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ABSTRACT

This paper presents evidence that the "cost channel" may be an important part of the monetary transmission mechanism. We argue that if working capital is an essential component of production and distribution, monetary contractions can affect output through a supply channel as well as the traditional demand-type channels. We specify an industry equilibrium model and use it to interpret the results of a VAR analysis. We find that following a monetary contraction, many industries exhibit periods of falling output and *rising* price-wage ratios, consistent with a supply shock in our model. We also show that the effects are noticeably more pronounced during the period before 1979.

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I. Introduction.

Traditional economic models posit that changes in monetary policy exert an effect upon the economy through a demand channel of transmission. This view of monetary policy has a long history that has been fraught with debate over whether monetary policy affects real economic variables, and if so, how powerful these effects may be. Much of this research has been devoted to identification of a demand-side transmission mechanism for monetary policy and quantifying its effects. Alternatively, some researchers have proposed that there may be important supply-side, or cost-side, effects of monetary policy (e.g. Galbraith (1969), Shapiro (1981), Blinder (1987), Fuerst (1991), Christiano & Eichenbaum (1992), Christiano, Eichenbaum & Evans (1997) and Farmer (1984, 1988a, b)). One version of this view, which ignores long-run effects, has been called the "Wright Patman Effect," after Congressman Wright Patman who argued that raising interest rates to fight inflation was like "throwing gasoline on fire" (1970).

This paper presents industry-level evidence on comovements between prices and output that suggests that these cost-side theories of monetary policy transmission deserve more serious consideration. It is not the purpose of this paper to deny the existence of demand-side effects. Rather, this paper presents evidence implicating supply-side channels as powerful collaborators in transmitting the real effects of monetary policy shifts in the short-run. In fact, for many important manufacturing industries, the evidence presented here implies that a cost channel is the primary mechanism of transmission for the first couple of years after a monetary shock.

There are compelling reasons, both theoretical and empirical, to consider the importance of cost-side effects of monetary policy actions. Just as interest rates and credit conditions affect firms' long-run ability to produce (by investing in fixed capital), they can also be expected to affect firms' short-run ability to produce (by investing in working capital). The value of the investment in working capital is substantial. According to the *Quarterly Financial Report*, the value of inventories plus trade receivables is approximately equal to the value of net plant, property and equipment in the combined manufacturing, wholesale and retail trade sector (1999:II). Both are equal to approximately three months' sales. Additionally, recent empirical research on the aggregate effects of monetary policy highlights several patterns in the data which are difficult to explain with the traditional view.

Bernanke & Mihov (1998), Christiano, Eichenbaum & Evans (1994), Bernanke & Gertler (1995), and others have used vector autoregressions (VARs) to identify monetary policy changes and to document the reaction of various aggregates to those shocks. The results of this research can be summarized in the following "stylized facts" about the effects of a contractionary monetary policy action: (1) Output falls after a lag of about four months, bottoming out nearly two years later, followed by a gradual recovery. (2) Short-term interest rates (including the Federal funds rate) have largely transitory responses. Initially higher, they return to previous levels within nine months. (3) Most strikingly, the price level is unresponsive for almost two years, and then begins to decline to a permanently lower level.

Traditional models attempt to explain these facts by assuming that sticky wages or prices allow monetary policy to affect real interest rates, which then impact consumer and investment spending. The crucial theoretical assumption of price stickiness is, however, subject to continued debate. It is difficult to explain why a decline in aggregate demand driven by a money shock does not lead firms to lower their prices, given reasonable assumptions on the cost of changing prices and forward-looking behavior. Furthermore, as this paper will demonstrate, these models are inconsistent with the industry-level response of prices for many manufacturing industries.

Another problem with the demand-only view of monetary transmission, noted by Bernanke & Gertler (1995), is the degree of amplification. Empirical evidence suggests that monetary policy shocks that induce relatively small movements in open market interest rates have large effects on output. Bernanke & Gertler use this result to support their argument that a credit channel working in tandem with the traditional monetary channel explains the data better. An alternative (or complementary) means to explain the observed amplification is to allow monetary policy shocks to have both supply-side and demand-side effects. If this is the case, then a shock to monetary policy could be viewed as shifting both the aggregate supply and aggregate demand curves in the same direction, leading to a large change in output accompanied by a small change in prices.

The literature offers several theoretical foundations for monetary policy as a cost shock. For example, Bernanke & Gertler's (1989) model contains both a demand and supply component of balance sheet effects. Several other credit channel papers suggest that there might be a cost-side channel of monetary policy (e.g. Kashyap, Lamont, & Stein (1994), Kashyap, Stein & Wilcox (1993), and Gertler & Gilchrist (1994)). Most of these papers are empirical, and do not explicitly model the supply-side effects. Nevertheless, the discussion of the results indicates the possibility of supply-side effects. Consider, for example, Gertler & Gilchrist's (1994) study of the cyclical properties of small versus large firms, in which they show that a monetary contraction leads to a decrease in the sales of small firms relative to large firms. The implication is that tight credit is impeding the ability of small firms to produce.[1]

[1] Some earlier empirical work studied whether rises in interest rates are passed on to prices. Seelig (1974) found small or insignificant effects on markups. Shapiro (1981), on the other hand, estimated a Cobb-Douglas markup

There are several other examples of general equilibrium macroeconomic models that explicitly analyze the supply-side effects of monetary policy through working capital. Blinder (1987), Christiano & Eichenbaum (1992), Christiano, Eichenbaum & Evans (CEE) (1997) and Farmer (1984, 1988a, b)) all begin with the assumption that firms must pay their factors of production before they receive revenues from sales, and must borrow to finance these payments. In most of the models, an increase in the nominal interest rate serves to raise production costs. Thus, a monetary contraction leads to a decline in output through an effect on supply. It is important to note that some type of rigidity is still required for money to be non-neutral. If prices and portfolios adjust immediately, then monetary policy has no initial effect on interest rates, so that neither aggregate demand nor aggregate supply shifts.

A clear framework for distinguishing between supply and demand-side effects of monetary policy is necessary. Blinder (1987), in exploring the theoretical foundations of this issue, notes a very simple test of supply-side effects that predicts the results presented here:

> "The idea of a supply failure contains a hint of what is to come: if recessions are initiated by declines in supply, rather than by declines in demand, then prices may rise, not fall, as economic activity contracts." (p. 328)

This is precisely what this paper examines at the industry level. Rising prices in the presence of falling output is taken as indication of a cost shock, while a positive correlation between these two quantities identifies a demand shock. The results confirm that for numerous manufacturing industries, contractionary changes in monetary policy are primarily cost shocks.

Section II of this paper presents a simple industry equilibrium model of firm costs that is used as a basis for identification of supply and demand shocks, as well as to evaluate the

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equation on aggregate data and found significant interest rate effects on the price level. To our knowledge, there has been little or no recent empirical work on the subject.

empirical evidence presented in the subsequent section. Section III presents the vector autoregression framework and identification scheme used to analyze two-digit level industry data. The results of this analysis show clear indications of the strength of monetary policy as a cost shock. Many industries display falling output and rising price-wage ratios. Furthermore, the effect appears to be much more pronounced during the period from 1959 to 1979. This is also the period in which monetary policy shocks have larger and longer effects on output. Section IV addresses possible alternative explanations of the empirical results presented in the preceding sections. Finally, Section V concludes with implications and suggestions for further research.

II. A Framework for Identifying Monetary Effects on Industry Output.

One of the main goals of this paper is to develop a test of whether monetary shocks have a supply-side effect. Developing such a test on an aggregate basis is difficult, however, unless one is very sure about the source of monetary non-neutrality. As pointed out by Christiano, Eichenbaum & Evans (1997), none of the leading models of monetary non-neutrality is completely satisfactory. As a result, there is no consensus on the sources of non-neutrality, and therefore no standard general equilibrium model for studying the effects.

We circumvent this problem by developing a test based on an *industry* equilibrium model. To be specific, we assume that through some unspecified mechanism, monetary policy can have effects on an industry's demand as well as its costs. We use a simply model of supply and demand to develop testable implications about the responses of the industry variables to the various types of shocks. This approach has several additional advantages. First, as we shall see, industry prices tend to move much more than the aggregate price level. This result is consistent with Blanchard's (1987) findings that industry-level prices adjust much more quickly than the aggregate price level. He argues that small lags and staggered price adjustment can cumulate to create long lags in the aggregate price level. Thus, it is difficult to interpret movements in the aggregate price level. A second advantage of this approach is that it allows for industry heterogeneity in the possible impact of monetary policy. We would expect monetary policy to have differential impacts on industries according to the importance of credit conditions for their demand and supply. Thus, industry differences can potentially provide additional insights.

The disadvantage of this approach is that we leave unanswered a key question: how does monetary policy work in general equilibrium? While we cannot answer this question directly, we hope that our more microeconomic study of how monetary policy affects industry supply and demand will shed light on the larger question.

We propose a simple test that relies on one of the most basic insights from microeconomics: that the sign of the correlation between output and relative prices can indicate whether supply or demand is shifting. We begin by presenting a simple model that incorporates supply and demand effects of monetary policy. We then discuss how various generalizations might change the predictions.

Consider a representative firm in industry i. Suppose the firm maximizes profits given by:

(1) $$\pi_{it} = P_{it}Q_{it} - R_{it}W_{it}C(Q_{it})$$

where P_{it} is the price of output, Q_{it} is production, R_{it} captures the supply-side effects of monetary policy, W_{it} is the wage and $C(Q_{it})$ is a convex cost function. This formulation of costs is similar to that used by CEE. In their set-up, R_{it} is the gross interest rate, which multiplies costs because firms must borrow to pay their wage bill at the beginning of the period and then repay the loan at the end of the time period at the gross interest rate R.

We normalize the number of firms to be equal to unity. Suppose the industry inverse demand curve is given by:

(2) $$P_{it} = f(Q_{it}, D_{it}), \quad where\ \ f_Q < 0,\ \ f_D > 0\,,$$

and where D_{it} is a demand shifter. Shifts in D_{it} capture the demand effects of monetary policy for industry *i*. We also allow for wages to be endogenous, i.e.,

(3) $$W_{it} = N(Q_{it}, D_{it}, R_{it}), \quad where\ N_Q \geq 0, N_D \geq 0, and\ N_R \leq 0.$$

This wage function captures three possible effects: (1) the industry may face an upward sloping labor supply curve (captured by the assumption that $N_Q \geq 0$); (2) the demand shifter D may be correlated across industries, so that a rise in D may increase the economy-wide demand for labor and hence raise the marginal cost of workers to this industry ($N_D \geq 0$); (3) a rise in R may increase costs and hence lower labor demand in other industries, thus lowering the marginal cost of employing workers in this industry ($N_R \leq 0$).

It is straightforward to show using comparative statics that in the competitive industry equilibrium the following results obtain (the details are given in the theoretical appendix):

1 A negative demand shock (i.e. a decline in D_{it}) leads to lower equilibrium output Q_{it} and lower equilibrium prices relative to wages, P_{it}/W_{it}, as long as the decline in D_{it} shifts the industry inverse demand curve down by more than it shifts the industry inverse supply curve.

2 A negative supply shock (i.e. a rise in R_{it}) leads to lower equilibrium output Q_{it} but higher equilibrium P_{it}/W_{it} as long as the net effect of the rise in R_{it} is to raise the inverse industry supply curve.

The conditions ensure that the effect of the particular shock on output or prices is not overwhelmed by any shifts in labor supply to the industry. For example, with respect to a decline in D_{it}, output will only fall as long as wages do not fall so much that the industry supply curve shifts out more than the demand curve shifts back. We believe these assumptions to be plausible.

These results imply that if a monetary contraction affects an industry primarily by lowering the demand for its product, we should observe a fall in both output and prices (relative to wages). In contrast, if a monetary contraction affects an industry primarily by raising its production costs, we should observe a fall in output accompanied by a rise in prices relative to wages. If a monetary contraction affects both supply and demand, then we should observe an amplified fall in output and an ambiguous effect on the price-wage ratio.

This simple model conveys the basic idea, but abstracts from several potentially important considerations. We now consider several of these factors.

Dynamic Aspects

The simple model presented abstracts from any dynamic elements of production, such as adjustment costs and inventories. The addition of these elements, however, does not change the basic implications of the model. An earlier version of this paper presented a more complex model with lags in production scheduling and inventory holding, but with the same implications for the comovement of prices and output. The only difference is the various lags introduced. Our empirical work allows for lags in the estimation and analyzes impulse response functions rather than just contemporaneous correlations. Thus, timing issues should not affect our analysis.

Materials Prices

Our simple model also abstracts from another potentially important part of marginal cost: materials prices. If monetary policy responds to incipient warnings of inflationary pressures, such as rises in raw materials prices, then a monetary contraction could be correlated with rises in output prices for reasons completely apart from any supply-side effects of monetary policy. To be specific, if both output prices and monetary policy respond to rises in raw materials prices, then we could observe rising output prices during a monetary contraction even if there were no supply-side effects of monetary policy. In fact, as we will discuss in more detail in the next section, this point is related to what has become known as the "price puzzle." We deal with this issue in the empirical work by controlling for raw materials prices.

Overall, these results give a rather clean test of a shock's origin. If output is falling with declining prices, then one should conclude that the shock is from the demand side. However, if one observes rising prices accompanying declining output, this is an equally clear indication of a cost-based shock.

Where this test becomes uninformative is in the presence of both demand and cost shocks of relatively equal strength. In this case, the effect on prices is indeterminate, and quite possibly flat. In an economy with no price frictions declining output in the face of flat prices would be taken as evidence of the presence of both shocks, depending on the relative elasticities of the supply and demand curves. Alternatively, one could explain such results with sticky price arguments.

This indeterminacy is not a problem, however, if the cost channel of transmission is sufficiently large relative to the demand channel. In this case, one should be able to test for rising prices in the presence of falling output. We will see in the empirical results of the following section that this appears to be the case for a significant number of industries.

It should be clear that our model makes no predictions about the aggregate price level since it does not specify the source of nonneutrality of money. The only price implications are for *relative prices*.

To summarize, the comovements between industry output prices relative to industry wages and production can potentially indicate the channel through which monetary policy affects that industry. If prices are observed to rise significantly as output falls significantly, one can reject the traditional null hypothesis that monetary policy is strictly (or even most importantly) a demand-related shock. The subsequent section in this paper provides details on how a shock to monetary policy is identified, and presents the results of a test of this hypothesis for aggregate manufacturing, durable manufacturing, non-durable manufacturing and two-digit manufacturing industries.

III. An Empirical Test of Monetary Policy as a Supply Shock.

A. Empirical Framework.

To test whether monetary policy has important supply-side effects, one could estimate a structural model similar to that presented in the last section to directly gauge monetary policy's affect on the R_t and the D_t terms. The disadvantage of such a method is that the results are likely to be sensitive to model specification and estimation method. Given the very simple and clearly testable implications developed in the last section for the comovement of relative prices and output, this approach is unnecessary. Vector autoregressions and their associated impulse response functions provide a convenient method for testing hypotheses about the dynamic movement of the endogenous variables of a system to exogenous shocks.

As noted in Section I, many researchers have used VARs to identify monetary policy actions and, almost uniformly, these researchers measure a monetary policy shock as an innovation to the Federal funds rate (hereafter FFR) after controlling for the Federal Reserve's "feedback function," or the endogenous reaction of the Federal Reserve to movements in important economic series.[2] This paper follows the work of Bernanke & Blinder (1992) and Christiano, Eichenbaum & Evans (1994) (CEE). The main reasons for choosing their identification scheme is that its relatively simple partial identification scheme allows for control of the so-called "price puzzle" and flexibility in examining the responses of individual time series to monetary policy shocks.

[2] Strongin (1995) points out that the Federal Reserve does *not* control the Federal Funds rate, but it does control access to the Discount Window, and hence the ratio of Non-borrowed to Total Reserves. He argues that this ratio should then be used to measure monetary policy. However, Christiano et al (1994) show that VARs using the Federal Funds rate to identify monetary policy changes yield qualitatively similar results to Strongin's measure, but have smaller standard errors.

The price puzzle, noted by Eichenbaum (1992) and by Sims (1992), is the finding that aggregate prices rise following a monetary contraction identified by the unexplained portion of the Federal funds rate. Under the traditional view of a demand driven transmission mechanism, this appears to be a puzzle. The proposed solution to this puzzle is that the Federal Reserve possesses better information about coming inflation than is captured in a parsimonious VAR and reacts appropriately. CEE, following Sims (1992), improve their VARs information set by including commodity prices as a leading indicator of inflation to which the Federal Reserve passively responds. CEE demonstrate that this eliminates the price puzzle (note that this is not true in pre-1979 sub-samples; see Part C of this section), and produces the flat prices referred to in Section I.

This paper will argue that the price puzzle may not be an enigma at all, since it ignores the possibility that the monetary transmission mechanism itself has cost effects. Prices *should rise* in the short-run following an unanticipated monetary contraction if the cost effects of the monetary transmission mechanism dominate the demand effects. However, in the interest of conservatism, this paper follows CEE by controlling for the price puzzle. Additionally, the empirical work here explicitly controls for exogenous oil shocks to prevent the cost effects of oil from tainting the results.

The CEE approach is designed to account for the "feedback function" of the Federal Reserve (Fed) in identification of policy shocks. The idea is that the Fed observes contemporaneous values of important aggregate series such as output, prices, commodity prices and demand for reserves before targeting the Federal funds rate (FFR), which is assumed to be the policy instrument of the Fed. Thus, the portion of the FFR which is orthogonal to these "feedback" variables is assumed to be an exogenous shift in policy. Further, the identification scheme assumes that these changes in policy do not affect the other aggregate variables in the system contemporaneously.

These identifying assumptions only partially identify the system. This partial identification strategy is achieved through recursive ordering and the use of a Cholesky decomposition of the variance-covariance matrix of the residuals as the rotation matrix of the system. By ordering "feedback" variables before the FFR, one allows contemporaneous effects on the FFR, but not the reverse. CEE then order equations for variables of interest following the FFR equation, assuming that data other than output, prices, commodity prices and demand for reserves do not have similar feedback potential, and that Fed policy affects such a variables immediately. These assumptions are particularly hard to dispute when working with monthly data as this paper does.

The key advantage of this partial identification is that since we have assumed Fed policy does not have contemporaneous effects on the "feedback" variables in the system, the ordering of those variables within the macro-equation block is irrelevant. There is no need to make assumptions about the contemporaneous affects of aggregate production on commodity prices or vice versa.

There are three crucial differences between our empirical model and that of Christiano et al. First, we follow the FFR equation by two equations for variables of interest, one for industry output and one for the industry price-wage ratio. Second, we include dummy variables in each equation to control for the cost effects of oil shocks. As Hamilton (1983, 1996b) points out, all but one U.S. recessions since World War II have been preceded by an oil price shock. Further, Hoover & Perez (1994) note that identified (negative) monetary policy shifts are highly correlated with these oil shocks. We control for the cost effects of oil shocks using an approach similar in spirit to that of Bernanke, Gertler & Watson (1997) by including dummy variables in each equation that take the value one during a "Hoover & Perez date" and zero otherwise[3]. Based on Hamilton's (1985) evidence that oil price shocks take an average nine months to induce recessions, we include current and twelve lags of the Hoover & Perez dummies.

Additionally, in the interest of more efficient estimation and consistent identification, the coefficients of the series of interest in the "feedback" variable and FFR equations are constrained to be zero for each of the industries examined. This is the approach pursued by Davis & Haltiwanger (1997), who point out that this is in essence a pseudo-panel data VAR, since the coefficients of the "feedback" and FFR equations are fixed across regressions, but the coefficients in the "series of interest" equations are allowed to vary across industries.

To make the above more explicit, consider the following system of seven equations:

$$\begin{aligned} &Y_t = F'SD_t + \sum_{j=0}^{12} G_j' HP_{t-j} + \sum_{k=1}^{7} A_k Y_{t-k} + \varepsilon_t \text{ where} \\ (4) \quad &Y_t' = \left[IP_{t,} P_{t,} PCOM_{t,} NB2TOT_{t,} FFR_{t,} Q_{t,} PW_{t,} \right] \end{aligned}$$

Here, IP_t is the industrial production (a proxy for output), P_t is the personal consumption expenditure deflator (a monthly measure of general price levels), $PCOM_t$ is a producer price index of commodities, $NB2TOT_t$ is the log difference of total reserves of the Federal Reserve system from non-borrowed reserves (as a measure of demand for reserves), FFR_t is the month end Federal funds rate, $Q_{i,t}$ is industrial production in industry *i*, and $PW_{i,t,}$ the ratio of price to wage in industry *i*. SD_t is a matrix of a constant and seasonal dummies and HP_t is a Hoover &

[3] That is, months identified by Hoover & Perez (1994) as having an exogenous oil supply shock based on their

Perez dummy. A is a matrix of endogenous variable coefficients, and following Bernanke, Gertler & Watson (1997), seven lags are used. All series are in natural log levels except FFR_t and those identified as log differences. Details on data construction are given in the Data Appendix.

We estimated vector autoregressions of this form for total manufacturing, durable manufacturing and non-durable manufacturing, 18 two-digit industries and two three-digit industries within these categories over three sample periods: the entire period from February 1959 to December 1996, and the two sub-sample periods from February 1959 to September 1979 and from January 1983 to December 1996. Explicitly, we tested the null hypothesis that the change in industry price relative to industry wage is less than or equal to zero following a monetary contraction. We take rejection of this hypothesis as evidence that a cost channel rather than a demand channel is the most important avenue of monetary transmission for that industry.

B. Full-Sample Results.

The results are presented in a series of graphs and tables. Figures 1A through 1C show the effect of a positive Federal funds rate shock on the price-wage ratio and output for the manufacturing aggregates as well as the individual two and three-digit industries using our entire sample for estimation. For 13 of the 21 industries examined and for all three aggregates, the impulse response functions show that in response to a positive shock to the Federal funds rate output falls and prices rise relative to wages. Columns two and three in Table 1 summarize the results by describing the behavior of the data during the first 24 months for each industry. Table 1 presents the results of a test of the null hypothesis that none of the price levels are significantly above zero during the first 24 months. The results clearly reject the null hypothesis at the 10%

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reading of Hamilton's (1985) history of post-war oil shocks.

level for nine of industries analyzed and we can thus reject the claim that monetary policy exerts its effects solely through a demand channel of transmission. In fact, for many important industries, and even for manufacturing as a whole and for aggregate non-durable manufacturing, the results indicate that monetary policy's primary effects on real variables are transmitted through a supply-side channel.

There is clear evidence of the importance of a demand channel of transmission for only six industries (Lumber Products, Primary Metals, Fabricated Metals, Other Durables, Food, and Rubber). For none of the manufacturing aggregates is there evidence that a demand channel clearly dominates the supply channel postulated in this paper.

Recall from the results of the theoretical model in Section II that if monetary shocks have an effect primarily through increases in costs, prices should rise as output falls. This is exactly what we observe in Figure 1C. Look at the price and output responses of Motor Vehicles: prices steeply rise and then decay slowly after a peak at nine months; the output response is nearly the mirror image, falling to a trough at nine months and slowly increasing from there.

Nor are these unimportant or non-influential industries showing significant cost effects of monetary policy. Among those with significant evidence of cost shock effects are Aircraft, Chemicals & Allied Products, Industrial Machinery, and Textiles. But these results are not limited to the industry level. Total manufacturing strongly exhibits supply-side effects, while non-durable manufacturing shows significant effects. Taken together this evidence provides a case for a supply-side channel of monetary transmission that is significantly more powerful in creating real effects than the often-assumed demand channel.

Some of the industries that exhibit strong cost-side effects run counter to our prior expectations. One such example is Motor Vehicles & Parts, which shows a very pronounced increase in the ratio of price to wages. One might think that an industry governed by such large firms would not experience large cost effects of a monetary contraction, since they have easy access to commercial paper. One possible explanation is that the primary cost-side effect of a monetary contraction is through changes in market interest rates, rather than bank loan behavior, so that even large firms experience significant increases in their costs. Another possible explanation is that the small companies that supply parts face loan reductions from their banks. We will discuss some other examples of differences across industries in the next section in which we consider alternative explanations for our results.

The heterogeneity of the results across industries raises many questions. In order to understand the differences across industries, one must not only measure the differences in the strengths of the demand and cost channels for each industry, but also the differences in working capital that would lead monetary policy to have varied cost channel effects. Factors that might be important are the role of financing in industry demand relative to industry supply, the fraction of firms that are bank dependent, and technological and institutional features that affect the time lag between payments of factors and receipts from sales. Measurement of these factors is beyond the scope of this paper.

Our findings on the behavior of price-wage ratios are consistent with those of Christiano, Eichenbaum & Evans (1997). These researchers show that a monetary contraction leads to a decline in real wages in most industries. They measure the real wage as the industry wage divided by the GDP deflator, so they are focussing on the real *consumption* wage. We instead focus on the inverse of the real *product* wage, since we use industry-specific prices. As pointed out by Ramey & Shapiro (1998), these two types of wages can behave very differently if relative prices vary. The industry equilibrium model presented earlier directs us to study ratios of industry specific prices and wages. Our finding that many industries experience rising price-wage ratios implies that many industries experience declining product wages.

C. Sub-Sample Results

We now explore the extent to which the effects we identified may have changed over the sample period. To this end, we split the sample into the period February 1959 to September 1979 (the pre-Volcker period) and from January 1983 to December 1996 (the "Modern Era"). We choose these two sub-samples based on the works of Faust (1998) and Gordon & Leeper (1994), who report substantial empirical differences between the aggregate effects of VAR-based identification of monetary policy in these two periods. Additionally, the choice of these two sub-samples removes the volatility of monetary policy and economic aggregates experienced between late 1979 and 1982 from the data.

Figures 2A through 2C show the results for the pre-Volcker period. To conserve space we do not show the graphs for the "Modern Era." The information for both periods is summarized in columns four through seven of Table 1.

The difference between the two periods is remarkable. Overall, we see that the early period through 1979 shows very strong cost channel effects, whereas the later period shows little evidence of cost channel effects. In the pre-Volcker period, total manufacturing and durable manufacturing, as well as nearly every industry exhibit some evidence of a cost channel price effect. For both aggregates and for fourteen of the individual industries, the price effects are significant at the ten percent level. In contrast, only Lumber and Leather & Hides exhibit dominant demand channel effects during this period.

During the "Modern Era," the cost channel effects are much weaker. Only nine industries show significant increases in their relative prices following a monetary contraction. Furthermore, even in the industries with significant relative price increases, the paths of relative prices and output are not as clearly consistent with a supply shock as in the pre-Volcker period.

This difference across periods is consistent with the institutional changes that have occurred. As has been discussed by many observers (e.g. Friedman (1986)), the financial structure of the U.S. changed significantly during the late 1970s and early 1980s. The private sector financial innovations beginning in the 1970s and the deregulation of the early 1980s led to more efficient and less regionally segmented financial markets. The banking and credit regulations of the earlier period, which limited the scope of lenders and borrowers to respond to sudden monetary contractions, may have allowed monetary policy to restrict the availability of working capital. In the later period, banks and firms had more alternative sources of funds.

A different type of institutional change also occurred over this time period. Owens & Schreft (1992) and Romer & Romer (1993) use narrative approaches to show that during the earlier period, contractionary monetary policy was often accompanied by "credit actions," in which the Federal Reserve sought to limit directly the amount of bank lending. The consequent non-price rationing led to particularly acute credit crunches which could have led to severe limitations in working capital. Thus, well-documented differences in financial markets and Federal Reserve policy combined with theory postulating the presence of a cost channel of monetary transmission can explain the variation we see in the effects of monetary policy through time.

We now present another type of evidence in support of the view that the nature of the monetary transmission mechanism changed over time. Recall from our earlier analysis that if monetary policy shifts both supply and demand in the same direction, the effect on output is greater than if it shifts only demand. Thus, if the cost channel of monetary transmission were more important during the earlier sub-period, as suggested by Bernanke & Gertler (1995), we might expect that the effects of monetary policy on output would be greater in magnitude and last longer in the earlier period.

To test this hypothesis, we estimate the basic aggregate CEE model for the two sub-periods (that is, system (4) minus the last two equations). Because we wish to compare the magnitude of the response of output to a given shock to monetary policy, we set the innovation for both periods equal to 25 basis points, the typical interval of change in Federal Reserve policy[4].

Figure 3 shows the responses of the Federal funds rate, industrial production and the aggregate price level to a 25 basis point Federal funds shock for the model estimated over each of the two sub-samples (February 1959 to September 1979 and January 1983 to December 1996) and the entire sample (February 1959 to December 1996). Consider first the difference in the behavior of the Federal funds rate, in Figure 3A. The peak response during the early period is slightly higher than the peak response during the second period. The funds rate returns to its original level 19 months after the initial shock during the early period and 10 months after the shock during the later period. Thus, the impact of a monetary policy shock on the Federal funds rate is similar in magnitude over the two periods, but has a somewhat longer duration during the earlier period.

Consider now the impulse responses of output, in Figure 3B. Comparison of the figures shows that the trough of output is more than three times as deep during the early period as the later period. Moreover, the duration of the effect on output appears to be much longer during the early period. The trough occurs two years after the initial shock during the early period, but only one year after the initial shock during the later period. Furthermore, during the early period output is still well below its previous level even four years after the shock. During the later period, output rebounds within two years of the shock to the Federal funds rate. Thus, both in magnitude and duration, a given monetary shock had much greater effects during the earlier period. The difference in the effects cannot be fully accounted for by the difference in the response of the Federal funds rate over these two periods.

Finally, consider the behavior of prices in response to a monetary contraction. Despite including commodity prices in the reaction function, the price puzzle appears to be fully operational in the early period.[5] After a contractionary monetary policy shock, prices rise for over two years before beginning to fall. In contrast, after a blip up for five months, prices fall for the most part during the later period.

Our finding that in the pre-Volcker period aggregate prices rise in the short-run following a monetary contraction is consistent with the results of Hanson (1998). Recall that Sims' (1992) original motivation for including an index of commodity prices in a VAR to identify the Fed's feedback function was as a leading indicator of incipient inflation. Hanson tests a variety of variables (including commodity prices) that might have power to forecast inflation in a similar VAR identification of monetary policy functions, and finds that in the pre-1979 sample period none of these eliminate the price puzzle. Hanson's work casts doubt on the now widely accepted view that the price puzzle is the result of the Fed possessing better information of coming

[4] The standard deviation of the innovation to the Federal Funds rate equation for a regression using the pre-Volcker sample is 28.5 basis points; for a regression on the modern period sample it is 17.7 basis points; and for a regression over the entire data sample it is 50.3 basis points.

inflation than is captured in a simple VAR with aggregate output, prices and monetary policy variables (like the Federal funds rate). The results of this paper suggest that the real solution to the price puzzle may lie instead with a cost channel of monetary transmission, which leads to a short-run increase in prices. As noted previously, if monetary policy does transmit its effects on real variables through a cost channel, then *rising prices in the short-run following a contractionary policy shock are not a puzzle*.

Thus, three pieces of evidence suggest that the cost channel may have been a more important part of the monetary transmission mechanism in the period before 1980. First, the industry level regressions show that many more industries experienced rising price-wage ratios and falling output after a monetary contraction. Second, we appeal to the restrictive regulations and policy actions during the earlier period as leading to particularly acute credit crunches. Third, we show that the amplification and duration effects on output and the price puzzle effects are substantially greater during the earlier period.

IV. Possible Alternative Explanations.

This section considers four possible alternative explanations of price and output responses discussed in the previous sections. The first is that our finding of rising price to wage ratios is due mostly to falling wages, rather than rising prices. One possible explanation for why wages might be more variable than prices is the behavior of overtime hours and the overtime premium. Initial cuts in output may involve the elimination of overtime hours which would imply a decline in average wages. The second alternative explanation is that we are not adequately addressing the Fed's forecasts of future inflation in our estimated reaction function.

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[5] And adverse oil shocks too! Recall the specification (4) includes dummy variables for Hoover & Perez dates. The rise in prices during this period is significant at the five-percent level from five months to 21 months following the

The third alternative explanation, *counter-cyclical markups*, has been the subject of intense research in recent years by several authors. Finally, *increasing returns to scale* potentially could explain our results. We discuss each of these possible explanations.

Sticky Prices and Flexible Wages

One possible explanation for the results of this paper is that the price-wage ratio rises in some industries after a monetary contraction because prices are sticky whereas wages are not. If a monetary contraction reduces the demand for an industry's output, firms respond by lowering their output and, consequently labor demand. If, for some reason, prices cannot adjust immediately but wages can, then wages would fall relative to prices.

We consider this explanation to be less plausible. Christiano, Eichenbaum and Evans (1997) show that behavior of profits is inconsistent with a sticky-price model of money. They show empirically that profits decline significantly in the wake of a monetary contraction. In contrast, a reasonable specification of a sticky price model predicts *rising* profits in response to a monetary contraction. Thus, it is unlikely that a sticky-price model can explain these facts.

We can also show direct evidence that this type of model cannot explain our results. Figures 4A-4C show the separate responses of nominal prices and wages by industry. We show the results for the period 1959 to 1979, the period with the strongest rises in the price-to-wage ratio. The graphs show that the *nominal price level itself* rises in virtually all of the industries. Nominal wages fall in some industries and rise in others, but it is clear that our earlier results are being driven primarily by the price level.

Federal funds rate shock.

Expected Future Inflation

As discussed earlier, a leading explanation for the price puzzle is misspecification of the Federal Reserve reaction function. In particular, if the Fed changes the Federal funds rate because it is forecasting future inflation that is not anticipated by a parsimonious VAR, then the incorrectly specified reaction function will make it look like shocks to the funds rate raise prices. It may be that industrial production, consumer prices and commodity prices are not sufficient to capture all of the information used the Fed to forecast future inflation.

The first relevant point is that our main result concerns relative prices, not nominal prices. That said, the price/wage ratio may rise due to price puzzle effects if firms respond to inflation more quickly than does labor. However, as pointed out earlier, the very reason given for the price puzzle – the Fed's better information on future inflation – is called into question by Hanson's work. Despite using sophisticated modern econometric methods and *ex post* data to create the inflation forecasts included in his VAR, Hanson is unable to remove the price puzzle in the pre-Volcker period.

We extend Hanson's work here by including actual Federal Reserve Board forecasts of current and future inflation and output in our policy equation. Romer & Romer (1996) have compiled a series of past forecasts from the Greenbooks prepared by the Federal Reserve's staff prior to each FOMC meeting. We use these monthly forecasts of inflation and output for the current quarter and one quarter ahead. Because the FOMC meetings do not occur every month, there are several months with missing values for the period 1965:11 to 1979:9. We filled in the missing values using the last available forecast. We included these series as exogenous variables in the Federal funds rate equation. In doing so, we are making two assumptions. First, only the Federal Reserve has access to its forecasts in the relevant period. Second, the Fed's *ex post* policy actions do not change its forecasts in subsequent months. While the first assumption is unimpeachable, the second is a bit more dubious. The Federal Reserve staff likely would change its forecasts as new information became available, however, this specification should serve as a convenient benchmark for testing the price puzzle hypothesis that *ex ante* the Fed possesses superior knowledge about coming inflation.

Specifically, we estimated equation (4) less the last two industry equations and with the following modification to the fifth equation for the Federal funds rate:

$$(5) \qquad FFR_t = \sum_{i=0}^{1}\left(\alpha_i GB\Delta Y_t^{t+i} + \beta_i GB\Delta P_t^{t+i}\right) + f_5' SD_t + \sum_{j=0}^{12} g_{5,j}' HP_{t-j} + \sum_{k=1}^{7} a_{5,k} Y_{t-k} + \varepsilon_{5,t}$$

where $GB\Delta Y_t^{t+i}$ is the Fed Greenbook forecast for output growth for quarter $t+i$ made in month t, and similarly, $GB\Delta P_t^{t+i}$ is the forecast of inflation.

Figure 5 shows the effect of controlling for the Fed's inflation forecasts on the aggregate results. As the graphs make clear, using a better measure of inflation forecast does not change the results noticeably. Aggregate prices still rise significantly in the first two years following an unanticipated increase in the Federal funds rate. Thus, it seems unlikely to us that our results could be explained by a misspecified reaction function.[6]

Counter-Cyclical Markups

Counter-cyclical markups have been offered as a possible factor in cyclical fluctuations in recent years by Rotemberg & Woodford (1991, 1992) and Chevalier & Scharfstein (1996) among others. A counter-cyclical markup is a spread between prices and marginal costs (the markup above marginal cost) that increases in recessions and decreases in booms. The direct

[6] The industry level results on price to wage ratio movements are available upon request from the authors, but show little change from those in figures 2A through 2C.

link with the evidence presented here is that the above authors often consider the price to wage ratio to be an accurate measure of markup. For example, Rotemberg & Woodford (1992) argue that a theory of counter-cyclical markups is required in order to explain the increase in real product wages after an increase in military spending. Subsequent work by Ramey & Shapiro (1998), however, shows that, in fact, real product wages fall in the wake of a military spending increase.

Chevalier & Scharfstein (1996) present the most compelling evidence of counter-cyclical markups in their analysis of the pricing behavior of national, regional and local supermarkets during national and regional downturns. They present a model of capital market imperfections in which firms with low cash flow sacrifice long-term market share in order to raise short-term profits. Firms implement this policy by raising their markups. In the data, Chevalier & Scharfstein find that leveraged firms do indeed lower their prices less (or raise them more) during recessions when compared to less leveraged firms.

An equally plausible explanation for the price increases observed for leveraged firms is that their marginal costs rose due to increased external financing premiums. In fact, the markup and cost channel theories are really just variations on a similar theme. The counter-cyclical markup hypothesis argues that liquidity constraints lead to higher prices because they raise optimal markups; the cost channel theory argues that liquidity constraints raise prices because they raise marginal costs. Without an accurate measure of the marginal costs of these firms (including financing costs), one cannot tell whether markups are indeed going up with prices, or whether marginal costs of production and distribution are rising.

This later point applies to the literature of counter-cyclical markups more generally. Proponents of this line of research fail to demonstrate that markups are indeed counter-cyclical.

Most consider the ratio of price to wage to be an accurate or at least a reasonable approximation to the markup. We argue that if the firm has to finance its production costs, credit is in essence an input to a Leontief production function where credit is the limiting input whose marginal cost is the determining factor in total marginal cost (not the wage).

Another point at which counter-cyclical markup models do not fully explain Section III's results is that they fail to rationalize why an industry like Transportation Equipment would exhibit *counter-cyclical prices*, and an industry like Lumber products would exhibit *pro-cyclical prices*. Both industries are dominated by large industrial firms (General Motors vs. Weyerhauser), but also have numerous smaller firms (auto parts manufacturers vs. independent logging mills), so intra-industry market organization and structure should be similar. Counter-cyclical markups do not explain why one industry exhibits counter-cyclical prices, but the other does not.

The hypothesis of this paper can, however, explain this result. For Transportation Equipment, cost shocks created by monetary policy are more important in causing output and price fluctuations than are the associated demand shocks, since financing is likely very important to undertake production in this industry. While for Lumber products, the demand channel of monetary transmission appears more important. It should be obvious why Lumber would be more affected by a demand channel. As mortgage rates rise following a monetary tightening, construction declines, shutting-off the primary demand for lumber products. Compared to firm costs associated with lumber production, this type of demand effect is understandably larger.

Indeed, a direct comparison with Rotemberg & Woodford (1991) is illuminating. Rotemberg & Woodford seek evidence of counter-cyclical markups in the same two-digit industries we examine here, and contend that Food, Lumber, Rubber and Primary Metals all exhibit counter-cyclical markups. However, we find that following a monetary contraction, these four industries have falling relative prices and output. Further, Rotemberg & Woodford (1991) find pro-cyclical markups for Paper & Pulp, Apparel, Chemicals, Petroleum and Electrical Machinery, where we find rising relative prices and falling output in these industries after a Fed tightening.

Increasing Returns to Scale

Another possible explanation for the results of Section III of this paper is increasing returns to scale. Murphy, Schleifer & Vishny (1989) present a business cycle model in which downward-sloping supply curves generate endogenous fluctuations. Moreover, some estimates of inventory models indicate declining marginal costs (e.g. Ramey (1991)).

Since an industry supply curve would be downward sloping (over at least some portion) under short-run increasing returns to scale, a demand-only contraction could be responsible for a contemporaneous drop in output and rise in prices. Thus, the empirical results are consistent with a demand-only channel if supply curves slope down across a wide variety of industries.

The empirical validity of downward-sloping supply curves is controversial, though. In work extending Ramey (1991), Bresnahan & Ramey (1994) find that while there are nonconvexities, they appear to the take the form of fixed costs and lumpiness in production rather than declining marginal costs. Shea (1993, p.26) reports in his study of industry level supply curves that his “results suggest that short-run increasing returns to scale and countercyclical [sic] price-cost margins may not be particularly important to the cyclical behavior or manufacturing prices.” Thus, most would believe that the evidence for downward-sloping supply curve is not strong.

V. Concluding Remarks.

This paper has presented an empirical test that provides evidence to support the contention that monetary policy has supply-side effects on real variables. The evidence given here shows that in key manufacturing industries, prices rise and output falls following an unanticipated monetary contraction, even after controlling for both the price puzzle and the cost effects of oil shocks. Further, the results call into question whether a price puzzle even exists. We find that the evidence for cost channel effects is much stronger during the period from 1959 to 1979 than from 1983 to 1996. During the earlier period, many more industries exhibited rising prices in response to a monetary contraction. Moreover, the effects of monetary policy on output were greater and the price puzzle was more pronounced during this earlier period. These results are not easily explained by competing theories, and yet are quite naturally and intuitively explained by treating monetary policy as a cost shock to important industries in the US Economy.

It is important to note that the results here do not preclude a demand channel of monetary transmission and the purpose of this paper was not to do so. This paper examined only manufacturing industries, and found strong support in these industries for the hypothesis of cost-side effects of monetary policy. However, it also found evidence that a demand related shock is stronger for some industries (notably, Lumber products) than for others. The important implication is not that unexpected changes in monetary policy are a cost shock *or* a demand shock, but rather that it is a *combination of a cost and a demand shock.* This hypothesis is not only better able to explain the stylized facts than sticky price models, but it is able to explain the microeconomic level evidence presented herein where traditional models fail.

Theoretical Appendix: Comparative Statics Exercises.

The representative firm's first-order condition for profit maximization is given by:

$$P_{it} = R_{it} \cdot W_{it} \cdot C'(Q_{it})$$

To obtain the industry equilibrium condition, we substitute the inverse demand function for P_{it} in the equation above to obtain:

$$f(Q_{it}, D_{it}) = R_{it} \cdot W_{it} \cdot C'(Q_{it}) \ .$$

Totally differentiating these two equations along with the wage equation (3) from the text with respect to D_{it} gives the following results:

$$\frac{dQ_{it}}{dD_{it}} = \frac{f_D - N_D \cdot R \cdot C'(Q_{it})}{R_{it} \cdot W_{it} \cdot C''(Q_{it}) - f_Q + R \cdot C'(Q_{it}) \cdot N_Q}$$

$$\frac{d\left(\frac{P_{it}}{W_{it}}\right)}{dD_{it}} = R_{it} \cdot C''(Q_{it}) \frac{dQ_{it}}{dD_{it}}$$

The assumptions on the signs of the derivatives of the *f* , *C*, and *N* functions ensure that the denominator is positive. When we allow $N_D > 0$, we must impose extra restrictions in order to show that both derivatives are positive. In order for a rise in D to raise Q and P/W, we require that $f_D > N_D \cdot R \cdot C'(Q_{it})$. This condition implies that a rise in D must shift the industry inverse demand curve more than it shifts the industry inverse supply curve in the neighborhood of equilibrium Q. If the opposite held, a rise in D would indirectly raise industry costs so much that output would fall.

The comparative static derivatives for a change in R_{it} are as follows:

$$\frac{dQ_{it}}{dR_{it}} = \frac{-C'(Q_{it}) \cdot W_{it} - C'(Q_{it}) \cdot R \cdot N_R}{R_{it} \cdot W_{it} \cdot C''(Q_{it}) - f_Q + C'(Q_{it}) \cdot R_{it} \cdot N_Q}$$

$$\frac{d\left(\frac{P_{it}}{W_{it}}\right)}{dR_{it}} = \frac{C'(Q_{it}) \cdot [C'(Q_{it}) \cdot R_{it} \cdot N_Q - R_{it}^2 \cdot C''(Q_{it}) \cdot N_R - f_Q]}{R_{it} \cdot W_{it} \cdot C''(Q_{it}) - f_Q + C'(Q_{it}) \cdot R_{it} \cdot N_Q}$$

If we allow N_R to be negative, then in order for a rise in R to lower Q we require that the numerator in the expression for $\frac{dQ_{it}}{dR_{it}}$ be negative. Thus, we require that $C'(Q_{it}) \cdot W_{it} > -C'(Q_{it}) \cdot R \cdot N_R$. In words, we require that the direct increase in marginal cost due to a rise in R (the left-hand side) be greater than the magnitude of any fall in marginal cost due to the indirect effect on wages (the right-hand side).

Data Appendix.

All regressions in this paper were calculated using data from February 1959 to December 1996, or on sub-samples described in the text. All series were taken as logarithms except the Federal funds rate, which was left as a level. The ratio of non-borrowed to total reserves is actually the log difference between these two series, and likewise the industry price-to-wage ratios described in the text are log differences.

The data used for the "Macroeconomic Equations" of the VARs come from two sources. The index of sensitive commodity prices (PCOM from equation (11)) was obtained from Charles Evans at the Federal Reserve Bank of Chicago. All other data were taken from Citibase-DRI. The Citibase-DRI codes are as follows: *Industrial Production*, IP; *Personal Consumption Expenditure Deflator*, GMDC; *Non-borrowed Reserves*, FZMRNB; *Total Reserves*, FZCMRR, *Federal Funds Rate*, FYFF.

Monthly Hoover & Perez dates taken directly from their 1994 paper are: (1947:12, 1953:06, 1956:06, 1957:02 not in our data sample period) 1969:03, 1970:12, 1974:01, 1978:03, 1979:09, 1981:02, 1990:08.

Industry level industrial production data come directly from the Federal Reserve Board of Governors. Industry price data come from two sources. Where possible, the appropriate PPI form Citibase-DRI was used. Where those data were not available, nominal sales and inventory data (sales where possible, then inventories) were divided by real sales and inventory data to obtain an industry level deflator. All sales and inventory data were obtained from the Department of Commerce, Bureau of Economic Analysis.

Producer price indices were used in the following industries (followed by the Citibase-DRI code): *Manufactured Goods (82=100, NSA)*, PWM; *Total Durable Goods (82=100, NSA)*, PWMD; *Lumber & Wood Products (82=100, NSA)*, PWLU; *Furniture & Household Durables (82=100, NSA)*, PWFH; *Motor Vehicles & Equipment (82=100, NSA)*, PWAUTO; *Total Nondurable Goods (82=100, NSA)*, PWMND; *Textile Products & Apparel (82=100, NSA)*, PWTEX; *Apparel (82=100, NSA)*, PW381; *Pulp, Paper & Allied Products (82=100, NSA)*, PWPA; *Chemicals & Allied Products (82=100, NSA)*, PWCH; *Rubber & Plastic Products (82=100, NSA)*, PWRUB; *Hides, Skins, Leather, Related Products (82=100, NSA)*, PWSK.

For the following industries, prices were inferred from nominal and real sales: *Stone, Clay & Glass Products*, *Primary Metals Products*, *Fabricated Metals Products*, *Industrial Machinery & Equipment*, *Electrical Machinery & Equipment*, *Transportation Equipment*, *Aircraft & Parts*, *Instruments & Related Products*, *All Other Durable Goods Industries*, *Food & Kindred Products*, *Petroleum & Coal Products*. For *Tobacco Products*, nominal and real inventory data were used to infer an industry price index.

All industry wage data were taken from the Bureau of Labor Statistics' web page.

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Table 1: Number of periods in 1st Two Years P/W (or P/PCE) response is greater than zero, significantly (@ 10% level)

Regression Sample:	**Whole Period**		**Pre-Volcker**		**"Modern Era"**	
Industry	**P/W > 0**	**Significant**	**P/W > 0**	**Significant**	**P/W > 0**	**Significant**
Total Mfg.	14	5	24	0	7	2
Durables	6	0	20	9	3	0
Non-Durables	6	1	14*	1*	7	0
Lumber SIC 24	1	0	1	0	8	0
Furniture SIC 25	14	0	23	17	24	10
Stone, Clay & Glass SIC 32	9	1	21	18	19	2
Primary Metals SIC 33	0	0	21	17	0	0
Fabricated Metals SIC 34	0	0	22	9	2	0
Industrial Mach. SIC 35	25	2	14	0	N/A	N/A
Electrical Mach. SIC 36	13	0	21	0	12*	2*
Trans. Equip. SIC 37	24	23	19	1	11	0
Motor Veh. SIC 371	24	18	22	14	23	5
Aircraft & Parts SIC 372	24	19	7	0	25	5
Instruments SIC 38	9	0	16	0	25	2
Other Durables SIC 39	0	0	12	1	16	1
Food SIC 20	2	0	24	4*	0	0
Tobacco SIC 21	6	0	23	3*	10	0
Textiles SIC 22	25	9	25	3	1	0
Apparel SIC 23	22	9	16	0	0	0
Pulp & Paper SIC 26	8	3	24	8	13*	0
Chemicals SIC 28	7	3	22*	16*	8	5
Petroleum & Coal SIC 29	17	0	25	19	17	0
Rubber & Plastics SIC 30	0	0	24	15	13	4
Leather SIC 31	0	0	10*	0	2	0
Total Industries	16	9	21	14	17	9
Total Industries, n>=2	15	8	20	12	16	8

* For these industries, in the periods noted, output may not be falling simultaneously.

Figure 1A: Industry Output & Relative Price Responses to a Federal Funds Rate Shock

Entire Sample Period: February 1959 to December 1996

Thin line with circles Output; filled significant at 10%, open significant at 25%
Thick line with boxes Price/Wage; filled significant at 10%, open significant at 25%

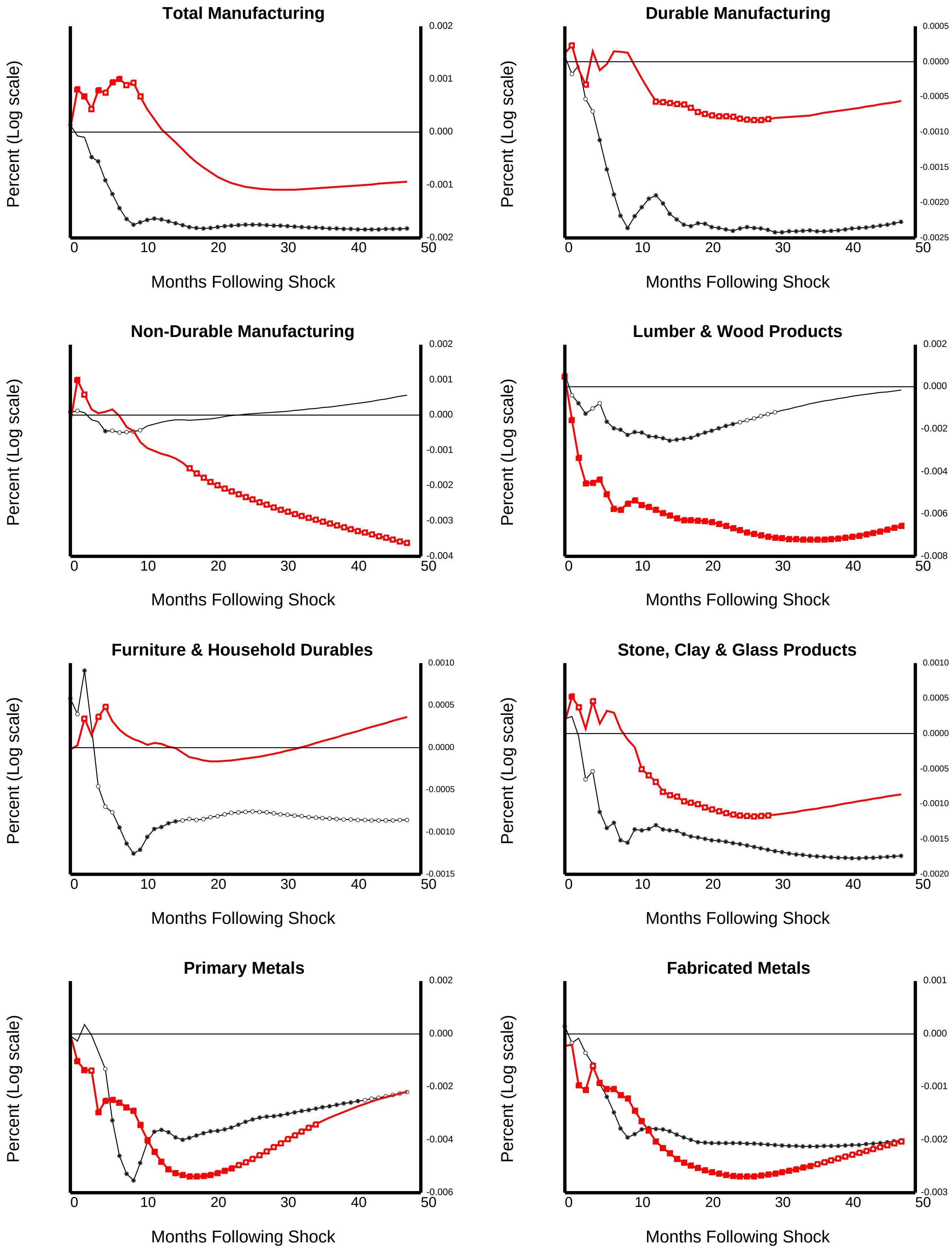


Figure 1B: Industry Output & Relative Price Responses to a Federal Funds Rate Shock
Entire Sample Period: February 1959 to December 1996

Thin line with circles Output; filled significant at 10%, open significant at 25%
Thick line with boxes Price/Wage; filled significant at 10%, open significant at 25%

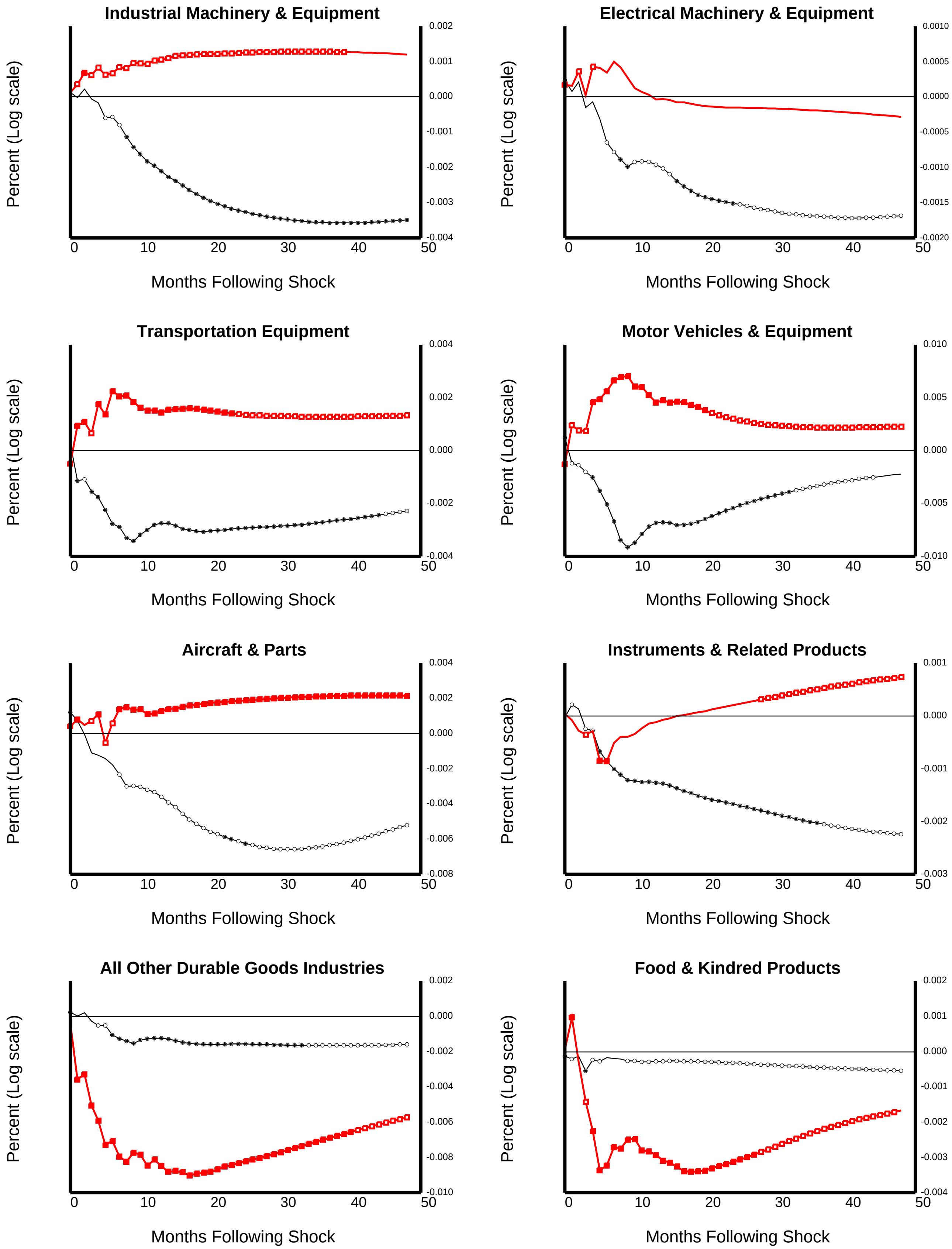


Figure 1C: Industry Output & Relative Price Responses to a Federal Funds Rate Shock
Entire Sample Period: February 1959 to December 1996

Thin line with circles Output; filled significant at 10%, open significant at 25%
Thick line with boxes Price/Wage; filled significant at 10%, open significant at 25%

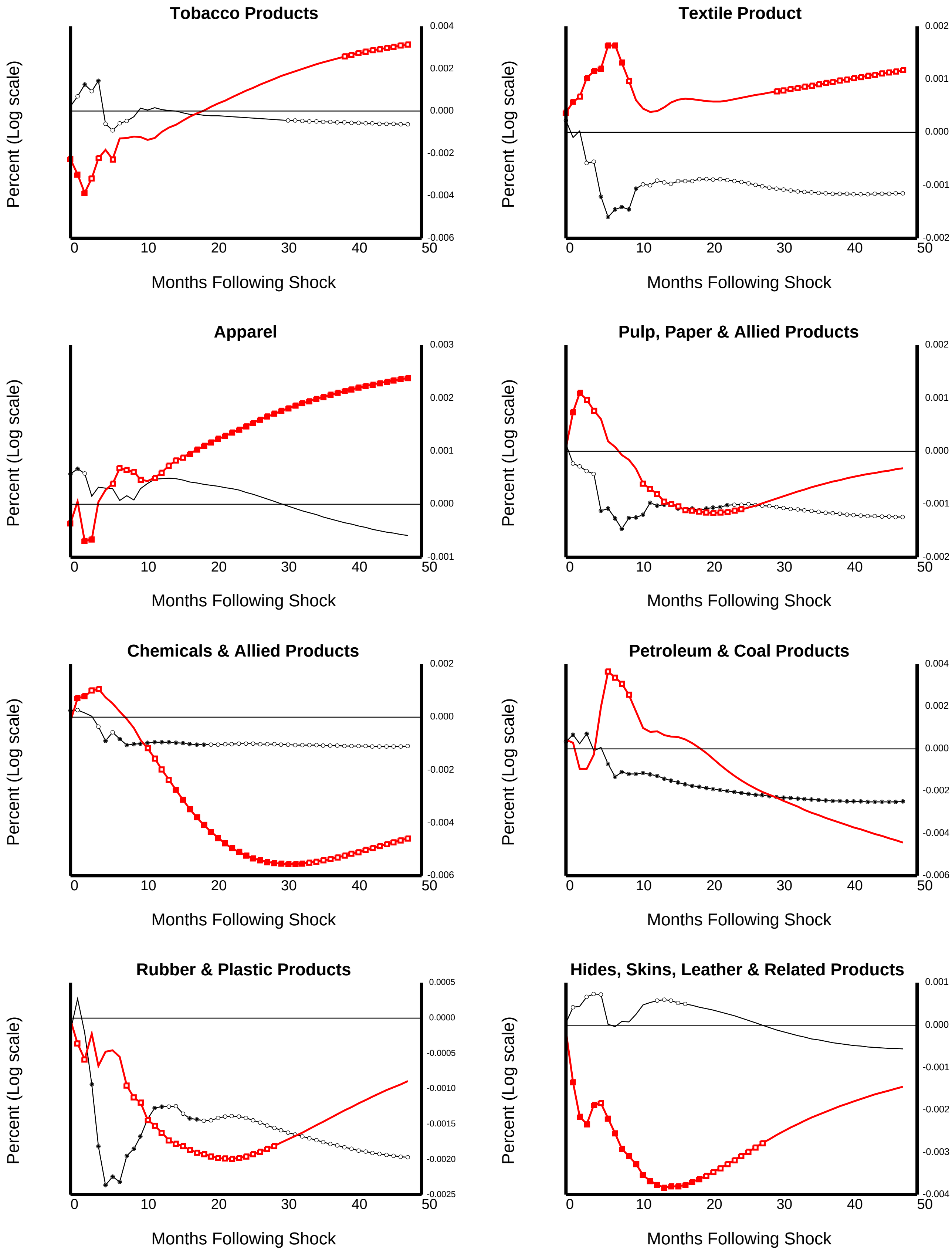


Figure 2A: Industry Output & Relative Price Responses to a Federal Funds Rate Shock
Early Sample Period: February 1959 to September 1979

Thin line with circles Output; filled significant at 10%, open significant at 25%
Thick line with boxes Price/Wage; filled significant at 10%, open significant at 25%

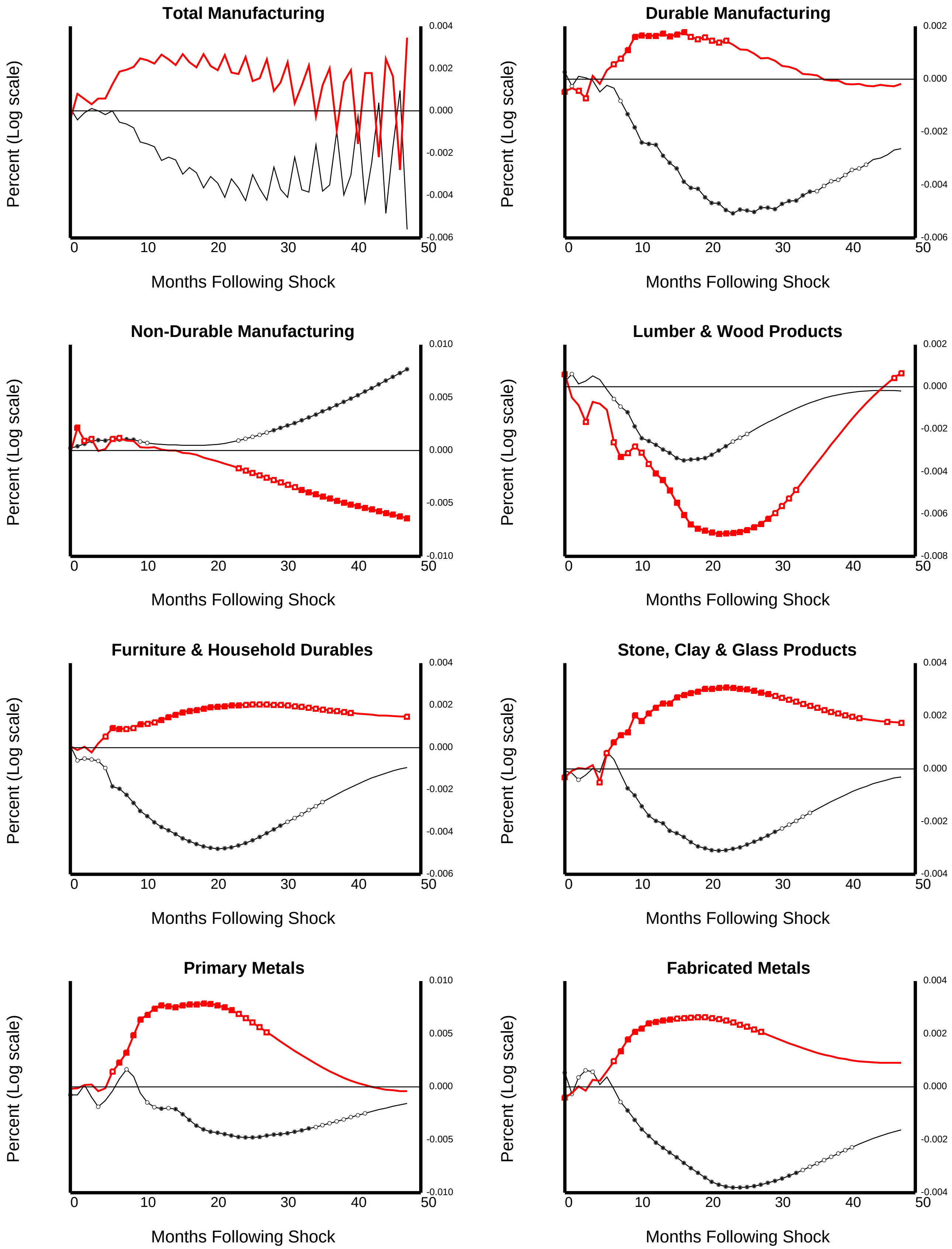


Figure 2B: Industry Output & Relative Price Responses to a Federal Funds Rate Shock
Early Sample Period: February 1959 to September 1979

Thin line with circles Output; filled significant at 10%, open significant at 25%
Thick line with boxes Price/Wage; filled significant at 10%, open significant at 25%

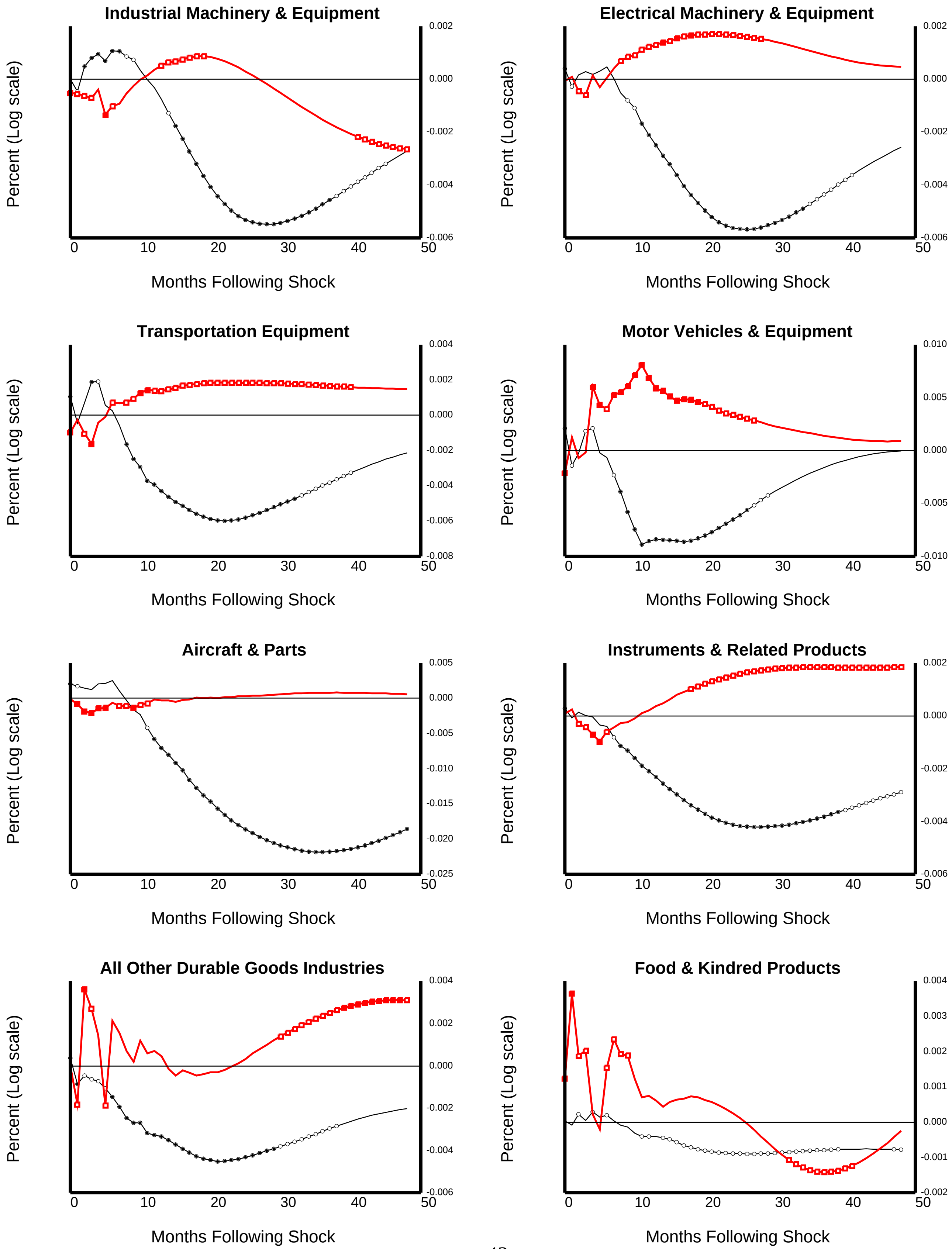


Figure 2C: Industry Output & Relative Price Responses to a Federal Funds Rate Shock
Early Sample Period: February 1959 to September 1979

Thin line with circles Output; filled significant at 10%, open significant at 25%
Thick line with boxes Price/Wage; filled significant at 10%, open significant at 25%

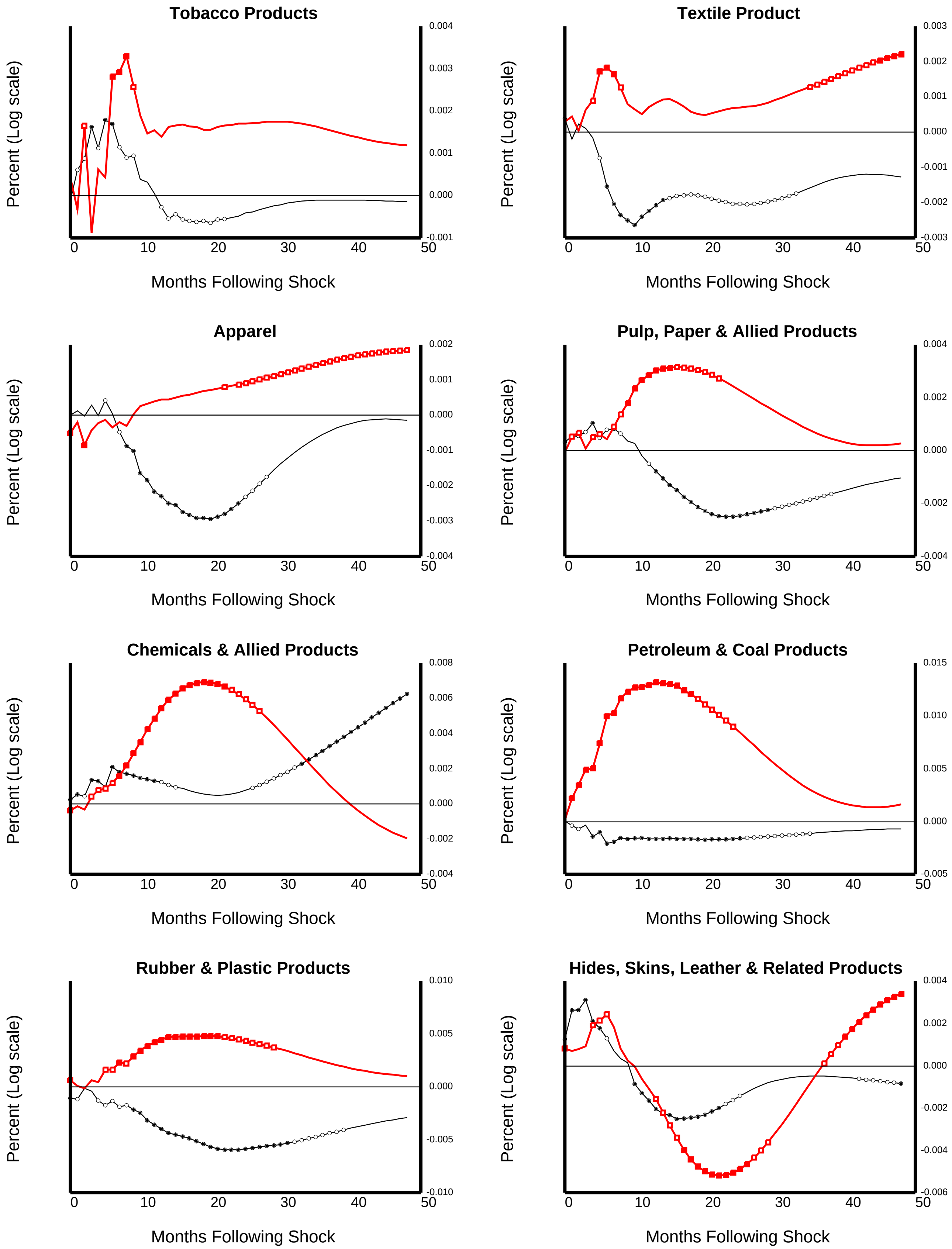
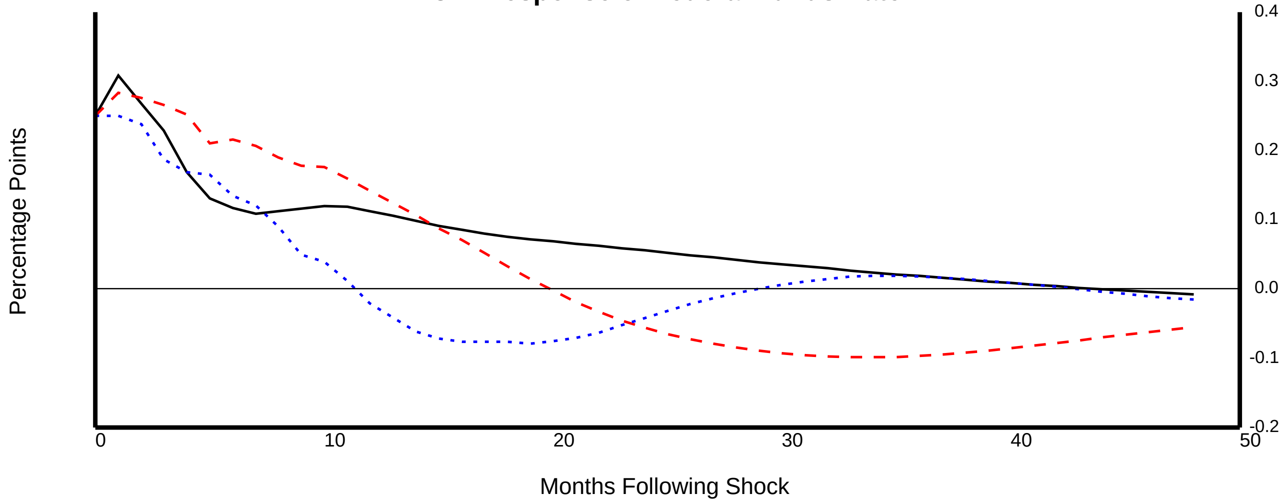


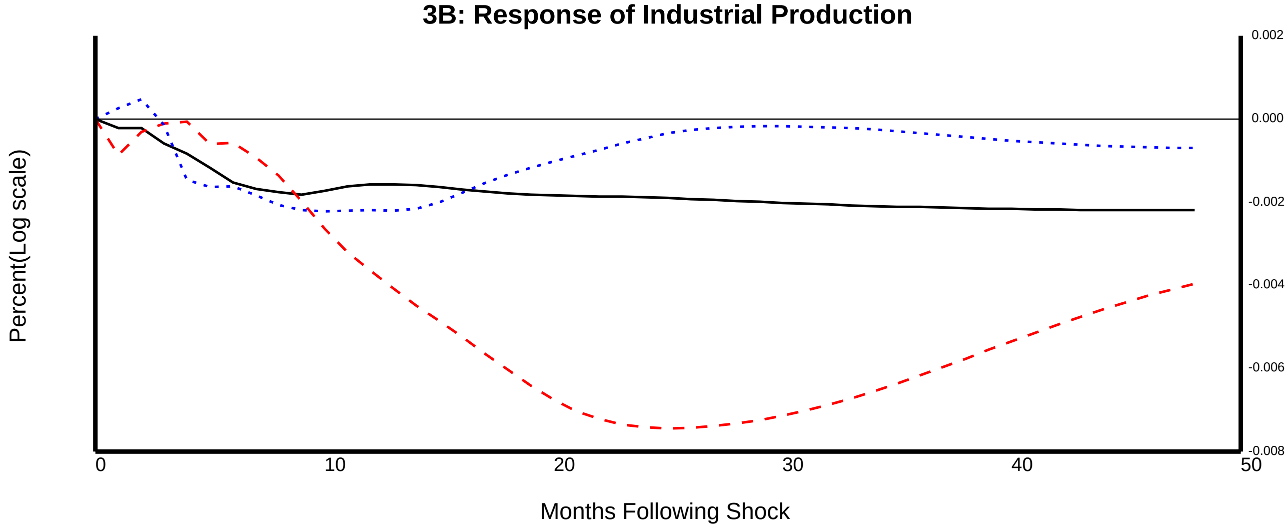
Figure 3: Aggregate Responses to a 25 basis point Federal funds rate shock, Across Data Samples

Solid line Response using entire sample: February 1959 to December 1996
Dashed line Response using early sample: February 1959 to September 1979
Dotted line Response using later sample: January 1983 to December 1996

3A: Response of Federal Funds Rate



3B: Response of Industrial Production



3C: Response of Consumption Deflator

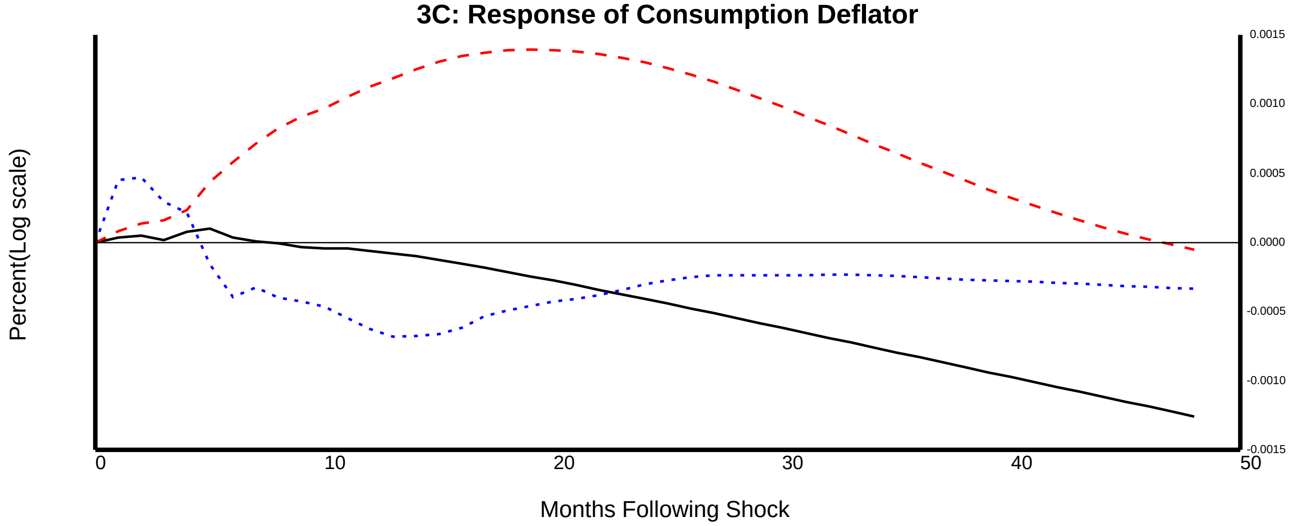


Figure 4A: Industry Price & Wage Responses to a Federal Funds Rate Shock
First Period: February 1959 to September 1979

Thin line with circles Price; filled significant at 10%, open significant at 25%
Thick line with boxes Wage; filled significant at 10%, open significant at 25%

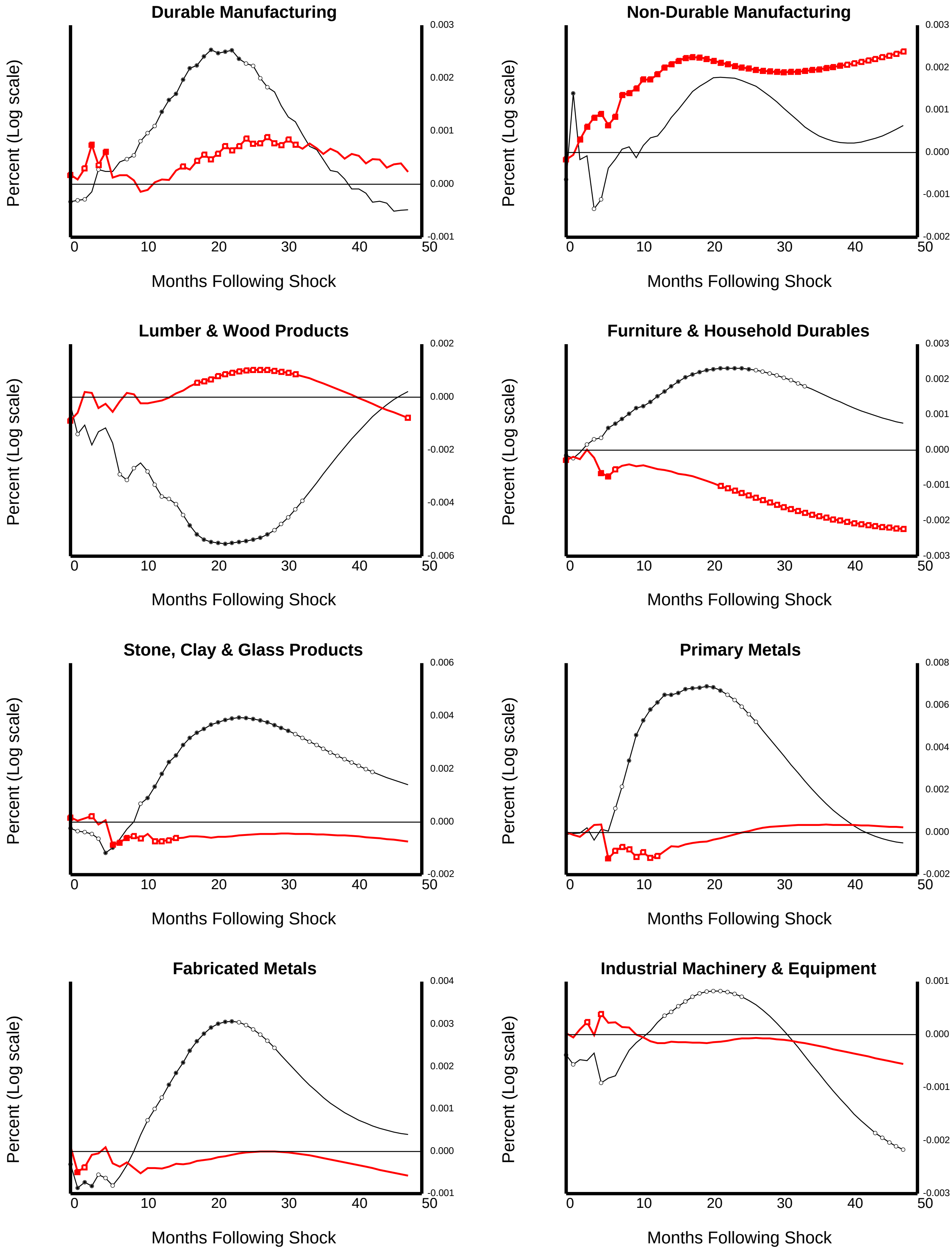


Figure 4B: Industry Price & Wage Responses to a Federal Funds Rate Shock

First Period: February 1959 to September 1979

Thin line with circles Price; filled significant at 10%, open significant at 25%
Thick line with boxes Wage; filled significant at 10%, open significant at 25%

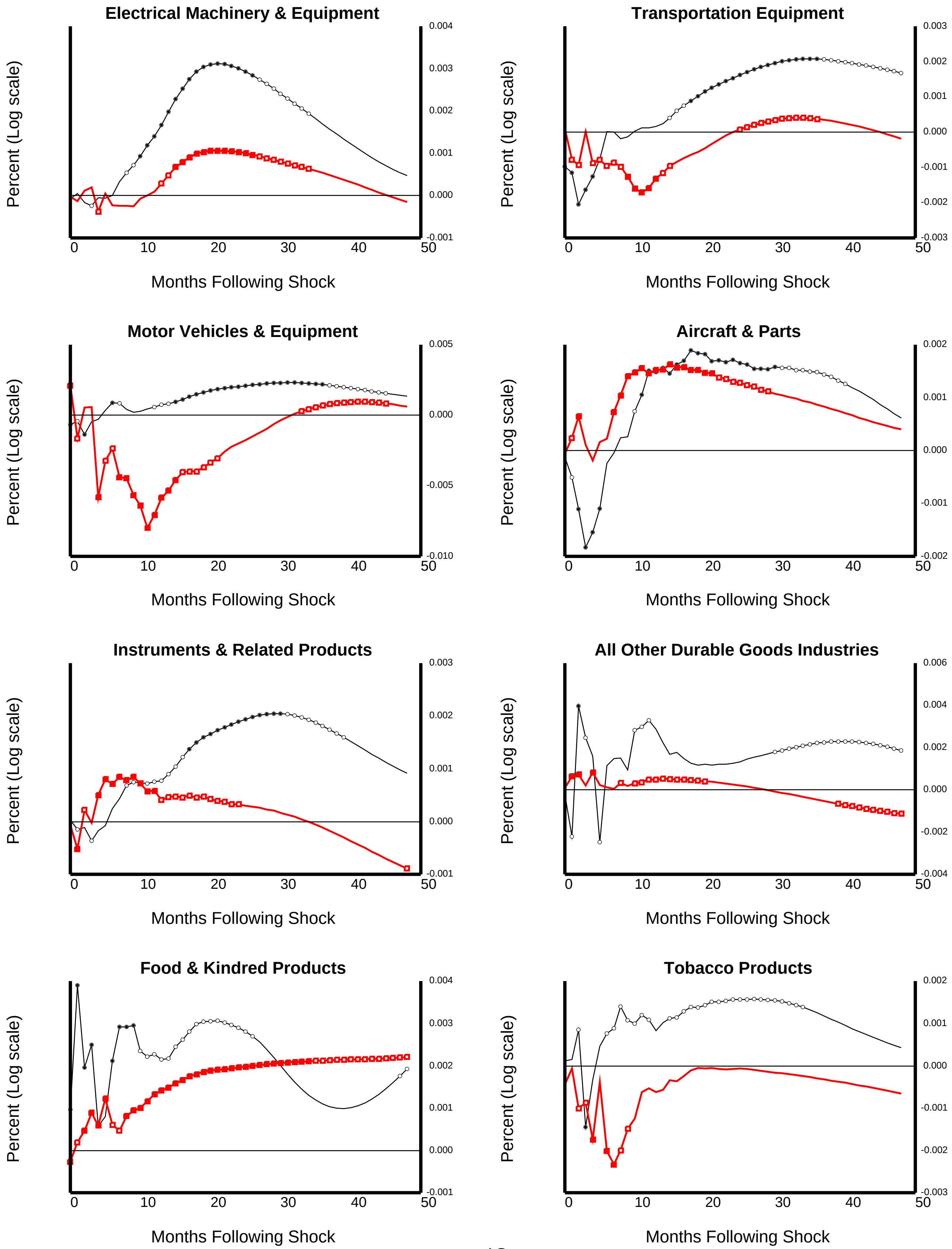


Figure 4C: Industry Price & Wage Responses to a Federal Funds Rate Shock
First Period: February 1959 to September 1979

Thin line with circles Price; filled significant at 10%, open significant at 25%
Thick line with boxes Wage; filled significant at 10%, open significant at 25%

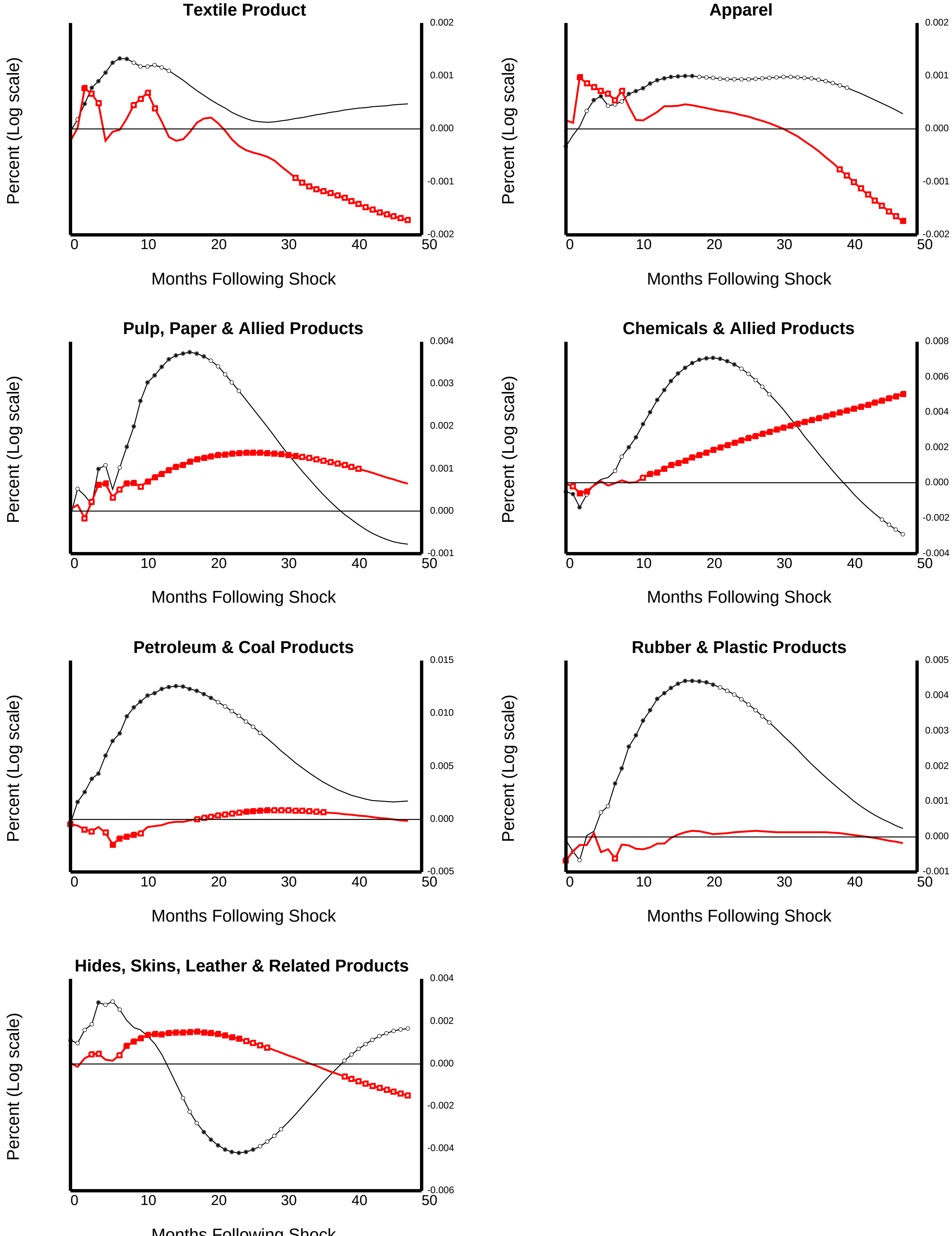


Figure 5: Aggregate Responses to a 25 basis point Federal funds rate shock, using Greenbook forecasts
Sample Period: November 1965 to September 1979

Thin line with circles standard specification; filled significant at 10%, open significant at 25%
Thick line with boxes Greenbook specification; filled significant at 10%, open significant at 25%