatility for manufacturing and wholesale trade in California and for mining in Florida. On the other hand, fiscal policy is a greater source of volatility for the retail trade sector in New York and for FIRE in Texas. In the long run we find that fiscal policy shocks are a greater source of volatility for all the state-level industries that are distinguishable. These industries include FIRE in California; construction, retail trade, wholesale trade and FIRE in New York; and manufacturing and wholesale trade in Texas.

Conclusions

Our analysis of policy sensitivity leads us to a number of broad conclusions. First, both fiscal and monetary policy have a significant effect on industry employment. For all nine major industry divisions, we can detect an employment response to both types of policy shocks at either the national or the state level.

Interestingly, increases in federal government spending (as a share of GDP) or the federal funds rate generally lead decreases in employment. While these employment patterns are broadly consistent with common expectations about the effects of contractionary monetary policy, they are inconsistent with common expectations about the near term effects of expansionary fiscal policy. However, the fiscal policy results are consistent with a model in which the growth of government crowds out private sector investment.

Our analysis of the effects of fiscal policy shocks also suggests that it would be inappropriate to use national estimates to forecast regional employment responses. For example, although U.S. employment in all of the major industry divisions responds negatively, if at all, to increases in federal government spending, California's employment responses are overwhelmingly positive. The variety of employment responses across states is not surprising given the redistributive nature of federal government spending. California's positive response may reflect the disproportionate role of national defense purchases in the state's economy.

National industry responses are better predictor's of regional responses to monetary policy shocks than to fiscal policy shocks. However, there is still substantial variation across states within the same industry. Therefore, the analysis suggests that regional variations in sensitivity to monetary policy arise from more than variations in industrial composition.

Finally, our analysis of variance decompositions suggests that the share of forecast error arising from national policy shocks tends to grow over time. Furthermore, the variance decompositions suggest that monetary and fiscal policy are generally indistinguishable from each other as sources of employment volatility. However, where we can distinguish between the two types of policy, fiscal policy tends to dominate monetary policy.

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Table 1: Variance Decompositions for Monetary (M) and Fiscal (F) Policy

Short Run:

	US		CA		FL		NY		TX	
	M	F	M	F	M	F	M	F	M	F
Total	1.1	2.6	8.1	0.7	0.6	3.3	2.2	6.9	11.3	10.9
Mining	1.6	13.2	0.5	7.0	22.9>	1.4	4.7	2.0	3.8	9.4
Construction	0.3<	32.3	9.9	12.1	5.6	18.8	0.5	14.1	0.9	9.8
Manufacturing	13.5	1.7	20.8>	2.4	3.1	0.2	12.2	2.6	1.3	8.0
Retail Trade	5.6	8.8	4.4	4.9	0.6	0.4	0.8<	19.0	5.7	5.5
Wholesale Trade	7.8	0.6	26.1>	1.5	0.7	0.6	1.2	12.2	1.0	4.0
TC&PU	2.7<	9.9	1.9	4.1	4.2	10.9	3.3	2.9	2.3<	14.1
FIRE	1.6	0.8	2.5	11.4	0.4	3.3	0.6	6.0	5.0	3.5
Services	0.9	2.3	7.4	1.5	1.0	12.1	1.0	2.5	0.6	5.3
Government	4.8	0.9	2.7	3.0	2.9	0.9	3.7	3.4	5.7	8.8

Long Run:

	US		CA		FL		NY		TX	
	M	F	M	F	M	F	M	F	M	F
Total	34.2	17.1	9.2	14.0	36.8	15.8	7.1	9.6	21.5	62.8
Mining	30.9	13.8	14.4	15.4	26.2	3.5	11.7	4.0	15.6	22.3
Construction	15.5	56.3	23.9	15.5	5.2	40.4	0.7<	51.6	12.1	42.7
Manufacturing	10.7	3.2	20.3	18.1	8.9	7.0	9.8	3.1	10.8<	53.8
Retail Trade	24.5	11.6	3.8	12.6	11.7	3.6	1.2<	29.9	24.2	60.1
Wholesale Trade	13.9	0.3	17.7	3.9	17.2	6.1	3.5<	32.4	5.7<	64.5
TC&PU	17.0	26.8	16.8	7.5	26.2	42.4	8.3	3.0	15.2	46.9
FIRE	11.2	2.7	4.5<	51.6	3.9	14.5	2.5<	52.6	11.1	26.7
Services	28.1	13.4	13.5	4.1	13.8	31.4	25.2	8.7	3.6	23.4
Government	24.5	6.0	4.6	12.6	28.0	9.6	1.6	32.4	8.5	16.0

note: The symbol > (<) indicates that the variance decomposition for our monetary policy variable is greater than (less than) the variance decomposition for our fiscal policy variable in at least 90 percent of the Monte Carlo replications.

Chart 1. Government Share in GDP

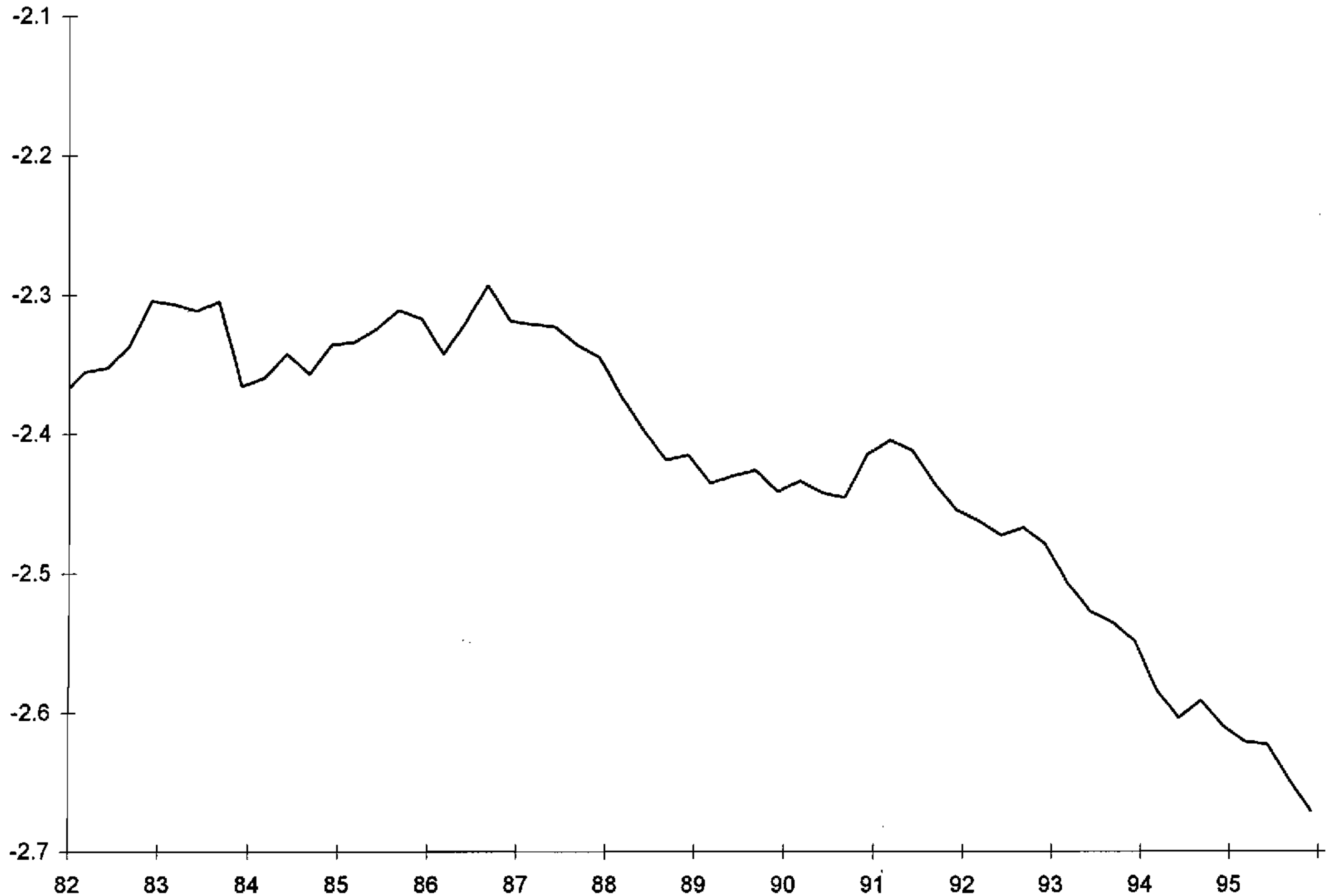


Chart 2. Federal Funds Rate

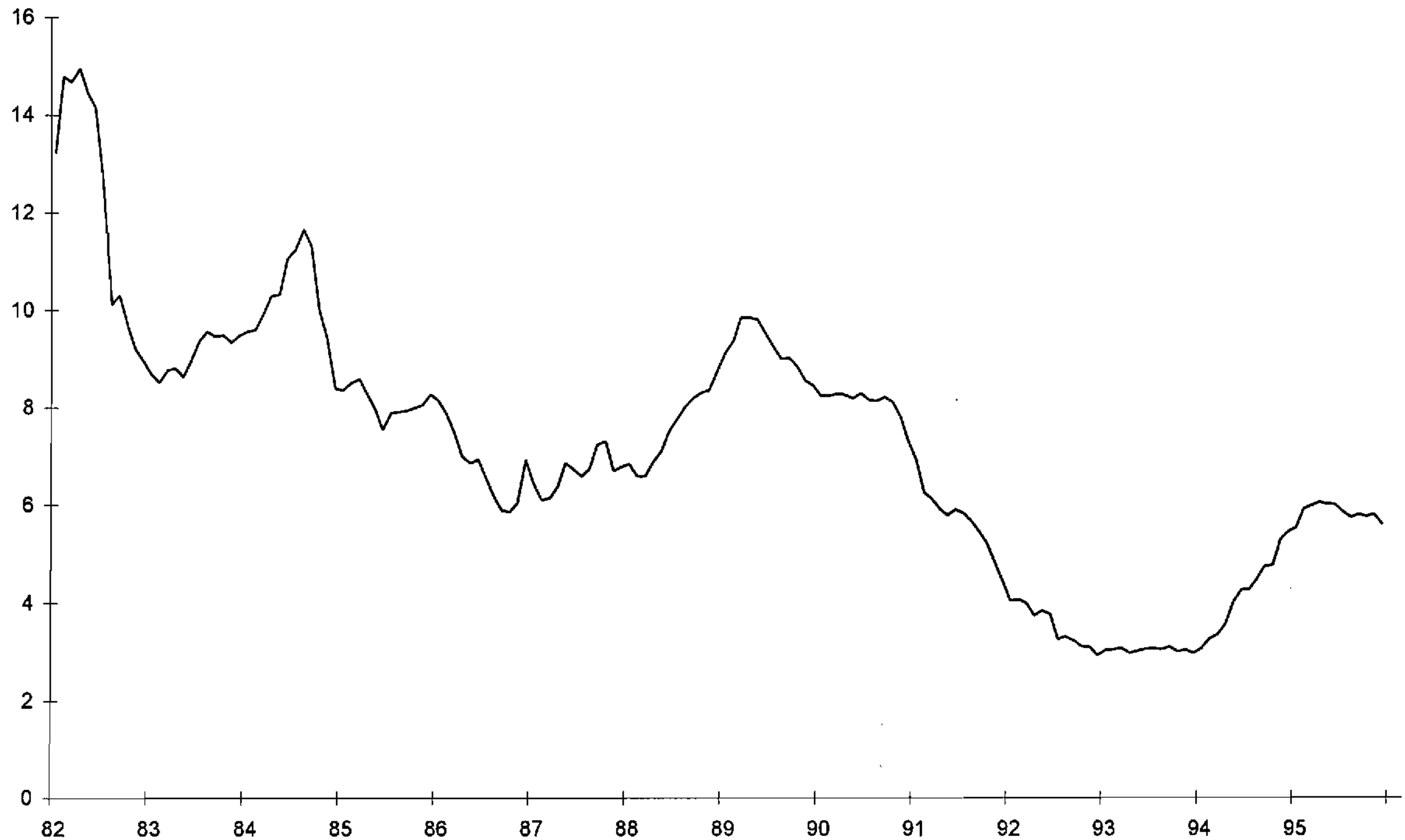


Chart 3. Impulse Responses to a Government Share Shock

(US Industry Employment)

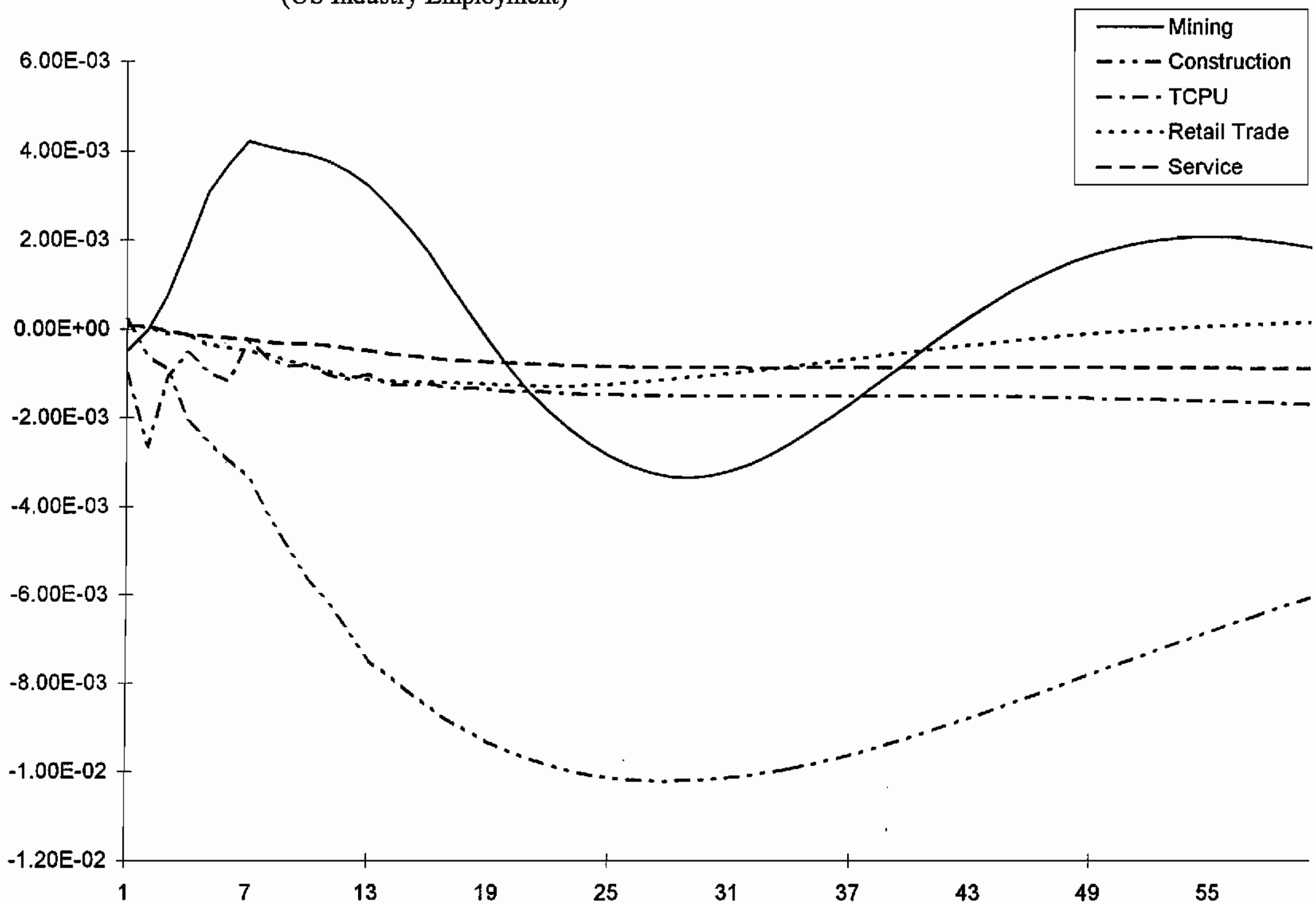


Chart 4. Impulse Responses to a Federal Funds Rate Shock

(US Industry Employment)

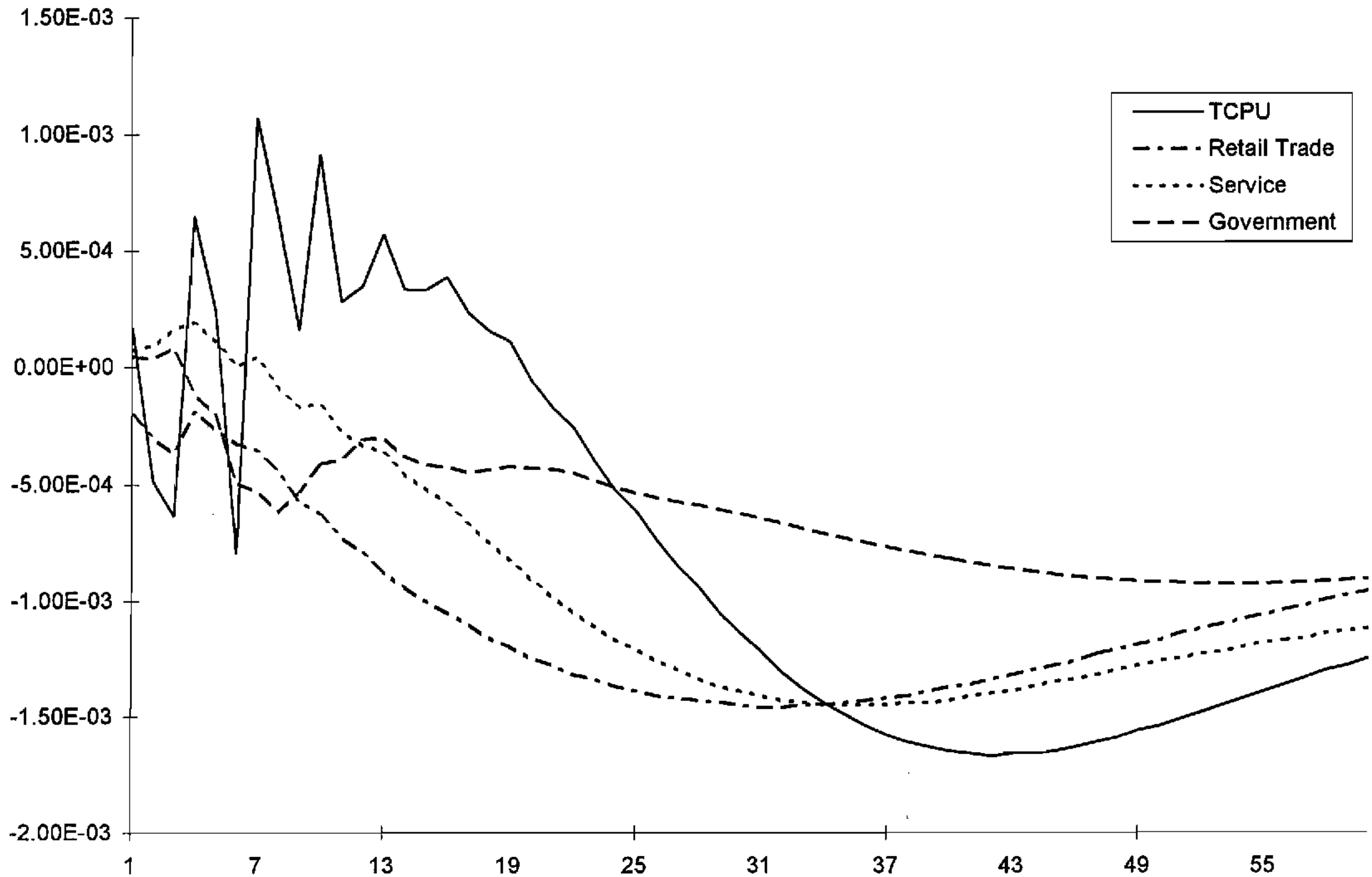


Chart 5. Impulse Responses to a Federal Funds Rate Shock

(US Industry Employment)

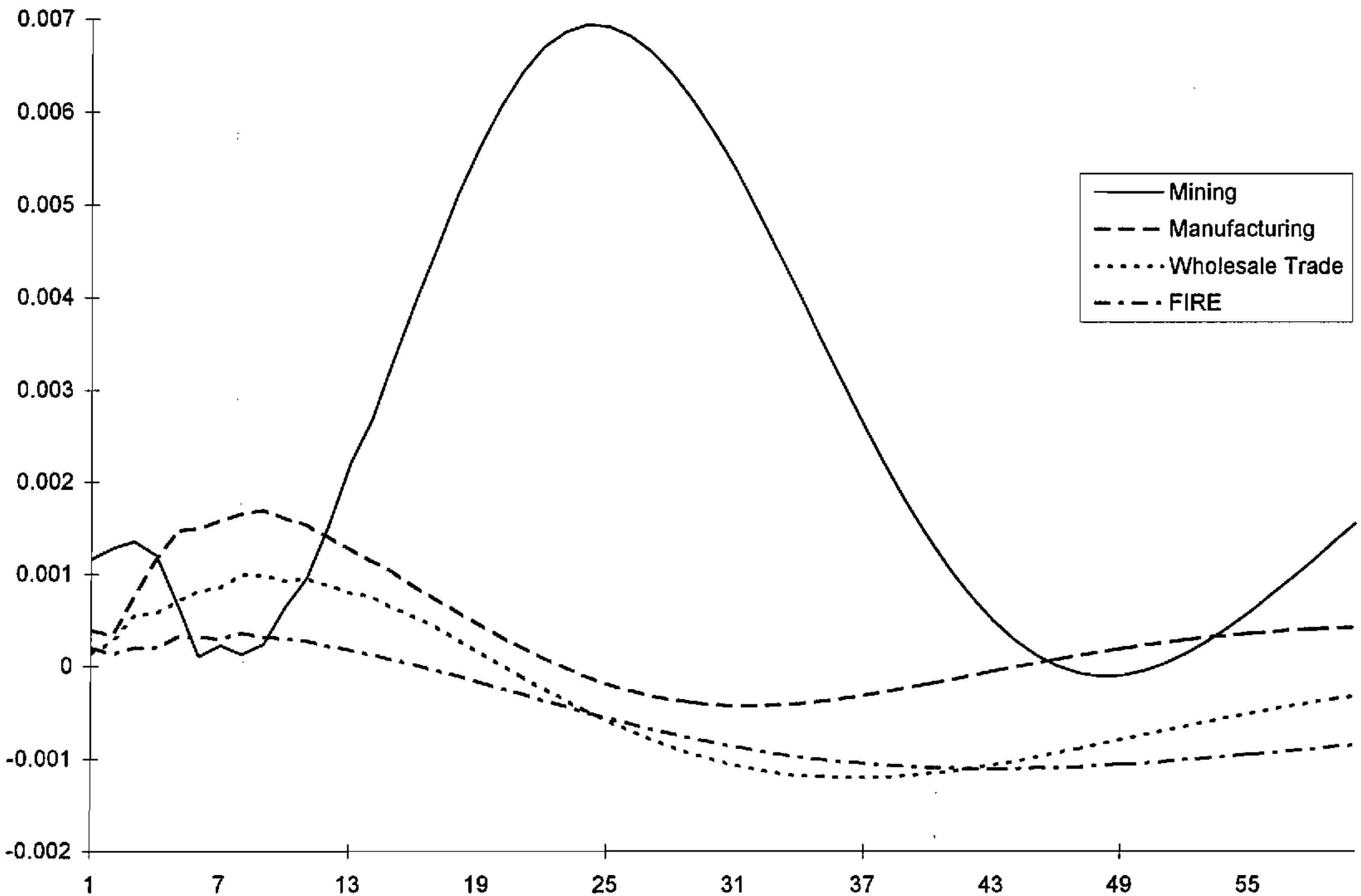


Chart 6. Manufacturing Employment Responses to a Government Share Shock

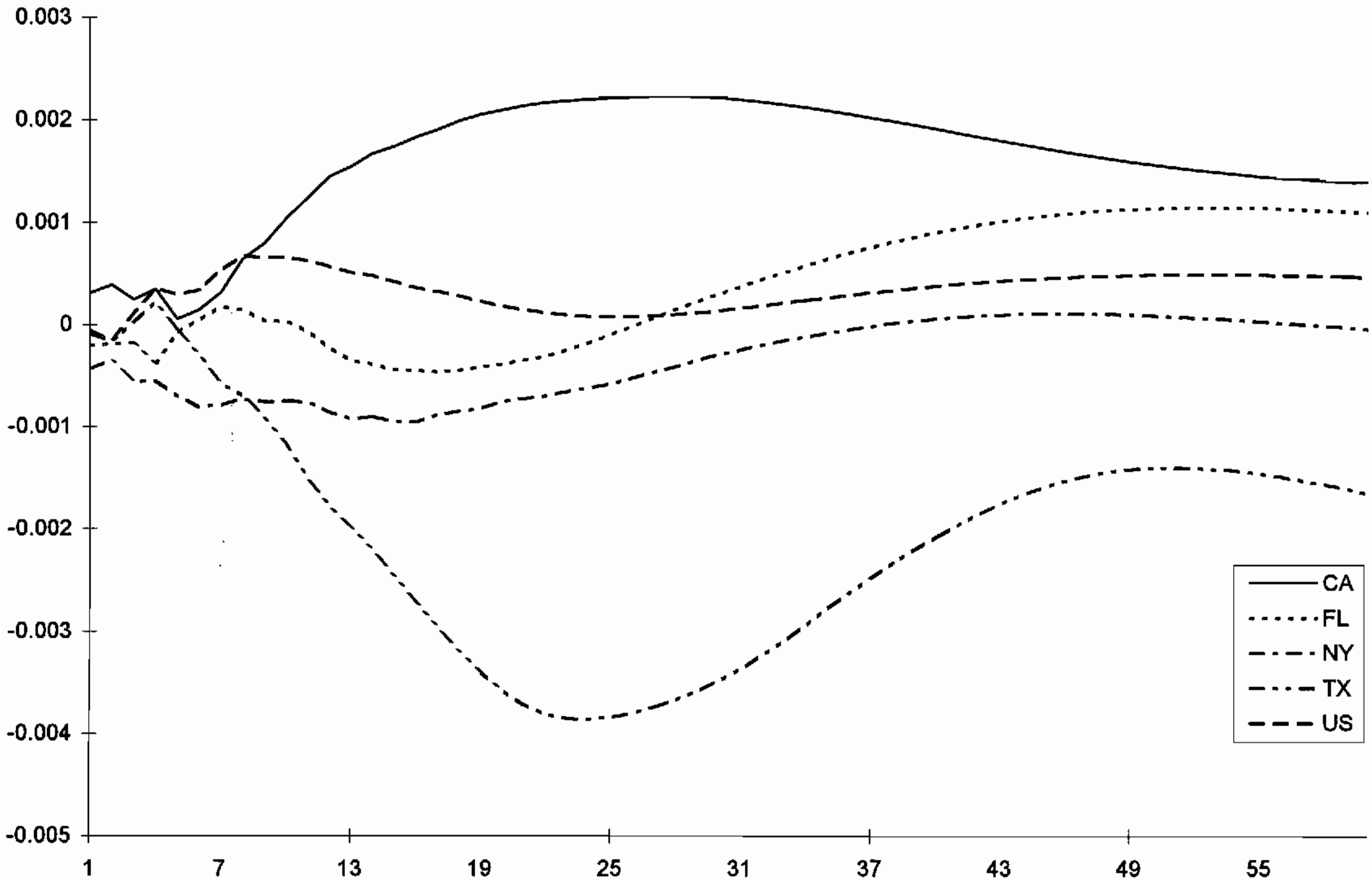
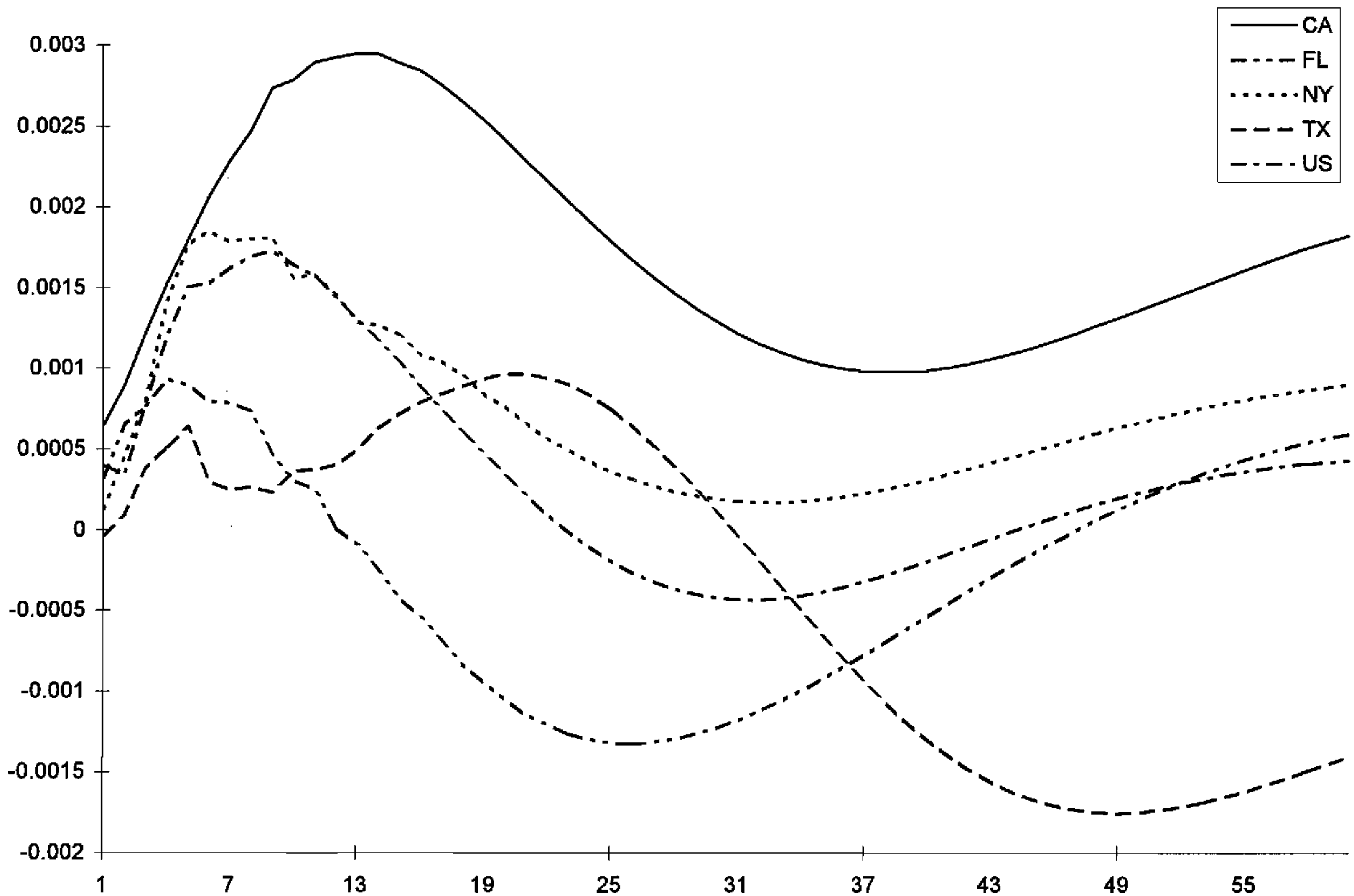


Chart 7. Manufacturing Employment Responses to a Federal Funds Rate Shock



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