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SECTORAL JOB CREATION AND DESTRUCTION RESPONSES TO OIL PRICE CHANGES

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ABSTRACT

We study the effects of oil price changes and other shocks on the creation and destruction of U.S. manufacturing jobs from 1972 to 1988. We find that oil shocks account for about 20-25 percent of the cyclical variability in employment growth under our identifying assumptions, twice as much as monetary shocks. Employment growth shows a sharply asymmetric response to oil price ups and downs, in contrast to the prediction of standard equilibrium business cycle models. The two-year employment response to an oil price increase rises (in magnitude) with capital intensity, energy intensity, and product durability. Job destruction shows much greater short-run sensitivity to oil and monetary shocks than job creation in every sector with the clear exception of young, small plants. Oil shocks also generate important reallocative effects. For example, we estimate that job reallocation rose by 11 percent of employment over 3-4 years in response to the 1973 oil shock. More than 80 percent of this response reflects greater job reallocation activity within manufacturing.

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I. Introduction

We study the effects of oil price changes and other shocks on the creation and destruction of jobs in the U.S. manufacturing sector. Our study provides a richer characterization of sectoral job creation and destruction dynamics than previous research, and it produces new evidence related to the role of oil shocks in economic fluctuations. The evidence speaks to several questions: Through what transmission mechanisms do oil shocks influence aggregate and sectoral employment? How does the economy's dynamic response to oil shocks differ from its response to monetary shocks? How do the job creation and destruction responses to oil shocks vary among industries and among sectors that differ by capital and energy intensity in production, age of production facilities, size of employer, and durability of final product? How many manufacturing jobs are created and destroyed in response to oil price shocks, and over what time span?

Our empirical analysis exploits quarterly measures of sectoral job creation and destruction rates from 1972 to 1988. The detailed sectoral measures reflect tabulations of the plant-level data in the Longitudinal Research Datafile (LRD), as described in Davis, Haltiwanger and Schuh (1996). The sectoral detail enables us to better evaluate the role of oil shocks and helps discriminate among alternative interpretations of the apparent responses to oil shocks. For example, interpretations that stress the coincident behavior of monetary policy suggest a different pattern of sectoral responses than interpretations that stress the reallocative effects of oil shocks. The decomposition of sectoral employment changes into job creation and destruction components also helps interpret the response to oil shocks. A concrete example serves to develop this point and motivate our study.

Consider the impact of oil price shocks on the U.S. automobile industry. The OPEC oil price shock of 1973 increased the demand for small, fuel-efficient cars and simultaneously reduced the demand for larger cars. American automobile companies were poorly situated to respond to this shock, because their capital stock and work force were primarily directed toward the production of large cars. Consequently, capacity utilization and output fell in the wake of the oil price shock, even though a handful of plants equipped to produce small cars operated at peak capacity, as documented by Bresnahan and Ramey (1993). This aspect of the auto industry's response to the 1973 oil price shock is difficult to discern and analyze with the aggregated data typically brought to bear on business cycle analysis. Even detailed industry-level data on output and employment will likely obscure the magnitude and nature of reallocative activity triggered by the shock.

The oil price shock adversely affected the closeness between the desired and actual characteristics of factor inputs in the auto industry along several dimensions. First, much of the physical capital in the auto industry was dedicated to the production of larger rather than smaller cars. Second, U.S. auto workers had accumulated skills that were specialized in the production of particular models, and these tended to be larger vehicles. Third, many auto workers laid off from large-car plants could not take up employment at small-car plants without a costly relocation. Fourth, the dealership network and sales force of the U.S. auto industry had evolved under an era of thriving large-car sales, and they were probably better suited to market, distribute and service larger cars. Fifth, the knowledge base and the research and design personnel at U.S. auto companies were specialized in engineering larger cars. The development of smaller, more fuel-efficient cars required a costly and time-consuming reorientation of the knowledge base and the development of new skills by research and design personnel.

These remarks suggest how factor specialization and reallocation frictions led to reduced output and employment in the auto industry in the wake of the first OPEC oil price shock. Similar remarks could be fashioned for many other industries. Coupled with the magnitude and widespread impact of oil price shocks over the past twenty-five years, these remarks also suggest how oil price shocks could cause large aggregate fluctuations by upsetting established patterns of production. Several previous studies investigate the hypothesis that oil price shocks drove large aggregate fluctuations in this way, but previous work lacks the sectoral detail on job creation and destruction that we exploit.[1]

Based on aggregated data alone, the output decline experienced by the auto industry in the wake of the 1973 oil price shock might appear to be driven entirely by the coincident behavior of monetary policy or other events. Bresnahan and Ramey's analysis of plant-level data undercuts this interpretation and illustrates the usefulness of a more disaggregated approach. Our study exploits sectoral job creation and destruction measures tabulated from plant-level data to investigate the channels through which oil shocks affect sectoral and aggregate outcomes. Our approach is similar in spirit to that of Bresnahan and Ramey (1993), but we bring to bear a different econometric framework and a much more extensive data set.

Our framework is designed to evaluate the importance of oil price shocks, and the channels through which they drive economic fluctuations, while simultaneously incorporating a role for observable indicators of monetary policy shocks and a variety of unobserved common and sector-specific disturbances. We use the framework to help assess whether oil shocks affect employment via aggregate or allocative channels. By "aggregate channels" we refer to the potential output, income transfer and sticky wage effects stressed by traditional macroeconomic analyses (described in Mork, 1994) and to the effects of oil shocks

[1] See, e.g., Davis (1985), Loungani (1986), Mork (1989) and Mork, Olsen and Mysen (1994). Hamilton's (1988) model of reallocation frictions is motivated by the apparent impact of oil price shocks on aggregate economic activity. See Bohi (1989), Mork (1994) and the conclusion to this paper for references to other work on whether oil price shocks drive aggregate fluctuations by upsetting established patterns of production.

in aggregative models with imperfectly competitive product markets (e.g., Rotemberg and Woodford (1996)).[2] By "allocative channels" we refer to the aspects of oil price changes that alter the closeness of the match between the desired and the actual distributions of labor and capital inputs, as in the auto industry example.

To assess whether oil price shocks operate primarily through aggregate or allocative channels, we exploit the decomposition of employment changes into job creation and destruction components. An important virtue of the decomposition is that the allocative and aggregate effects of an oil price shock induce qualitatively different job creation and destruction dynamics. For example, the unfavorable aggregate aspects of an oil price rise reduce creation and increase destruction, whereas the allocative aspects increase both creation and destruction. This qualitative difference serves as one means for assessing which type of mechanism dominates the linkage between oil price shocks and economic fluctuations.

By including measures of the magnitude and direction of oil price movements in our econometric models, we obtain a second means for assessing how oil shocks operate. In particular, we compare the dynamic employment and job flow responses associated with positive oil price shocks to the responses associated with negative price shocks.[3] If oil price shocks matter primarily because they alter the closeness of the match between the desired and actual distribution of factor inputs, then employment responds to the magnitude of the price change, irrespective of the direction of change. Alternatively, if oil price shocks

[2]Mork and Hall (1980), Finn (1991), Kim and Loungani (1992) and Rotemberg and Woodford (1996) capture several of the effects operating through "aggregate channels" in explicit, dynamic equilibrium models.

[3]This aspect of our approach builds on an idea previously exploited by Davis (1985), Loungani (1986), Mork (1989), Mork, Olsen and Mysen (1994) and others.

matter primarily because they shift aggregate labor supply or labor demand as in Kim and Loungani (1992), Rasche and Tatom (1977, 1981) and Rotemberg and Woodford (1996), then employment responds roughly symmetrically to positive and negative oil price shocks.

To carry out our investigations, we estimate sectoral vector autoregressions (VARs) that contain common and sector-specific variables. We specify the VARs so that the oil and monetary shocks and two unobserved common shocks are identical across sectors, but we allow the estimated shock response functions to differ freely across sectors. We also allow for two sector-specific shocks in each VAR. The resulting econometric model can be interpreted as a constrained panel VAR that simultaneously exploits the time-series data for all sectors while allowing for multiple common and sector-specific shocks.

The next section describes the data, highlights prominent aspects of job creation and destruction behavior, and summarizes how the level and cyclical behavior of job flows relate to sectoral characteristics. Section III articulates our econometric framework and spells out our identifying assumptions. We apply the econometric framework in Section IV to evaluate the relative importance of the various shocks and to estimate dynamic response functions. We find a larger role for oil shocks than monetary shocks in our sample period, much greater short-run sensitivity of destruction than creation to both monetary and oil shocks, sharply asymmetric responses to oil price ups and downs, and pronounced differences among sectors in the size of shock responses.

These response differences prompt an investigation into which sectoral characteristics matter for sensitivity to the shocks. We pursue this matter in Section V by relating shock response functions for about 450 detailed manufacturing industries to observable industry characteristics. We find that the cumulative two-year employment response to a positive oil price shock rises sharply (in magnitude) with capital intensity and product durability. It rises with energy intensity over the lower two-thirds of the energy intensity distribution and then flattens out. The cumulative two-year employment response to an adverse monetary shock is typically modest, but it rises with product durability and with the fraction of employment at young plants.

We quantify the number of jobs created and destroyed in response to typical oil and monetary shocks in section VI. According to our point estimates, a unit standard deviation positive oil shock triggers the destruction of an extra 290,000 production worker jobs and the creation of an extra 30,000 jobs in the first two years after the shock. A unit standard deviation adverse monetary shock triggers the destruction of an extra 150,000 jobs and the creation of 10,000 fewer jobs over two years. After four years, the net employment response to a unit positive oil shock is only 60,000 fewer jobs, but the gross reallocation response amounts to 410,000 jobs or more than 3 percent of employment. This sizable gross job reallocation response points to important allocative effects of oil shocks.

Section VII draws together our main findings and sets forth several conclusions.

II. Data Description

A. Measurement and Basic Facts: Sectoral Job Flows

For data on sectoral job flows, we tabulate quarterly job creation and destruction time series from the LRD following Davis, Haltiwanger and Schuh (1996). These tabulations reflect plant-level changes in the number of employed production workers in the middle month of each quarter. We express job flows as rates by dividing by the simple average of current and previous-period employment, and we remove seasonality using sector-specific seasonal dummies.

We consider several sectoral classification schemes: (i) detailed industry, defined by 20 two-digit or 450 four-digit SICs; (ii) energy intensity, defined by deciles of the employment-weighted plant-level distribution of energy costs as a percent of shipments value; (iii) capital intensity, defined by quintiles of the employment-weighted 4-digit industry-level distribution of capital per production worker; (iv) product durability, defined in terms of the 4-digit industry-level product depreciation rates for consumer goods in Bils and Klenow (1998); and (v) establishment size-age categories, defined in terms of employment level and years since first manufacturing employment. Classifications (i) and (ii) are drawn directly from our earlier work with Schuh, and (iii)-(v) are newly tabulated series for this paper.[4]

Table 1 provides summary statistics for sectoral job flows, and Figures 1 display the quarterly time series. A key feature of the data is the large magnitude of gross job flows. On average over the 1972:2-1988:4 period, the number of newly destroyed (newly created) manufacturing production worker jobs equals 5.5 (5.2) percent of employment per quarter – an average quarterly job reallocation rate of 10.7 percent. We interpret this large magnitude to mean that the economy continually adjusts to a stream of allocative disturbances that cause a reshuffling of employment opportunities across locations. Table 1 makes clear that large-scale job reallocation occurs within detailed industries and sectors as well.

Looking across industries, the average quarterly job reallocation rate ranges from 7.4

[4]Major revisions to the 4-digit SIC were implemented in 1987. We spliced the 4-digit data across the 1986-1987 breakpoint using the concordance described in Bartelsman and Gray (1996). For energy (capital) intensity, we grouped plants into deciles (quintiles) on a yearly basis. We measure establishment size as the simple average of current and previous-period employment. See the Appendix to Davis, Haltiwanger and Schuh (1996) for a detailed treatment of measurement procedures. The Bils-Klenow depreciation measure is available for 106 four-digit industries, 40 of which are in SIC 20 (Food and Kindred Products). Relative to most other manufacturing industries, the food industries exhibit high average rates of creation and destruction and considerably more high-frequency (seasonal) variation.

percent in Paper and Allied Products to 13.5 percent in Lumber and Wood Products. Looking at other employer characteristics, the job reallocation rate declines sharply with establishment age and size. The job reallocation rate averages 18.2 percent per quarter for young manufacturing plants (less than 9-13 years old) with fewer than 20 employees, as compared to 7.2 percent for plants with more than 2500 employees.

Another prominent feature of the data is the distinct cyclical behavior of job creation and destruction. Figures 1 reveal that recessions involve sharp increases in job destruction accompanied by milder declines in job creation in virtually every 2-digit industry and most other sectors. Table 1 confirms this visual impression, showing that the standard deviation of destruction exceeds that of creation for every 2-digit industry and for every other sector except for young manufacturing plants, especially those with fewer than 100 employees. The distinct cyclical dynamics of creation and destruction are quite evident in the plots for major durable goods industries such as Primary Metals, Electrical Machinery, Nonelectrical Machinery and Transportation. Table 1 indicates that the relative volatility of job destruction rises with establishment size (conditional on age) and establishment age (conditional on size). It also tends to rise with capital intensity, energy intensity and product durability.

The data also show interesting patterns in the time-series mean and volatility of creation and destruction. The volatility of net employment growth and job destruction rates tend to rise with capital intensity and product durability. Conditional on size, younger plants exhibit higher mean rates of creation and destruction and greater volatility of creation, destruction and net growth.[5] Conditional on age, larger plants exhibit sharply lower

[5]Mean creation and destruction rates show no evident relationship to capital intensity in Table 1, in contrast to the negative relationship found in Table 3.6 of Davis, Haltiwanger and Schuh (1996). They use a different method for measuring capital intensity that is

average rates of creation and destruction. Interestingly, controlling for age, net employment growth is an *increasing* function of employer size.

B. Oil Price and Money-Credit Measures

In earlier work on the driving forces behind fluctuations in manufacturing job creation and destruction (Davis and Haltiwanger, 1996), we considered four indicators of shocks to monetary policy or credit intermediation: a credit mix variable, measured as the ratio of bank loans to the sum of bank loans and commercial paper; the federal funds rate; the term spread between the 10-year constant maturity government bond rate and the federal funds rate; and the quality spread between the six-month commercial paper rate and the six-month treasury bill rate. Each measure is featured in one or more recent papers that investigate the impact of monetary policy and credit market conditions on the economy.[6] We found that all four variables generated similar results and yielded considerable predictive power for total manufacturing rates of job creation and destruction. The quality spread and credit mix variables yielded virtually identical results, and they showed greater predictive power for creation and destruction rates than the other two measures. In view of our earlier findings, we focus on the quality spread variable in this paper. We think of this variable as potentially informative about shocks to monetary policy and credit intermediation and, as a shorthand, refer to it as $SPREAD$.

Recent work by Hooker (1996a) and Hamilton (1996a) raises questions about the appropriate measure of oil price shocks. Hamilton argues for an oil shock measure that filters out both price declines and price increases that merely offset recent past declines. In

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superior for cross-sectional comparisons but less suitable for time-series analysis than the measure used in this paper.

[6]See Bernanke and Blinder (1992), Friedman and Kuttner (1992), Kashyap, Stein and Wilcox (1993), and Stock and Watson (1989).

a similar vein, Davis (1987) argues that allocative disturbances (including oil shocks) cause more powerful effects on aggregate outcomes when they reinforce, rather than reverse, the direction of recent past allocative disturbances.

We are sympathetic to these arguments, and we construct an oil shock index accordingly. Our index equals the log of the following ratio: the current real oil price divided by a weighted average of real prices in the prior 20 quarters, with weights that sum to one and decline linearly to zero. We measure the real price as the nominal price of crude petroleum deflated by the producer price index. We include the oil shock index and its absolute change in our VARs, which allows us to investigate whether positive and negative oil shocks have asymmetric effects.[7]

Figure 2 plots quarterly time series for the oil shock index, its absolute change, and the interest rate quality spread from 1972:1 to 1988:4. Three major oil shock episodes – two increases and one decrease – stand out clearly. The two oil price increases are accompanied by large increases in the quality spread, but the persistence and volatility of movements in the oil index and the quality spread differ between these two episodes. The quality spread also rises notably in 1987.

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[7]In Davis and Haltiwanger (1996), we also generated results using a measure of the real oil price growth rate. Specifically, we calculated the time-t real oil price growth rate as the twelve-month log difference for the middle month of quarter t and included this measure and its absolute value in multivariate VARs. The results using this approach to measuring oil shock measures were quite similar to those based on our index, *if* we end the sample in 1985:4, but the index described in the text yields a larger role for oil shocks in samples that extend to 1988:4. Thus, as in recent work by Hooker and Hamilton, the choice among alternative reasonable oil shock measures matters for samples that extend beyond 1985.

III. Econometric Specification and Identification

Consider a seven-variable linear stochastic system for a particular sector. Let $Y_t = [OIL_t, ABS_t, TPOS_t, TNEG_t, SPREAD_t, POS_t, NEG_t]'$ be a vector that contains time-t values of the oil shock index, its absolute change, the manufacturing job creation and destruction rates, the interest rate quality spread, and the sectoral job creation and destruction rates, respectively. We assume that Y_t has a linear moving average (MA) representation in terms of innovations to structural disturbances, given by

$$Y_t = B(L)\epsilon_t, \quad B(0) = B_0, \tag{1}$$

where $B(L)$ is an infinite-order matrix lag polynomial, and where $\epsilon_t = [\epsilon_{ot}, \epsilon_{mt}, \epsilon_{at}, \epsilon_{rt}, \epsilon_{ct}, \epsilon_{pt}, \epsilon_{nt}]'$ is a vector of white noise structural innovations. The elements of ϵ_t correspond to time-t values of innovations to the two oil disturbances, two unspecified common disturbances, the $SPREAD$ disturbance, and two sector-specific disturbances, respectively.

When we estimate a VAR on Y_t, we do not immediately recover the matrix lag polynomial, $B(L)$, or the vector of structural innovations, ϵ_t. Instead, the estimated VAR yields

$$Y_t = D(L)\eta_t, \quad D(0) = I, \tag{2}$$

where $D(L)$ is an infinite-order matrix lag polynomial implied by the estimated coefficients in the VAR representation of Y_t, and where $\eta_t = [o_t, m_t, a_t, r_t, c_t, p_t, n_t]'$ is the vector of reduced-form innovations. The elements of η_t correspond to time-t values of reduced-form innovations to the two oil variables, the manufacturing job creation and destruction rates, the $SPREAD$ variable, and the sectoral job creation and destruction rates, respectively.

Comparing (1) and (2) implies $\eta_t = B_0\epsilon_t$ and $B(L) = D(L)B_0$, so that full knowledge of B_0 would allow us to recover estimates of both $B(L)$ and the structural innovations from the estimated VAR parameters. We could then proceed to evaluate the role played by the various shocks as driving forces behind movements in sectoral job creation and destruction. Of course, the time-series data on Y_t do not provide full knowledge of B_0, so that identification requires additional, a priori information.

We partially identify the structural response functions $B(L)$ and the structural innovations ϵ_t by placing restrictions on certain elements of B_0, $D(L)$ and the contemporaneous covariance matrix of ϵ_t. With respect to $D(L)$, we assume

$$d_{ip}(l) = d_{in}(l) = 0, \qquad \text{for all } l, \text{ and } i = o, m, a, r, c, \tag{3}$$

where $d_{ij}(l)$ denotes the ij element at lag l of $D(L)$. In other words, we do not allow sector-specific variables (sectoral job creation and destruction rates) to affect variables in the system that are common to all sectors.

The zero restrictions on $D(L)$ mean that our estimated systems are more accurately described as near VARs rather than fully symmetric VARs. In combination with our restrictions on B_0, this near-VAR specification implies that the oil, $SPREAD$ and unspecified common shocks, $[\epsilon_{ot}, \epsilon_{mt}, \epsilon_{at}, \epsilon_{rt}, \epsilon_{ct}]$, are identical across sectors. At the same time, our specification allows the response functions $B(L)$ to freely vary across sectors. Hence, we can relate sectoral differences in the shock response functions to observed sectoral characteristics.

Suppressing time subscripts, we next present our restrictions on B_0:

$$o = \epsilon_o + b_{om}\epsilon_m \tag{4.a}$$

$$m = b_{mo}\epsilon_o + \epsilon_m \tag{4.b}$$

$$a = b_{ao}\epsilon_o + b_{am}\epsilon_m + \epsilon_a + b_{ar}\epsilon_r \tag{4.c}$$

$$r = b_{ro}\epsilon_o + b_{rm}\epsilon_m + b_{ra}\epsilon_a + \epsilon_r \tag{4.d}$$

$$c = b_{co}\epsilon_o + b_{cm}\epsilon_m + b_{ca}\epsilon_a + b_{cr}\epsilon_r + \epsilon_c \tag{4.e}$$

$$p = b_{po}\epsilon_o + b_{pm}\epsilon_m + b_{pa}\epsilon_a + b_{pr}\epsilon_r + b_{pc}\epsilon_c + \epsilon_p + b_{pn}\epsilon_n \tag{4.f}$$

$$n = \quad b_{no}\epsilon_o \quad + \; b_{nm}\epsilon_m \quad + \quad b_{na}\epsilon_a \; + \quad b_{nr}\epsilon_r \quad + \quad b_{nc}\epsilon_c \quad + \; b_{np}\epsilon_p \; + \qquad \epsilon_n. \tag{4.g}$$

Lastly, we place three sets of restrictions on the contemporaneous covariance matrix:

$$\text{cov}(\epsilon_{ot}, \epsilon_{jt}) = \text{cov}(\epsilon_{mt}, \epsilon_{jt}) = 0, \quad j = a, r, c, p, n, \tag{5.a}$$

$$\text{cov}(\epsilon_{at}, \epsilon_{ct}) = \text{cov}(\epsilon_{rt}, \epsilon_{ct}) = 0, \tag{5.b}$$

$$\text{cov}(\epsilon_{pt}, \epsilon_{jt}) = \text{cov}(\epsilon_{nt}, \epsilon_{jt}) = 0 \quad j = a, r, c. \tag{5.c}$$

Assumptions (4) and (5) impose a block recursive structure with four blocks: (i) two oil variables, (ii) total manufacturing job creation and destruction, (iii) *SPREAD*, and (iv) sectoral job creation and destruction. The block recursive nature of the system suffices to identify the contribution of each block of shocks to fluctuations in total and sectoral job creation and destruction. We do not attempt to achieve identification within blocks, except for our efforts to isolate the magnitude and direction aspects of the oil shock structural response functions.

We take the oil innovations ϵ_o and ϵ_m to be exogenous in our near-VAR systems, as described by the zero restrictions in equations (4.a) and (4.b) and the covariance restriction (5.a). These assumptions are sufficient to estimate the joint contribution of the oil shocks to the forecast-error variances of all variables in the system.

The unspecified common disturbances ϵ_a and ϵ_r capture the components of the reduced-form innovations to total manufacturing job creation and destruction that are orthogonal to the oil innovations. In Davis and Haltiwanger (1996), we interpret the ϵ_a and ϵ_r shocks as reflecting unobserved aggregate and allocative disturbances that affect the pace of job creation and destruction. The identification strategies we develop in that paper could be implemented here to achieve identification within block (ii) (and likewise within block (iv)). However, strategies for identification within blocks (ii) and (iv) play no role in the inferences we draw in this paper.

Equation (4.e) identifies the structural money-credit innovation as the component of the reduced-form SPREAD innovation that is orthogonal to innovations in the oil variables and the total job creation and destruction rates. This assumption reflects the view that movements in monetary policy and SPREAD variables often respond in a passive, systematic manner to developments in the real side of the economy. The inclusion of the ϵ_c term in (4.e) allows for the possibility that some innovations in the SPREAD variable reflect exogenous monetary policy events or other shocks to the intermediation process.

The last two equations in (4) pertain to the sectoral job creation and destruction rates. We allow all common disturbances to contemporaneously affect sectoral job creation and destruction. In addition, we include two unspecified sectoral shocks, ϵ_p and ϵ_n, that we do not separately identify.

In closing this section, we stress four appealing features of our specification and identifying assumptions. First, our approach allows for multiple observed and unobserved shocks. Second, our approach identifies common oil and money-credit shocks that hit all sectors, while allowing the shock response functions to vary freely across sectors. Third, our specifications do not prejudge the issue of whether oil shocks influence manufacturing and sectoral employment through allocative or aggregate channels. Instead, we rely on the estimated shock response functions to investigate whether positive and negative oil price shocks have symmetric effects on employment growth, and to investigate whether oil shocks increase both creation and destruction.

Finally, the sectoral near-VAR systems that we estimate separately can be reinterpreted as a constrained panel VAR that simultaneously uses the time-series data for all sectors. By including lagged values of manufacturing creation and destruction in each sectoral equation, it is as though we included sectoral creation and destruction rates as regressors and constrained their coefficients to be proportional to sectoral size.[8] Thus, we

[8]Our discussant, Michael Horvath, pursued this issue by augmenting our panel VARs to

can think of our econometric framework as a collection of distinct near VARs, one for each sector, or as a constrained panel VAR that we estimate one seven-equation block at a time. However, our estimation procedure does not constrain the weighted sum of sectoral creation and destruction responses to equal the total responses. In practice, violations of this adding up constraint are usually small.

IV. Sectoral Creation and Destruction Responses

A. Summary of Variance Decompositions

We estimated the sectoral VAR systems on quarterly data from 1973:2 to 1988:4 using four lags of each variable. Table 2 summarizes the contribution of each block of shocks to the variance of the 8-step ahead forecast error for sectoral rates of employment growth and gross job flows. The table entries are employment-weighted average contributions to the forecast-error variance for the indicated sectoral classification schemes. For example, the entry in the first row and column reports that oil shocks account for 22 percent of the variance in the 8-step ahead forecast error of the employment growth rate in the average 2-digit industry.

Oil shocks account for 18-25 percent of the variance in the employment growth across alternative sectoral classifications. The classification by plant-level energy intensity yields the largest average contribution of oil shocks to net employment growth, job reallocation and job destruction. Indeed, 40 percent of the variance in job reallocation is accounted for by oil shocks when we group plants by energy intensity. This result indicates that much

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allow industry-level creation and destruction rates to enter into the common subsystem. He found that this relaxation of our constrained specification did not greatly alter the pattern of impulse response functions. Another interesting approach would be to use input-output shares to place structure on sectoral linkages in a constrained panel VAR.

of the job reallocation response to oil shocks occurs within energy-intensity categories.

SPREAD shocks contribute, on average, between 6 and 12 percent of the forecast-error variance in employment growth. The largest average contributions of SPREAD shocks arise for sectoral classifications by capital intensity and plant age-size characteristics.

The unspecified common and sector-specific shocks account for most of the forecast-error variability in net and gross job flow rates. Common shocks are especially important for the energy-intensity classifications, and sector-specific shocks are especially important for the 4-digit industry and product durability breakdowns.

The results in Table 2 make clear that each block of shocks plays a nontrivial role in accounting for the variability of net and gross job flows. The results also show, not surprisingly, that the relative importance of each category of shocks varies somewhat across the sectoral classification schemes. In what follows, we focus on the dynamic response to the observable oil and SPREAD shocks. The unspecified common and sector-specific shocks capture the many other, unobserved shocks that influence employment and job flows.

B. The Dynamic Response to Oil Shocks

We first characterize the dynamic effects of oil shocks on total manufacturing employment growth and gross job flows. Recall that each sectoral near-VAR system contains a common symmetric subsystem (the two oil variables, total manufacturing job creation and destruction, and the SPREAD variable). Figure 3 displays the oil and SPREAD shock response functions implied by the common subsystem.[9] We focus here on oil price shocks and defer a discussion of SPREAD shocks to the next section.

[9]The specification and identifying assumptions that underlie Figure 3 are identical to the ones that underlie Figure 10 in Davis and Haltiwanger (1996). Our earlier paper uses a longer sample that begins in 1960. Happily, Figure 3 is similar to the corresponding figure in the earlier paper.

To generate response functions for positive and negative oil price shocks, we simultaneously perturb the two structural oil innovations, ϵ_o and ϵ_m. We perturb ϵ_o up or down by one standard deviation, and we perturb ϵ_m by an amount that satisfies the identity linking the oil shock index to its absolute change. We then trace out the response functions implied by the MA representation of the structural VAR.[10]

Figure 3 shows a large adverse response to a positive oil price shock and very little response to a negative one. Destruction rises sharply and employment growth declines in the aftermath of a positive oil shock, while job creation declines modestly. Peak responses occur four quarters following the shock and involve an employment growth rate nearly one percentage point below the baseline value.

The upper right panel of Figure 3 isolates the effects of the absolute change component of an oil shock. The response pattern fits the profile of an "allocative disturbance" in three respects. First, the short-run employment response is negative, with a peak response at four steps that accounts for about 40 percent of the peak response to an oil price increase. Second, the longer term employment response is approximately zero. In fact, cumulating the first 16 response coefficients for net employment growth yields a long run employment response of only -.05 percent.[11] Third, the longer term job reallocation

[10]In principle, the MA representation that underlies the oil shock response functions in Figure 3 depends on assumptions about b_{mo}, b_{om} and $\text{cov}(\epsilon_o, \epsilon_m)$. It turns out, however, that reduced-form innovations in the oil shock index and its absolute change are not highly correlated ($\text{corr}(o, m) = -.17$), so that assumptions about these structural parameters matter little. In practice, we derive the MA representation by placing the oil index ahead of its absolute change in the causal ordering; i.e., we set $b_{om} = \text{cov}(\epsilon_o, \epsilon_m) = 0$.

[11]Since we calculate employment growth as creation minus destruction, we are effectively measuring the growth rate as $2\Delta x_t/(x_t + x_{t-1})$, where x denotes the level of employment.

response is nontrivial. Cumulating the first 16 response coefficients indicates that the absolute change component of a unit size oil shock causes the reallocation of 0.63 percent of all manufacturing jobs.

These results suggest that oil shocks influence manufacturing activity through a mixture of aggregate and allocative effects. The employment effects roughly cancel out in response to an oil price decrease, because the allocative and aggregate aspects of the shock work in opposite directions. The short-run employment effects are large and negative in response to an oil price increase, because the two aspects of the shock work in the same direction. The longer term employment response is small for any oil price shock, in line with the view that the economy eventually adjusts fully to the relative price change.

We also examined the sectoral creation and destruction responses to oil shocks for all 51 detailed sectors listed in Table 1. In the interests of brevity, we display impulse response functions for selected sectors in Figure 4 and summarize other results. (A full set of sectoral reults is available upon request from the authors.)

The detailed results reveal short-run employment declines in response to unanticipated oil price increases in almost every sector. In half of the sectors, the cumulative decline seven quarters after a unit standard deviation positive shock to the price of oil exceeds 2 percent of employment.

The sign pattern of the separate creation and destruction responses is also noteworthy. The cumulative effect of a positive oil shock is typically to increase both job destruction and creation in the two years after the shock. This response pattern points to the reallocative consequences of oil shocks, and it indicates that these effects operate within sectors, as we

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This growth rate measure is identical to the log change up to a second-order Taylor series expansion, which means that we can safely sum response function coefficients to obtain the cumulative response.

have defined them.

Another interesting result involves the relative magnitudes of the short-run destruction and creation responses. With the exception of young plants with fewer than 20 employees, the magnitude of the two-year sectoral destruction response is larger – and usually much larger – than the corresponding creation response. Figure 4 clearly illustrates the greater short-run sensitivity of job destruction to oil shocks. Apparel, Rubber and Plastics, Furniture, Primary Metals and Transportation Equipment are among the industries with especially large job destruction responses to oil shocks. In addition, while the relationships are not always monotonic, the results suggest that the asymmetric response of destruction is greater the more energy and capital intensive is the production process and the more durable is the output good.

To examine the statistical significance of the point estimates, we computed Monte Carlo standard errors for the cumulative creation and destruction responses. Only one sector (Food) exhibits a cumulative creation response at seven steps (after the shock) that exceeds two standard errors. In contrast, the cumulative step-7 job destruction reponses exceed two standard errors for more than a third of the sectors including total manufacturing, Food, Rubber and Plastics, Primary Metals, Fabricated Metals and Transportation Equipment. Other sectors with statistically significant cumulative destruction responses include the most energy intensive group, the most capital intensive group and large, mature plants.

In another exercise, we compared the actual path of employment growth to the counterfactual path generated by feeding the contemporaneous and seven lagged values of the realized oil shocks through the MA representation of the structural VAR. This exercise revealed a clear role for oil shocks as a major driving force behind fluctuations in particular sectors and in certain historical episodes such as the prominent sector-specific fluctuations in the 1985 to 1988 period. The results of this exercise also indicate that oil shocks played an important role in the deep employment decline of the early 1980s, but that they do not explain the prolonged nature of the contraction. The oil-shock counterfactual generates sectoral employment growth rates that typically turn up in 1982, which fits the experience of a few sectors such as Apparel, the bottom energy class and the top durability class but is sharply at odds with the continued contraction in many sectors such as Rubber and Plastics, Electrical Machinery, Primary Metals, Transportation Equipment, the top energy class, and the top capital class.

C. The Dynamic Response to SPREAD Shocks

Returning to Figure 3, we see that job destruction rises and job creation falls in the aftermath of a spread shock. The peak employment growth response occurs 3 quarters after the shock, and its size is about half as large as for a unit positive oil shock. The longer term employment and reallocation responses to the spread shock are modest. At step 15, the cumulative response is an employment decline of -.48 percent and the reallocation of 1.53 percent of manufacturing jobs.

Figure 4 shows displays dynamic responses to SPREAD shocks for selected sectors. The full set of (unreported) results show show that two-thirds of all sectors exhibit opposite signs for the step-7 cumulative creation and destruction responses to SPREAD shocks. This sign pattern contrasts with the pattern for oil shocks, in which two-thirds of the cumulative creation and destruction responses showed the same sign. Thus, the results suggest that SPREAD shocks have less of a (within-sector) reallocative character than oil shocks.

In another respect, however, the SPREAD shock response functions are similar to the oil shock response functions: the magnitude of the short run response is typically larger for destruction than creation. Twenty percent of the cumulative step-7 destruction responses to a SPREAD shock differ from zero by more than two standard errors, but none of the creation responses do. This aspect of the oil and SPREAD shock response dynamics mirrors the greater cyclical volatility of job destruction that stands out clearly in the time-series plots of the raw data (Figures 1).

Two other aspects of the SPREAD shock response results are noteworthy. First, relatively large SPREAD shock responses occur for Rubber and Plastics, most durable goods industries (especially Electrical Machinery), and younger plants. Second, young, small plants exhibit response dynamics that differ greatly from other sectors. For these plants, a SPREAD shock triggers little change in job destruction and a comparatively large decline in job creation (Figure 4). In this regard, recall from Table 1 that young, small plants are one of the few sectors that exhibit large cyclical fluctuations in job creation relative to job destruction. This pattern in the raw data carries over to the estimated response functions as relatively greater shock sensitivity of job creation.

In other unreported results, we considered a variety of alternative specfications involving monetary and credit variables. First, we experimented with the Federal Funds Rate as an alternative indicator of monetary and credit conditions. Second, we allowed positive and negative SPREAD shocks to have asymmetric effects in like manner to our treatment of oil shocks. Third, we placed SPREAD first in the five-variable common subsystem.

The main character of our results was not affected by these specification changes, but a few findings are worth mentioning. First, alternative treatments of SPREAD have virtually no impact on the results for oil shocks. Second, the impulse response functions depicted in Figure 3 are qualitatively similar for all of these alternative specifications. Third, using the SPREAD variable leads to a somewhat larger role for monetary-credit shocks than the Federal Funds Rate. Fourth, the results show weak evidence of asymmetric responses to positive and negative SPREAD shocks (with larger responses to positive shocks). Fifth, the quantitative importance of the SPREAD shock is sligtly higher when SPREAD is placed first in the VAR subsystem. Given that our main results do not seem unduly sensitive to these specification issues, we continue to focus on our baseline specification.

V. Which Sectoral Characteristics Matter?

The preceding results identify particular sectors that exhibit unusually large or small shock responses, but the one-way and two-way classification schemes make it difficult to discern how the response depends on sectoral characteristics. For example, SPREAD shocks generate bigger employment responses in several durable goods industries, which tend to be dominated by large, mature plants. SPREAD shocks also generate bigger responses among smaller and, especially, younger plants. Each finding has a ready interpretation, but together they strongly suggest that the results confound the effects of multiple sectoral characteristics.

In this section, we adopt an approach that allows us to control simultaneously for multiple sectoral characteristics that potentially influence the response to SPREAD and oil shocks. We implement our approach in three steps. First, we estimate near-VAR systems for approximately 450 4-digit manufacturing industries over the 1972 to 1988 period. Second, using the same identifying assumptions as before, we estimate the shock response functions for each 4-digit industry. Third, we regress cumulative responses on industry-level measures of (average) energy intensity, capital intensity, plant size, plant age and product durability. The cross-industry variation in these measures and the large number of 4-digit industries provide leverage for disentangling the roles of the multiple characteristics that influence the shock response functions.

We construct measures of 1972-1988 average industry-level characteristics as follows. Using the Bartelsman-Gray (1995) NBER Productivity database, we measure energy intensity as the ratio of energy costs to total shipments and capital intensity as capital per production worker in 1987 dollars. We summarize the industry-level size distribution by the coworker log, defined as the employment-weighted mean of the log of plant-level employment. To summarize the age distribution of plants, we use the fraction of industry-level employment at mature plants (more than 9-13 years old). We calculate the coworker log and the mature plant fraction directly from plant-level data in the LRD. Some of our regressions also make use of the Bils-Klenow product durability measure, which is available for 106 industries.

Table 3 summarizes the statistical significance of the characteristics in explaining industry variation in the step-7 cumulative response of the employment growth rate and the step-15 cumulative response of the excess job reallocation rate.[12] The underlying regressions contain cubic polynomials in the energy, capital, size and age measures. Panel A shows that, with respect to oil shocks, the energy, capital and size variables are statistically significant at the 5 percent level in accounting for the cross-industry variation in the cumulative employment response. The capital and age variables account for significant variation in the cumulative reallocation response. With respect to SPREAD shocks, the capital and age variables are statistically significant for the cumulative employment response, and the energy and age variables are significant for the cumulative reallocation response.

Since the regression specifications are nonlinear in variables, we display the fitted relationships in Figures 5A and 5B. Each panel plots the fitted employment and excess reallocation relationship from the 10th to the 90th percentiles of the indicated regressor, while evaluating the other regressors at medians. The line atop the horizontal axis provides

[12]The excess reallocation rate is the gross job reallocation rate minus the absolute value of the net employment growth rate. The excess reallocation response equals the smaller (in magnitude) of the job creation and destruction responses, multiplied by two.

additional information about the distribution of the regressor.

The oil shock response functions now show several clear patterns. The cumulative employment decline triggered by a unit positive oil shock rises sharply from 1.3 percentage points at the 10th percentile of the capital intensity distribution to 2.5 percentage points at the 90th percentile. The oil-shock employment decline also rises with energy's cost share over the lower two-thirds of the energy distribution. Industries with mid-sized plants exhibit relatively small employment responses to oil shocks. In addition, the excess reallocation response to oil price shocks is dramatically higher in more capital intensive industries, and it is also higher in industries with many young plants.

The SPREAD shock responses show less evidence of important variation with measured sectoral characteristics. The only noteworthy effect involves the plant age variable. The cumulative 7-step employment decline triggered by a unit positive SPREAD shock is about 1 percentage point for an industry with 92% of employment in mature plants, as compared to about 1.7 percentage points for an industry with 64% of employment in mature plants.

Younger plants are likely to be disproportionately owned by younger firms, and younger firms may have less access to capital markets. In this light, our findings of greater employment responses among younger plants to SPREAD shocks recalls earlier work by Gertler and Gilchrist (1994), Kashyap, Lamont and Stein (1994) and others that finds greater sensitivity to monetary shocks among small firms. These studies develop evidence that greater sensitivity among small firms arises because of their more limited access to capital markets. Our findings are consistent with this interpretation, but we regard the plant age measure as a very crude proxy for access to capital markets. A careful assessment of the reasons for greater sensitivity among young plants, and the possible role of capital market imperfections in job creation and destruction dynamics, awaits further research.

We re-estimated the cumulative response regressions for the 106-industry subsample, adding a cubic polynomial in the Bils-Klenow durability measure. Since capital intensity proved to be the most important sectoral characteristic in the full sample, we focus on the role of durability and capital intensity in the subsample.

Figure 6 displays the fitted relationships for the 106-industry subsample. The cumulative employment response to oil shocks is even more sensitive to capital intensity than in the full sample: the step-7 employment decline is almost 3 percentage points greater at the 90th percentile of the capital intensity distribution (for the subsample) than at the 10th percentile. Unreported results reveal that the greater role for capital intensity in the SPREAD shock response functions arises from a different sample, not from conditioning on product durability. The differences between Figures 5 and 6 in the cumulative response functions for job reallocation also arise from sample differences.

Turning to the role of product durability, Figure 6 shows a strong effect on the cumulative employment responses to both shocks. Nondurable goods (depreciation rates of 1) show an oil-shock employment response of about -1 percent, as compared to -2.8 percent at the 90th percentile of the durability distribution. There is a similar range of variation in the cumulative employment responses to SPREAD shocks, with larger responses by industries that produce more durable goods. These results are very much in line with the findings and analysis in Bils and Klenow (1998).

VI. How Many Jobs Are Created and Destroyed in Response to the Shocks?

We now quantify the number of jobs created and destroyed in response to oil and monetary shocks. We focus on three questions: How large is the medium-term (1-2 years) employment response to the shocks? How large is the longer term (4 years) excess job reallocation response? How is the longer term reallocation response apportioned among employment shifts out of manufacturing, employment shifts between sectors within manufacturing, and reallocation within manufacturing sectors?

Table 4 speaks to the first two questions. According to Panel A, the cumulative employment response to a unit standard deviation positive oil price shock is tiny at step 3 but exceeds 2 percent of production worker employment at step 7. Almost all of the employment decline between steps 3 and 7 reflects an increase in gross job destruction. Over the next 8 steps, cumulative job destruction declines slightly, while cumulative creation rises from near zero to 1.4 percent of employment. Hence, net job loss is a modest -0.5 percent at step 15, but the cumulative reallocation response exceeds 3 percent of all manufacturing production worker positions (more than 410,000 jobs).

The large job reallocation response at step 15, coupled with a modest change in the level of employment, is evidence that the longer term response to oil shocks shows up mostly as the reallocation of labor (and presumably capital). But the medium-term response involves significant declines in the level of employment, because the destruction of existing jobs 1-2 years after the shock mostly precedes the creation of new jobs 2-4 years after the shock.

Comparing Panels A and B reveals a noteworthy asymmetry in the responses to positive and negative oil price shocks. The cumulative impact on net employment growth at 7 steps is very modest (less than .2 percent) for a negative oil shock, whereas a positive shock of equal magnitude yields a cumulative employment decline of more than 2 percent. Cumulating the responses for steps 0 to 15, a unit positive shock induces an *increase* in excess job reallocation of almost 3 percent of jobs whereas a unit negative shock induces a *decrease* of 1.4 percent. This finding does not support the hypothesis that only the size of relative price changes matters for the long run job reallocation responses.

One possible interpretation is that the aggregate aspect of positive and negative oil shocks trigger asymmetric job reallocation responses. For example, in the search equilibrium model of Mortensen (1994), a negative aggregate shock pushes jobs with low match quality across a destruction threshold and into the pool of unemployed workers, who eventually form new matches and participate in new job creation. A positive aggregate shock, in contrast, does not trigger a wave of destruction and subsequent creation, because it reduces the reservation match quality below which job destruction occurs. This type of nonlinearity in the creation and destruction effects of aggregate shocks fits the asymmetric response of excess reallocation to positive and negative oil shocks in Table 4.

Panel C in Table 4 reports the estimated effects of the largest oil-shock episode in our sample. Using the innovations for the 1973:4-1973:1 oil-price changes in the estimated VAR, panel C reports estimated cumulative responses. This oil-shock episode has very large estimated effects on employment and job reallocation activity. The cumulative employment decline at step 7 is almost 8 percent, but it diminishes to about 2 percent at 15 steps. The cumulative response of excess job reallocation at 15 steps is $(11.05 - |-2.24| =)$ 9.8 percent of employment.

Panel D in Table 4 shows that SPREAD shocks generate more rapid creation and destruction responses than oil shocks and less evidence of reallocative effects. At step 3, a unit standard deviation positive SPREAD shock yields a cumulative creation decline of .3 percent and a cumulative destruction increase of .5 percent. At step 7, the SPREAD shock generates a small decline in job creation and a cumulative job destruction increase of 1.1 percent.

Panel E reports the estimated effects of the largest SPREAD shock in our sample period, the 1979:3-79:4 period. This period is commonly associated with a significant contraction in monetary policy. This particular episode involves a step-7 cumulative employment decline of more than 3 percent. At 15 steps, the cumulative employment response is a more modest -1.3 precent, and the cumulative excess reallocation response is 2.7 percent of employment.

Table 5 shows that the largest oil and monetary shocks in our sample induced large *temporary* employment declines and large *permanent* increases in job reallocation. Because of the modest number of major shocks in our sample, the standard errors on the cumulative responses are quite large, especially at 15 steps. Hence, readers with strong prior views may not be greatly swayed by these results. But, taken at face value, the results point to major longer term reallocative consequences of oil and monetary shocks that were associated with large medium-term downturns in aggregate measures of economic activity.

Turning to the third question posed at the beginning of this section, Table 5 apportions the job reallocation response among between-sector and within-sector components. The first column shows the estimated step-15 cumulative job reallocation response generated by the employment-weighted average of the sectoral responses. The remaining columns are generated from the decomposition,

$$SUM_{mfg} = |NET|_{mfg} + [\sum_s |NET|_s - |NET|_{mfg}] + [\sum_s SUM_s - |NET|_s], \qquad (6)$$

where SUM denotes job reallocation, NET denotes net employment change, and the subscripts index sectors. The first term on the right side of (6) is the overall change in manufacturing employment; the second term captures between-sector employment shifts within manufacturing; and the third term equals the sum of excess job reallocation within sectors. Columns 2-4 in Table 5 show the fraction of the job reallocation response accounted for by these three terms.

About 15-17% of the estimated job reallocation response to a positive oil shock arises from the estimated decline in manufacturing employment except for classifications by capital intensity (4%) and plant age and size (28%). Excess job reallocation within sectors accounts for two-thirds or more of the total job reallocation response, except for the highly detailed 4-digit industry classification and, more surprisingly, the breakdown by plant age and size. Almost 30% of the job reallocation response is accounted for by employment shifts among our 11 size-age categories. In contrast, and rather remarkably, employment shifts among sectors defined in terms of capital intensity and energy intensity account for virtually none of the estimated job reallocation response.

The change in overall manufacturing employment accounts for one-third to more than half the job reallocation response to SPREAD shocks, depending on sectoral classification scheme. The role of within-sectoral excess reallocation is correspondingly smaller for SPREAD shocks, as compared to a positive oil shock. In other words, SPREAD shocks generate smaller reallocative effects than a positive oil shock.

VII. Summary and Conclusions

We organize our main findings and conclusions under several headings:

DESCRIPTIVE CHARACTERIZATION OF GROSS JOB FLOWS

Gross job flows are large in every sector we consider, averaging 10.7% of employment per quarter. Job destruction shows much greater cyclical variation than job creation in almost every sector. The clear exceptions, accounting for 7 percent of manufacturing employment, are young plants (less than 9-13 years old) with fewer than 100 employees. In addition, the relative volatility of job destruction tends to rise with capital intensity, product durability, and plant age and size.

ASYMMETRIC SHOCK RESPONSE OF CREATION AND DESTRUCTION

Both oil and monetary shocks generate much greater short-run responses in job destruction than job creation in almost every sector. One plausible explanation for the greater volatility of job destruction and its greater sensitivity to common shocks is a rising short-run supply schedule for new capital goods. Caballero and Hammour (1994) develop this point, and Goolsbee (1996a,b) provides evidence that the short-run supply price of capital goods rises steeply. Campbell and Fisher (1998) develop a different theory that explains how certain forms of employment adjustment costs can make job destruction more sensitive to shocks that job creation. Search frictions in labor markets provide another candidate explanation for this asymmetry (Mortensen, 1994).

THE IMPORTANCE OF OIL SHOCKS

Oil price shocks account for about 20-25% of the variance in 2-year-ahead forecast errors for manufacturing employment growth under our identifying assumptions, about twice as much as monetary shocks. The largest oil shock in our sample (1973:3-1973:4) caused an estimated eight percent decline in manufacturing employment within two years.

ASYMMETRIC EMPLOYMENT RESPONSE TO OIL PRICE UPS AND DOWNS

Employment growth declines sharply following a large oil price increase but changes little following a large oil price decrease. A unit standard deviation positive oil shock leads to a cumulative two-year employment decline of about 2 percent, ten times bigger than the estimated response to the same size negative oil shock.

Several other studies, most based on different econometric specifications and identifying assumptions, also conclude that oil price increases have larger effects on aggregate or regional activity than oil price decreases. See Mork (1989), Mory (1993), Lee, Ni and Ratti (1995), Davis and Haltiwanger (1996), Hamilton (1996b), Hooker (1996b) and Davis, Loungani and Mahidhara (1997). In light of this work, we view the evidence for asymmetric responses to oil price ups and downs as well established (for the United States).

WHICH CHARACTERISTICS MATTER FOR SHOCK RESPONSE SIZE?

The employment sensitivity to a positive oil shock rises sharply with capital intensity and product durability. It also rises with energy's share of total costs over the lower two-thirds of the energy cost distribution. The magnitude of the two-year employment response to monetary shocks rises sharply with product durability. It also rises with the fraction of employment in young plants.

REALLOCATIVE CONSEQUENCES OF OIL SHOCKS

Our results point to important reallocative consequences of oil price shocks. For example, we estimate that the 1973:3 - 1973:4 oil shock episode caused job reallocation activity to rise by an amount equal to 11 percent of employment over the following 15 quarters. More than 80% of this reallocation response reflects greater excess job reallocation within manufacturing.

In separate work, Davis, Loungani and Mahidhara (1997) find that oil shocks have been a major driving force behind regional employment and unemployment fluctuations in the United States since 1972. The cross-state dispersion of cyclical unemployment rose sharply in the aftermath of each major oil shock in 1973-74, 1979-80 and 1986.

OIL SHOCKS AND FLUCTUATIONS: WHAT IS THE STORY?

Most equilibrium business cycle models (as reviewed in Cooley, 1995) fail to offer any explanation for the sharply asymmetric response to oil price ups and downs. Two exceptions are Atkeson and Kehoe's (1994) analysis of energy intensity choice in a model with differentiated putty-clay capital goods and Hamilton's (1988) analysis of labor market reallocation frictions in a multi-sector model.[13] Equilibrium models with reallocation frictions

[13] Although not directed to the study of oil shocks per se, several other dynamic equilibrium models with reallocation frictions readily suggest insights into the asymmetric response to oil price ups and downs. See, for example, Davis and Haltiwanger (1990), Mortensen and Pissarides (1994), Phelan and Trejos (1999) and Ljungqvist and Sargent (1998)

offer the promise of simultaneously explaining (i) the asymmetric aggregate response to oil price ups and downs, (ii) the magnitude of the medium-term aggregate response to oil shocks, (iii) the large-scale job reallocation activity triggered by large oil price increases, and (iv) the large role of oil shocks in regional unemployment fluctuations.

Research to date has not pinned down the precise nature of the reallocation frictions that influence the aggregate response to oil price changes and other shocks. Do the frictions mainly involve worker reallocation, capital reallocation, or the development of new organization capital to facilitate business expansion and entry? How important are relocation costs, human capital acquisition, rigidities in the employment relationship, unemployment insurance, and the appropriability of specific investments?[14]

Lastly, we emphasize that oil shock response magnitudes vary systematically with observable sectoral characteristics, in some respects sharply. This response heterogeneity is another challenge to business cycle modeling and a useful source of information for assessing model performance.

[14]There are vast literatures that bear on these questions, directly or tangentially. The broad empirical significance of worker reallocation costs is well established, but see Hall (1995) for a treatment that emphasizes aggregate implications. On capital reallocation costs, see Ramey and Shapiro (1996). On organization capital and its cost of adjustment, see Prescott and Visscher (1980). On job creation and destruction dynamics in models that highlight the effects of incentive problems in the employment relationship and the appropriability of specific investments, see Ramey and Watson (1996) and Caballero and Hammour (1996), respectively. On the effects of unemployment insurance in a search economy subject to reallocation shocks, see Ljungqvist and Sargent (1998).

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Table 1. Quarterly Job Flow Rates by Sector
Summary Statistics, 1972:2 to 1988:4

Panel A. Total Manufacturing

Mfg. Emp. Share	Mean Job Creation Rate	Mean Job Destruction Rate	St. Dev. of Creation Rate	St. Dev. of Destruction Rate	St. Dev. of Employment Growth Rate
100.0	5.2	5.5	0.87	1.45	1.92

Panel B. Nondurables Manufacturing Industries

INDUSTRY	Employment Share	Mean Job Creation Rate	Mean Job Destruction Rate	St. Dev. of Creation Rate	St. Dev. of Destruction Rate	St. Dev. of Employment Growth Rate
Food Products	8.2	9.0	9.0	1.35	1.37	1.54
Textile Mill Products	5.3	3.5	4.1	0.84	1.44	1.90
Apparel and Other Textiles	7.8	5.4	6.3	1.31	1.50	2.30
Paper and Allied Products	3.8	3.6	3.8	0.70	1.18	1.57
Printing and Publishing	5.2	4.5	4.5	0.72	1.09	1.30
Chemicals and Allied Products	4.0	3.6	4.0	0.76	1.05	1.39
Petroleum and Coal Products	0.7	3.9	4.3	1.31	1.70	2.11
Rubber and Plastics	4.2	5.4	5.3	1.18	2.02	2.70
Leather Products	1.4	4.8	6.1	1.23	1.84	2.56

Panel C. Durables Manufacturing Industries

INDUSTRY	Employment Share	Mean Job Creation Rate	Mean Job Destruction Rate	St. Dev. of Creation Rate	St. Dev. of Destruction Rate	St. Dev. of Employment Growth Rate
Lumber and Wood Products	4.1	6.6	6.9	1.68	2.40	3.13
Furniture and Fixtures	2.9	5.1	5.3	1.17	1.81	2.45
Stone-Clay-Glass Products	3.4	5.3	5.7	1.04	1.58	2.17
Primary Metals	6.0	3.7	4.6	1.30	2.64	3.49
Fabrictated Metals	8.7	5.3	5.6	1.14	1.74	2.40
Nonelectrical Machinery	10.3	4.9	5.3	1.02	2.02	2.68
Electrical Machinery	9.2	4.7	4.9	1.08	1.92	2.65
Transportation Equipment	9.5	5.5	5.7	1.58	2.73	3.52
Instruments and Related Products	2.8	4.2	4.2	1.04	1.26	1.85
Miscellaneous Manufacturing	2.2	6.7	7.1	1.33	1.64	2.38

Panel D. Energy Intensity Deciles (Energy Costs as Percent of Shipments Value)

ENERGY INTENSITY	Mfg. Emp. Share	Mean Job Creation Rate	Mean Job Destruction Rate	St. Dev. of Creation Rate	St. Dev. of Destruction Rate	St. Dev. of Employment Growth Rate
0.0 - 0.4	10.0	6.3	5.9	1.22	1.49	2.05
0.4 - 0.6	10.0	5.5	5.5	0.88	1.41	1.77
0.6 - 0.8	10.0	5.2	5.2	0.88	1.39	1.88
0.8 - 1.0	10.0	5.0	5.2	0.82	1.52	1.95
1.0 - 1.3	10.0	5.1	5.3	0.94	1.42	1.93
1.3 - 1.6	10.0	5.1	5.4	0.97	1.52	2.06
1.6 - 2.1	10.0	5.3	5.7	0.98	1.55	2.02
2.1 - 2.9	10.0	5.2	5.8	0.99	1.60	2.10
2.9 - 5.3	10.0	5.1	5.8	0.88	1.65	2.07
5.3+	10.0	4.4	5.5	1.00	1.80	2.40

Panel E. Capital Intensity (of Industry) Quintiles

CAPITAL INTENSITY	Mfg. Emp. Share	Mean Job Creation Rate	Mean Job Destruction Rate	St. Dev. of Creation Rate	St. Dev. of Destruction Rate	St. Dev. of Employment Growth Rate
0.0 - 24.8	20.0	5.4	5.9	0.99	1.34	1.81
24.8 - 34.3	20.0	5.0	5.0	1.00	1.31	1.82
34.3 - 44.8	20.0	5.1	5.2	0.88	1.49	1.96
44.8 - 70.9	20.0	5.6	5.9	1.17	1.97	2.44
70.9+	20.0	4.9	5.5	1.24	1.94	2.67

Panel F. Durability of Final Product Classes

ANNUAL DEPRECIATION RATE	Mfg. Emp. Share	Mean Job Creation Rate	Mean Job Destruction Rate	St. Dev. of Creation Rate	St. Dev. of Destruction Rate	St. Dev. of Employment Growth Rate	Number of 4-digit SIC Industries
1	11.1	7.5	7.5	1.09	1.19	1.29	54
.37 - .59	4.1	4.3	5.2	0.92	1.42	1.98	11
.14 - .33	4.2	5.1	6.0	1.35	1.69	2.32	10
.10 - .13	4.9	6.7	7.1	2.12	3.70	4.67	13
(minus autos)	3.3	4.9	5.4	1.14	1.66	2.33	12
.04 - .09	2.7	5.3	5.8	1.16	2.03	2.67	19

Panel G. Mature Manufacturing Plants (At Least 9-13 Years Old)

EMPLOYEES	Mfg. Emp. Share	Mean Job Creation Rate	Mean Job Destruction Rate	St. Dev. of Creation Rate	St. Dev. of Destruction Rate	St. Dev. of Employment Growth Rate
Fewer Than 20	2.4	5.4	9.9	1.64	2.86	2.75
20 - 99	12.0	5.6	7.0	1.11	1.53	1.86
100 - 249	14.2	5.2	6.1	0.88	1.46	1.86
250 - 499	13.7	4.8	5.3	0.81	1.36	1.79
500 - 2,499	22.3	3.7	4.1	0.70	1.35	1.79
2,500+	13.5	3.6	3.8	1.12	1.92	2.56

Panel H. Young Manufacturing Plants (Less Than 9-13 Years Old)

EMPLOYEES	Mfg. Emp. Share	Mean Job Creation Rate	Mean Job Destruction Rate	St. Dev. of Creation Rate	St. Dev. of Destruction Rate	St. Dev. of Employment Growth Rate
Fewer Than 20	2.8	7.9	10.3	3.89	3.09	4.46
20 - 99	7.6	7.9	7.3	2.20	1.76	2.70
100 - 249	5.2	7.4	6.0	1.65	1.67	2.56
250 - 499	3.1	6.6	5.1	1.34	1.58	2.48
500 - 2,499	3.1	6.2	4.4	1.56	1.49	2.52

Notes:
The data are seasonally adjusted by removing quarterly fixed effects from the sectoral job creation and destruction rates. Employment shares are averages for the 1972 to 1988 period. The cutoff between young and mature plants varies by year, as described in section 7.3.1 of the appendix to Davis, Haltiwanger and Schuh (1996). See the text for a fuller definition of the energy intensity deciles, the capital intensity quintiles and the product durability quintiles.

Sources: (1) Panels A-D: Davis, Haltiwanger and Schuh (1996).
(2) Panels E-H: authors' tabulations from the LRD.

Table 2: Summary of Variance Decompositions

Contribution of Shocks to 8-Step Ahead Forecast Error Variance

Panel A. Employment-Weighted Average Contribution to Net Employment Growth

Sectoral Classification	Oil Shocks	Common Shocks	SPREAD Shocks	Sector-Specific Shocks
2-digit Industry	0.22	0.33	0.11	0.34
4-digit Industry	0.22	0.24	0.10	0.44
Energy Intensity	0.25	0.49	0.06	0.20
Capital Intensity	0.22	0.41	0.12	0.26
Durability	0.18	0.24	0.10	0.49
Age/Size Class	0.20	0.37	0.12	0.31

Panel B. Employment-Weighted Average Contribution to Job Reallocation

Sectoral Classification	Oil Shocks	Common Shocks	SPREAD Shocks	Sector-Specific Shocks
2-digit Industry	0.26	0.27	0.11	0.36
4-digit Industry	0.23	0.22	0.10	0.46
Energy Intensity	0.40	0.32	0.12	0.17
Capital Intensity	0.26	0.28	0.08	0.39
Durability	0.30	0.21	0.07	0.43
Age/Size Class	0.26	0.28	0.14	0.32

Panel C. Employment-Weighted Average Contribution to Job Creation

Sectoral Classification	Oil Shocks	Common Shocks	SPREAD Shocks	Sector-Specific Shocks
2-digit Industry	0.16	0.34	0.11	0.52
4-digit Industry	0.18	0.22	0.10	0.75
Energy Intensity	0.08	0.52	0.10	0.32
Capital Intensity	0.12	0.35	0.12	0.47
Durability	0.17	0.22	0.10	0.65
Age/Size Class	0.13	0.27	0.11	0.50

Panel D. Employment-Weighted Average Contribution to Job Destruction

Sectoral Classification	Oil Shocks	Common Shocks	SPREAD Shocks	Sector-Specific Shocks
2-digit Industry	0.26	0.30	0.11	0.33
4-digit Industry	0.23	0.24	0.10	0.42
Energy Intensity	0.35	0.42	0.07	0.16
Capital Intensity	0.26	0.35	0.09	0.29
Durability	0.27	0.23	0.08	0.43
Age/Size Class	0.26	0.37	0.12	0.24

Notes: (1) Table entries report weighted average values of percentage contributions to eight-step forecast error variances, where weights equal 1972-1988 sectoral shares of manufacturing employment. (2) The results reflect estimates of seven-variable near VARs, one for each sector, and the identification assumptions described in the text. (3) Manufacturing and sectoral rates of job creation (POS) and job destruction (NEG) rates are seasonally adjusted prior to estimation.

Table 3. Summary Statistics for Industry-Level Shock Response Regressions

Dependent Variables: Cumulative 7-Step Employment Responses and Cumulative 15-step Excess Reallocation Responses

A. Full Sample (N=447), Cubic Specification

	Oil Shock		SPREAD Shock	
	Employment	Reallocation	Employment	Reallocation
p-value for:				
Cubic in Log(Energy Share)	.017	.218	.868	.001
Cubic in Log(Capital Per Worker)	.000	.000	.000	.500
Cubic in Coworker Log	.030	.583	.173	.195
Cubic in Mature Plant Fraction	.900	.000	.008	.000
R-bar Squared	.094	.096	.065	.121

B. Limited Sample (N=106), Cubic Specification

	Oil Shock		SPREAD Shock	
	Employment	Reallocation	Employment	Reallocation
p-value for:				
Cubic in Log(Energy Share)	.151	.164	.737	.504
Cubic in Log(Capital Per Worker)	.030	.533	.884	.314
Cubic in Coworker Log	.311	.434	.291	.695
Cubic in Product Depreciation Rate	.000	.355	.000	.889
Cubic in Mature Plant Fraction	.000	.165	.520	.000
R-bar Squared	.330	.155	.321	.160

C. Limited Sample (N=106), Linear Specification

	Oil Shock		SPREAD Shock	
	Employment	Reallocation	Employment	Reallocation
p-value for:				
Log(Energy Share)	.138	.830	.394	.040
Log(Capital Per Worker)	.000	.036	.481	.338
Coworker Log	.579	.530	.065	.126
Product Depreciation Rate	.000	.864	.000	.709
Mature Plant Fraction	.020	.010	.616	.003
R-bar Squared	.230	.047	.350	.075

Notes:

We regressed the estimated industry-level cumulative responses to oil and SPREAD shocks on the indicated industry characteristics. The Product Depreciation Rate is available for 106 industries that produce consumer goods. See the text for full decriptions of the variables.

Table 4: Job Creation and Destruction Responses to Various Oil and Credit Shocks Based on 5 Variable VAR

A. Impact of Positive Standard Deviation Oil Shock

Effect after __ Quarters	Job Creation	std	Job Destruction	std	Net Employment Change	std	Job Reallocation	std
3	0.10	(.26)	0.33	(.50)	-0.23	(.57)	0.44	(.55)
7	0.14	(.58)	2.33	(.86)	-2.19	(1.0)	2.48	(1.1)
11	1.03	(.89)	2.11	(1.2)	-1.08	(1.3)	3.14	(1.7)
15	1.36	(1.3)	1.85	(1.6)	-0.49	(1.5)	3.20	(2.5)

B. Impact of Negative Standard Deviation Oil Shock

Effect after __ Quarters	Job Creation	std	Job Destruction	std	Net Employment Change	std	Job Reallocation	std
3	-0.32	(.24)	0.08	(.45)	-0.40	(.51)	-0.24	(.50)
7	-0.34	(.51)	-0.51	(.70)	0.18	(.83)	-0.85	(.89)
11	-0.45	(.76)	-1.00	(.99)	0.55	(1.1)	-1.45	(1.4)
15	-0.71	(1.0)	-1.10	(1.3)	0.39	(1.2)	-1.81	(2.0)

C. Impact of 1973:4-1974:1 Oil Shock

Effect after __ Quarters	Job Creation	std	Job Destruction	std	Net Employment Change	std	Job Reallocation	std
3	0.07	(.51)	0.42	(1.1)	-0.35	(1.3)	0.49	(1.2)
7	-0.36	(1.7)	7.61	(2.7)	-7.97	(3.1)	7.25	(3.2)
11	2.81	(2.9)	7.67	(4.2)	-4.86	(4.7)	10.49	(5.5)
15	4.41	(4.2)	6.64	(5.7)	-2.24	(5.6)	11.05	(8.4)

D. Impact of Positive Standard Deviation Credit Shock

Effect after __ Quarters	Job Creation	std	Job Destruction	std	Net Employment Change	std	Job Reallocation	std
3	-0.30	(.11)	0.54	(.24)	-0.84	(.27)	0.24	(.25)
7	-0.10	(.29)	1.02	(.46)	-1.12	(.53)	0.92	(.55)
11	0.30	(.47)	1.07	(.67)	-0.77	(.72)	1.37	(.91)
15	0.52	(.67)	1.01	(.86)	-0.48	(.81)	1.53	(1.3)

E. Impact of 1979:3-1979:4 Credit Shock

Effect after __ Quarters	Job Creation	std	Job Destruction	std	Net Employment Change	std	Job Reallocation	std
3	-0.57	(.22)	1.00	(.50)	-1.58	(.57)	0.43	(.52)
7	-0.42	(.68)	2.63	(1.1)	-3.05	(1.3)	2.20	(1.3)
11	0.64	(1.2)	2.95	(1.7)	-2.32	(1.8)	3.59	(2.2)
15	1.37	(1.7)	2.71	(2.2)	-1.34	(2.1)	4.08	(3.3)

Table 5
Decomposition of Job Reallocation Response to Oil and SPREAD Shocks

A. Cumulative Response to Unit Standard Deviation Positive Oil Shock at Step 15

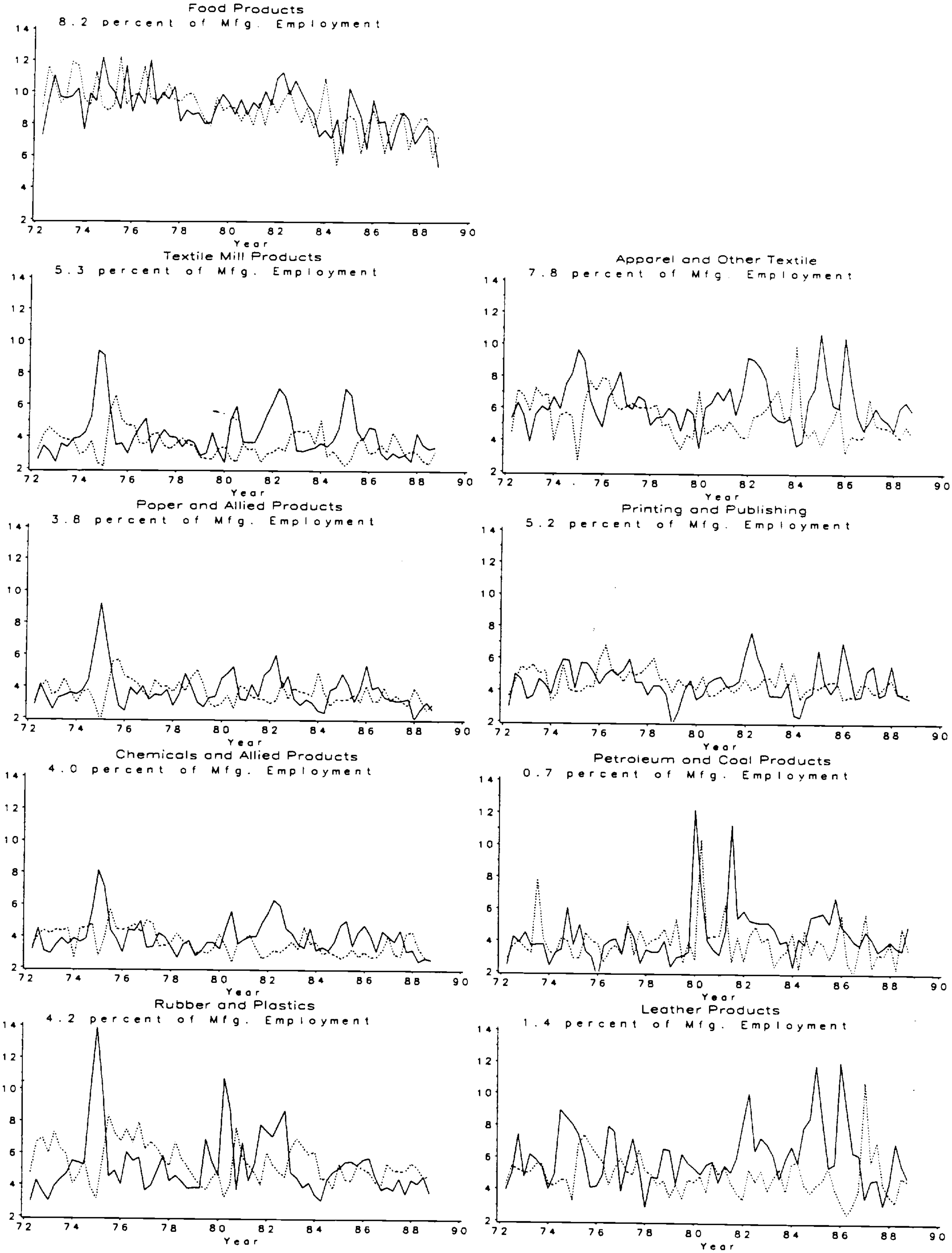
Sectoral Classification	Job Reallocation	Share from Shifts in and out of Mfg	Share from Shifts Between Sectors in Mfg	Share from Shifts Within Sectors
Total Mfg	398864	0.155	0.000	0.845
2-digit Industry	429763	0.153	0.175	0.672
4-digit Industry	413953	0.146	0.400	0.455
Energy Intensity	369307	0.170	0.047	0.783
Capital Intensity	431418	0.040	0.055	0.904
Age/Size Class	308831	0.279	0.292	0.429

B. Response to Unit Standard Deviation Positive SPREAD Shock at Step 15

Sectoral Classification	Job Reallocation	Share from Shifts in and out of Mfg.	Share from Shifts Between Sectors in Mfg.	Share from Shifts Within Sectors
Total Mfg	200934	0.316	0.000	0.684
2-digit Industry	228756	0.482	0.049	0.469
4-digit Industry	226889	0.388	0.239	0.374
Energy Intensity	232607	0.277	0.116	0.607
Capital Intensity	202089	0.552	0.020	0.428
Age/Size Class	255124	0.283	0.318	0.399

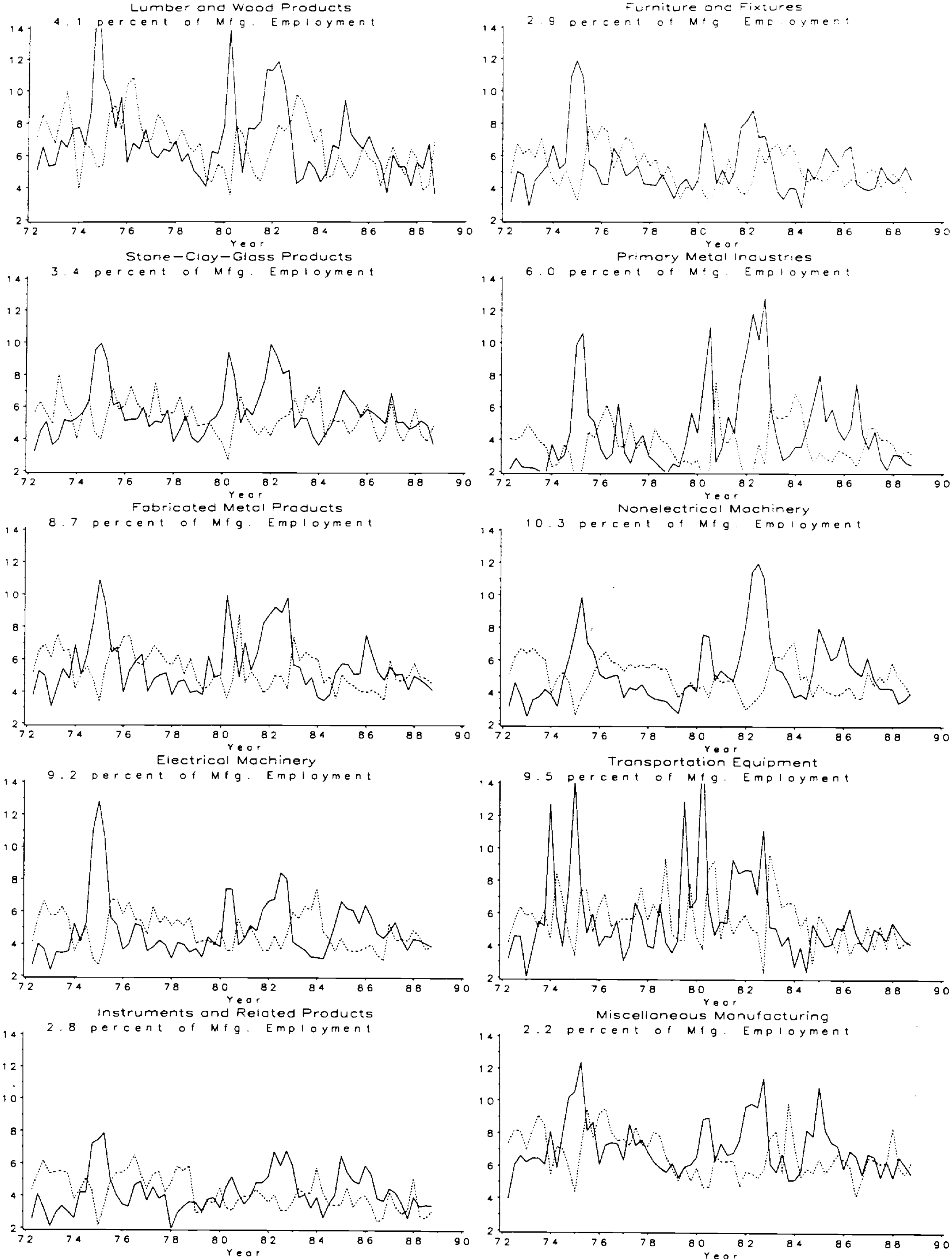
Notes: See notes to Table 2.

Figure 1(A) - Job Creation and Destruction Rates, Nondurables



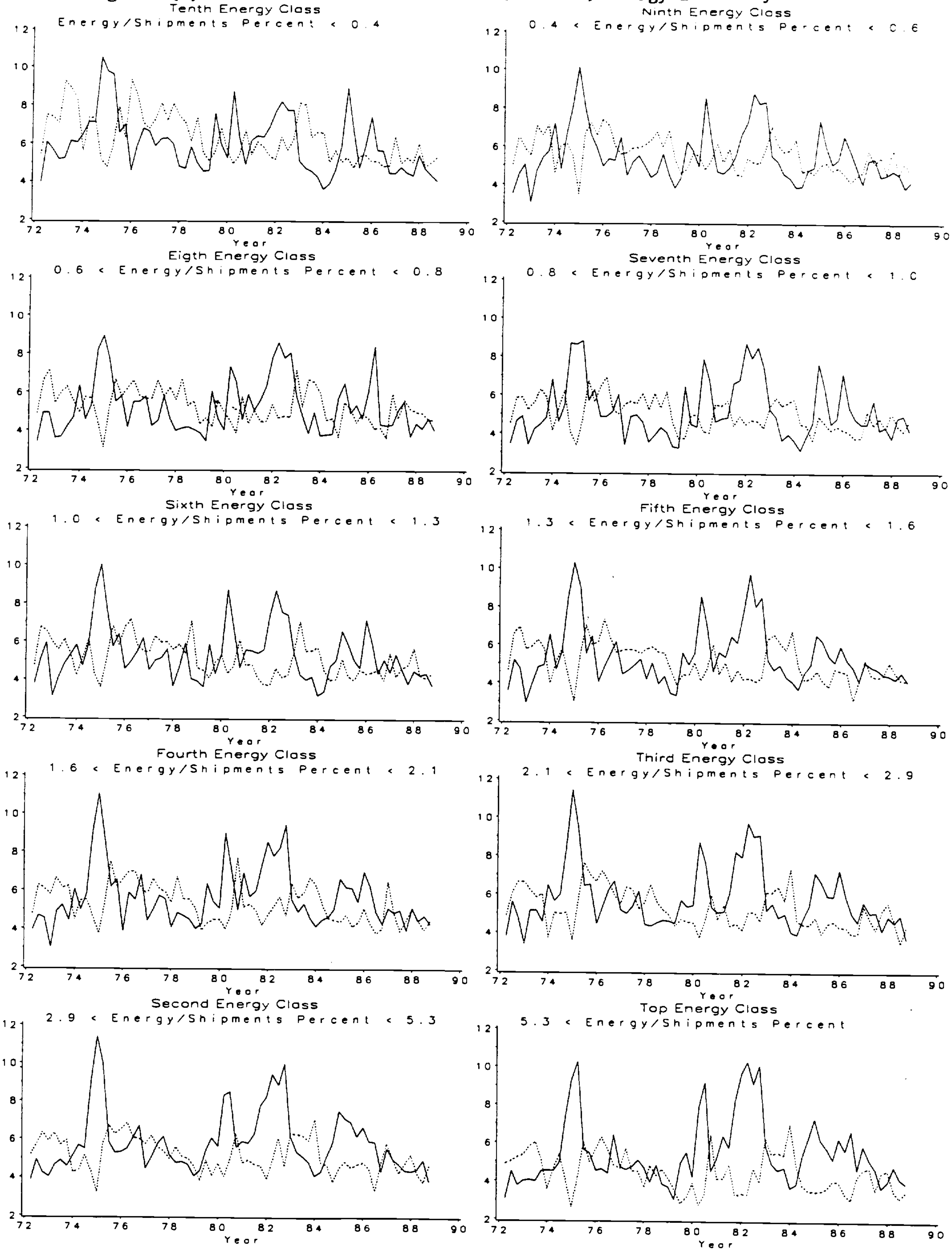
Note: The solid (dashed) line is job destruction (creation)

Figure 1(B) - Job Creation and Destruction Rates, Durables



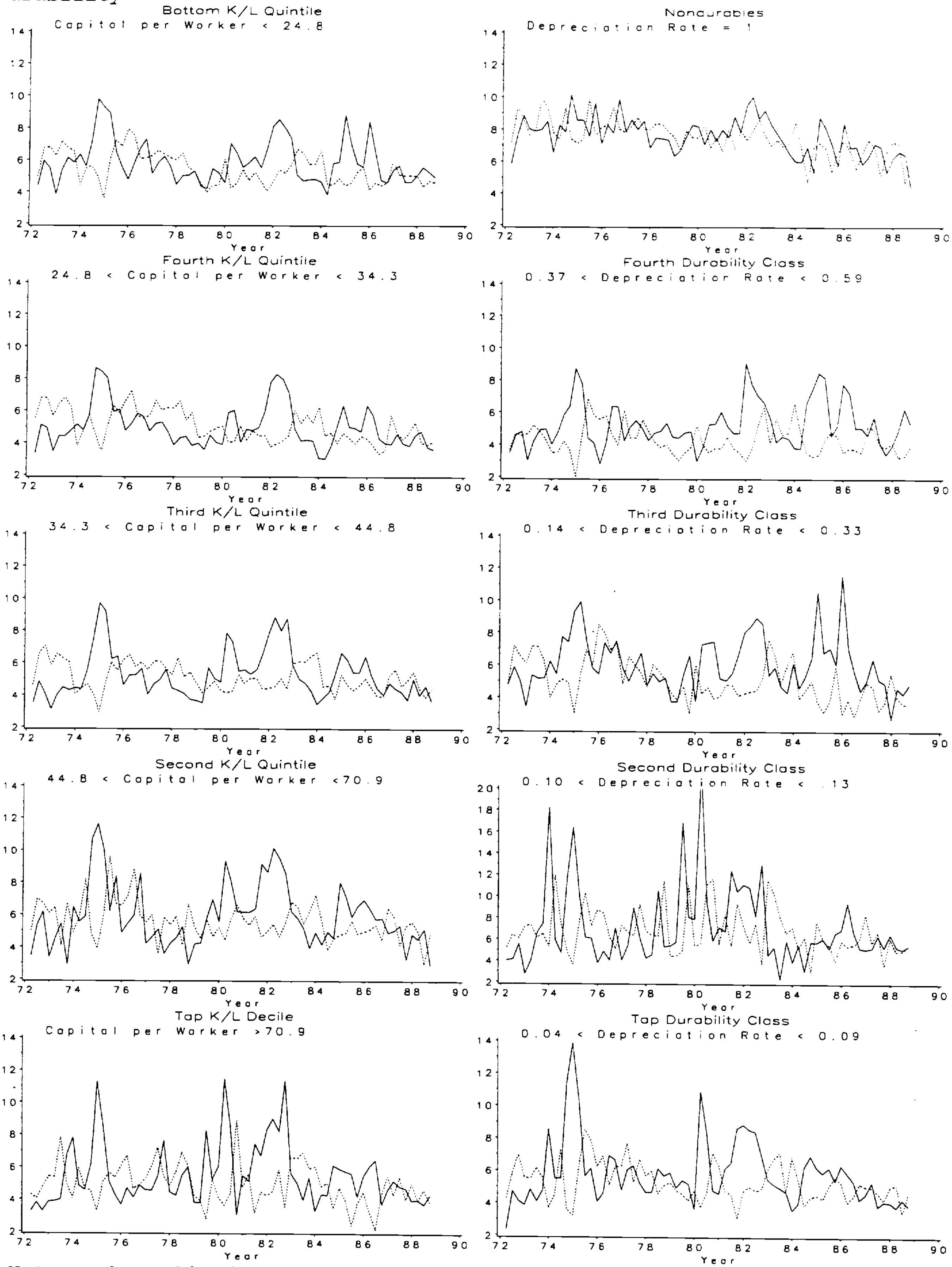
Note: The solid (dashed) line is job destruction (creation)

Figure 1(C) - Job Creation and Destruction Rates, Energy Intensity Deciles



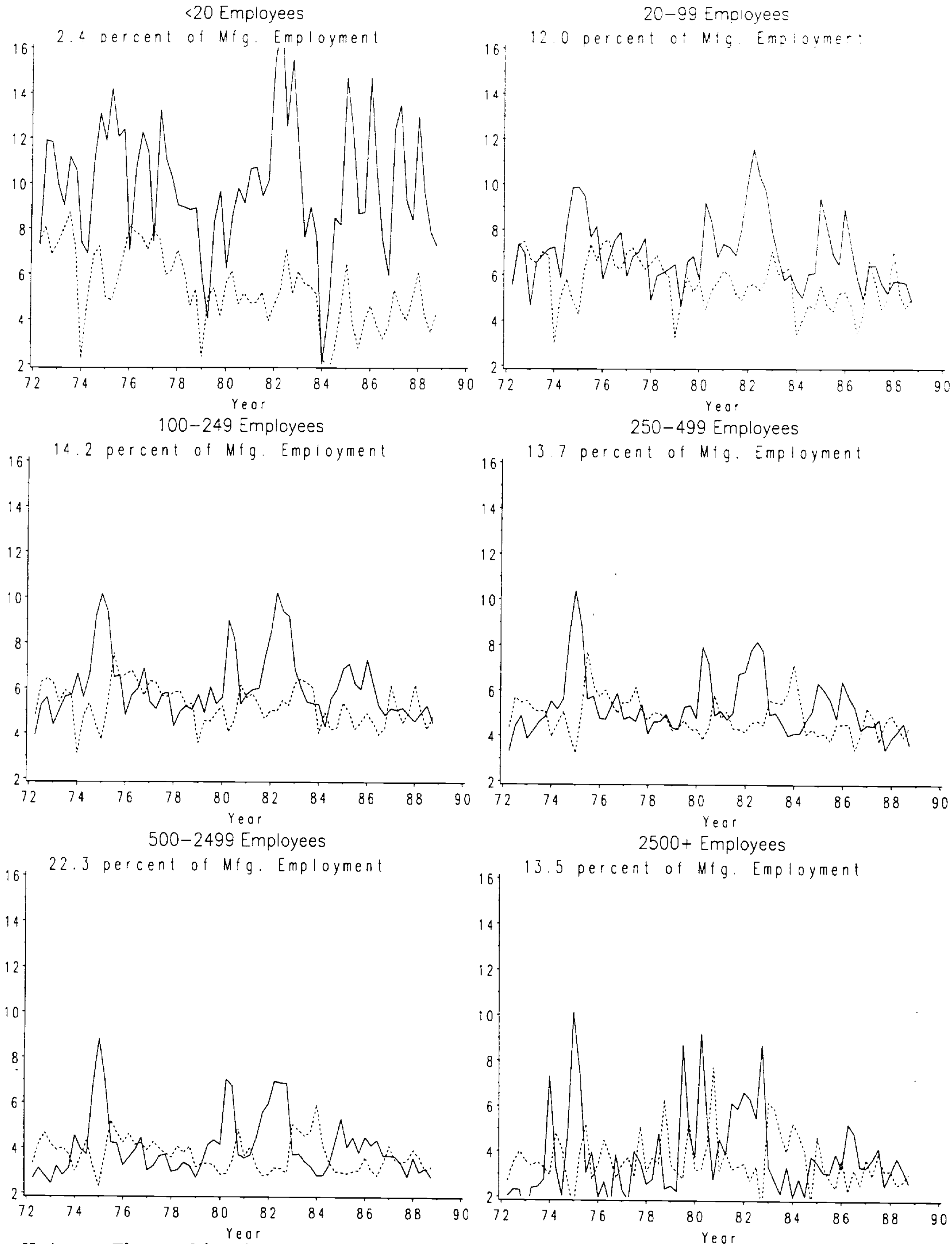
Note: The solid (dashed) line is job destruction (creation)

Figure 1(D) - Job Creation and Destruction Rates, Capital Intensity and Product Durability



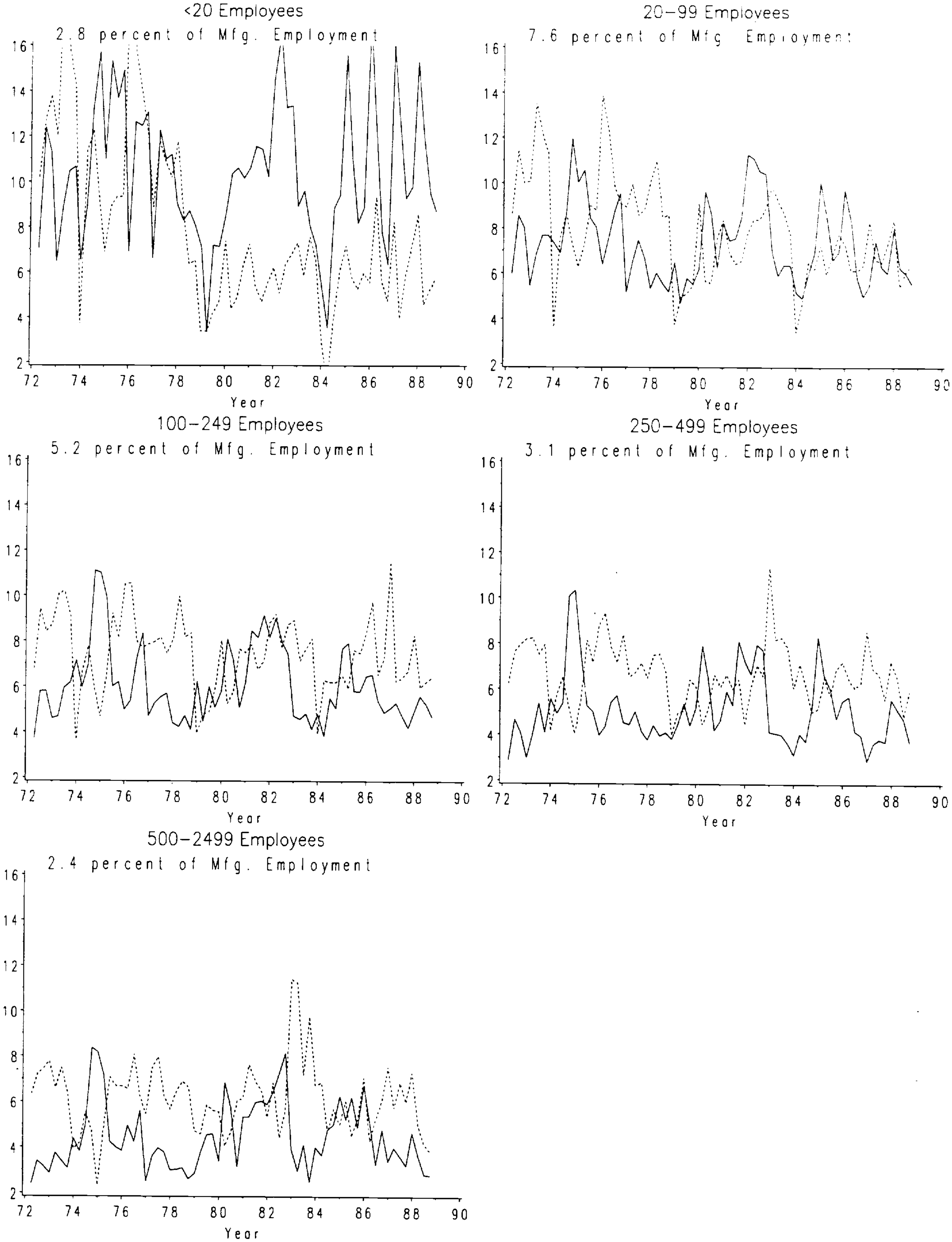
Note: The solid (dashed) line is job destruction (creation)

Figure 1(E) - Job Creation and Destruction Rates, Young Plants



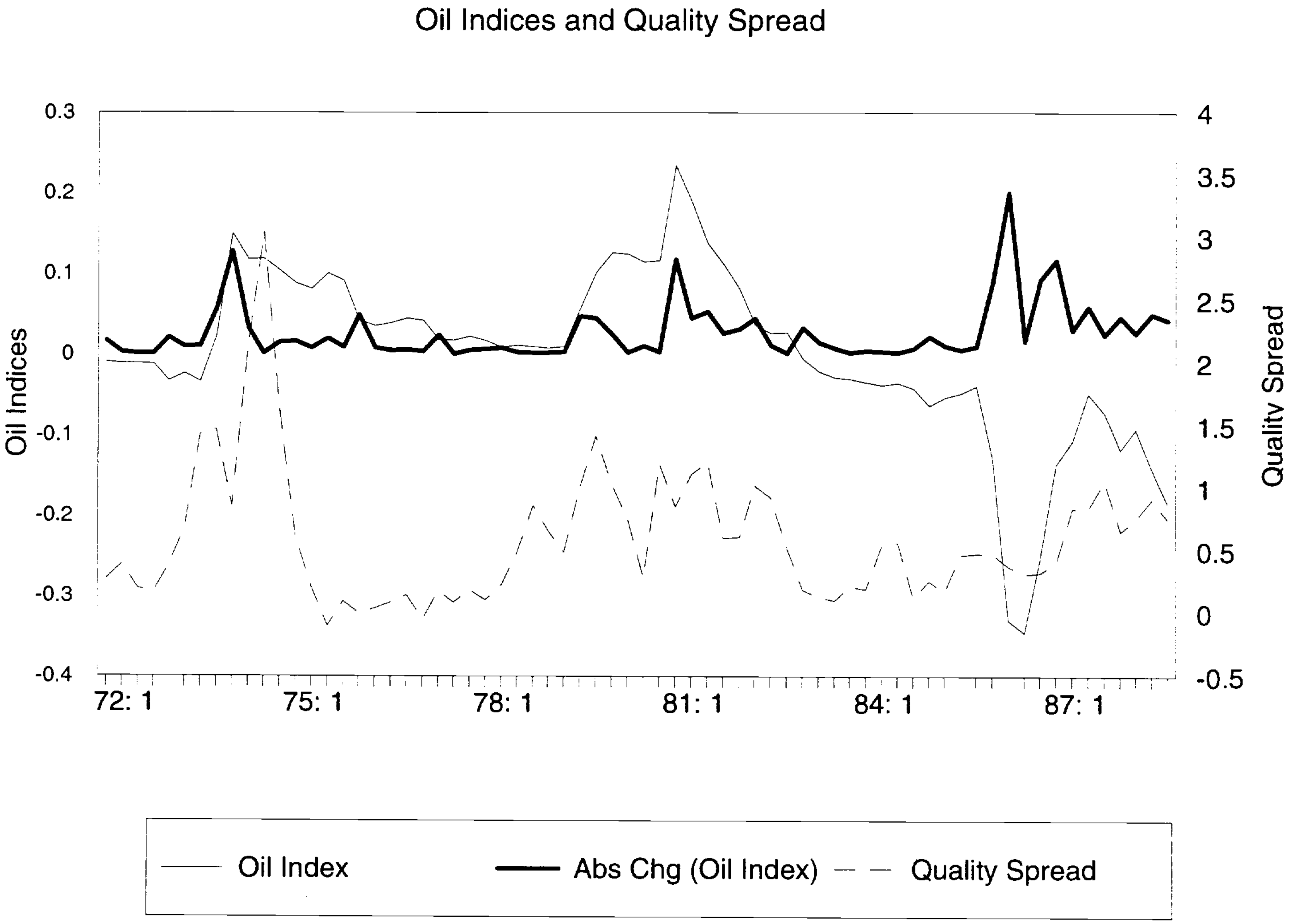
Note: The solid (dashed) line is job destruction (creation)

Figure 1(F) - Job Creation and Destruction Rates, Mature Plants



Note: The solid (dashed) line is job destruction (creation)

Figure 2



Oil Indices and Quality Spread
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
Oil Indices
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
Quality Spread
72: 1
75: 1
78: 1
81: 1
84: 1
87: 1
Oil Index
Abs Chg (Oil Index)
Quality Spread

Figure 3: Impulse Response Functions for Total Manufacturing, Five–Variable VAR Subsystem

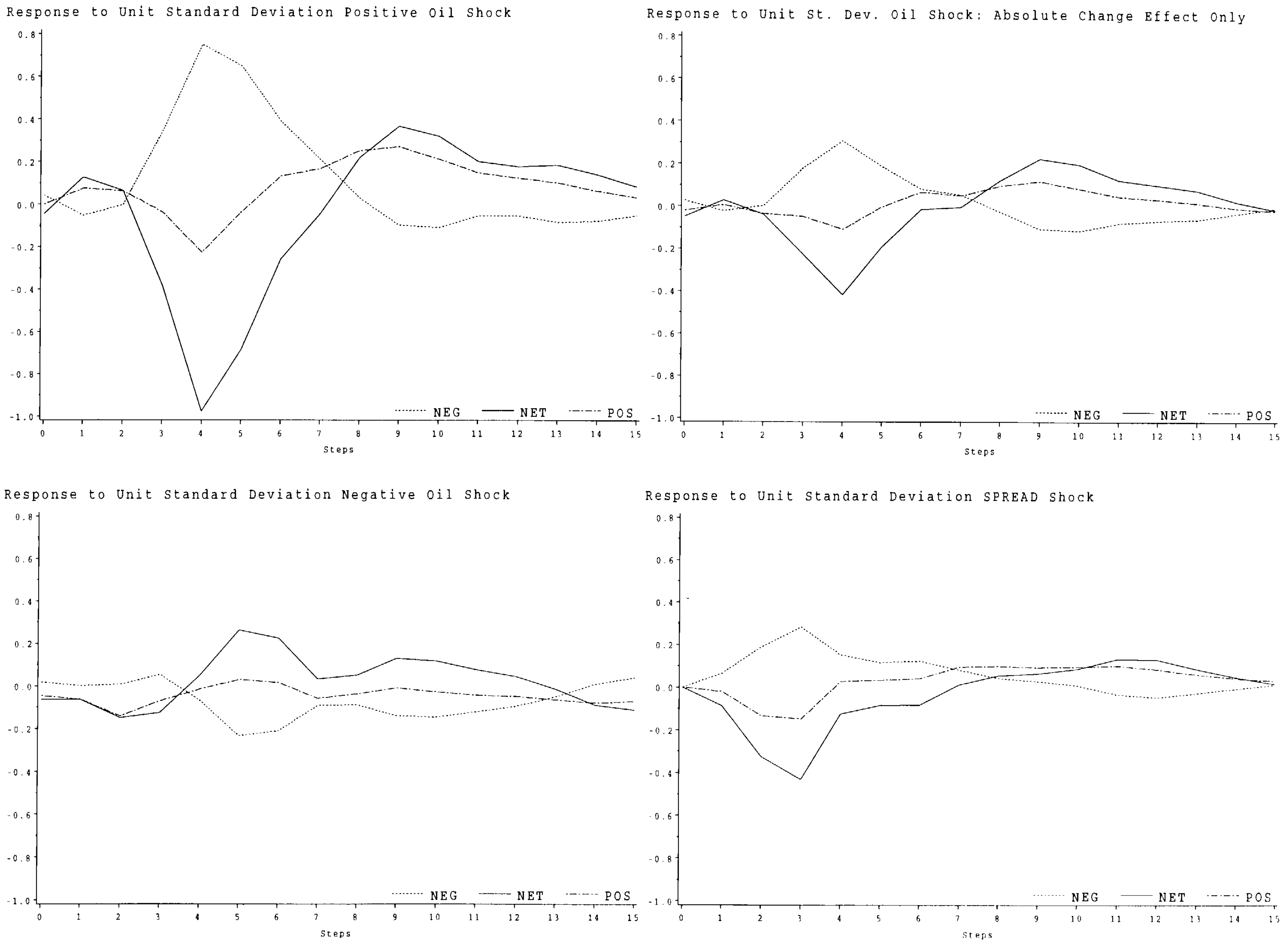


Figure 4 - Impulse Response Functions, Selected Sectors

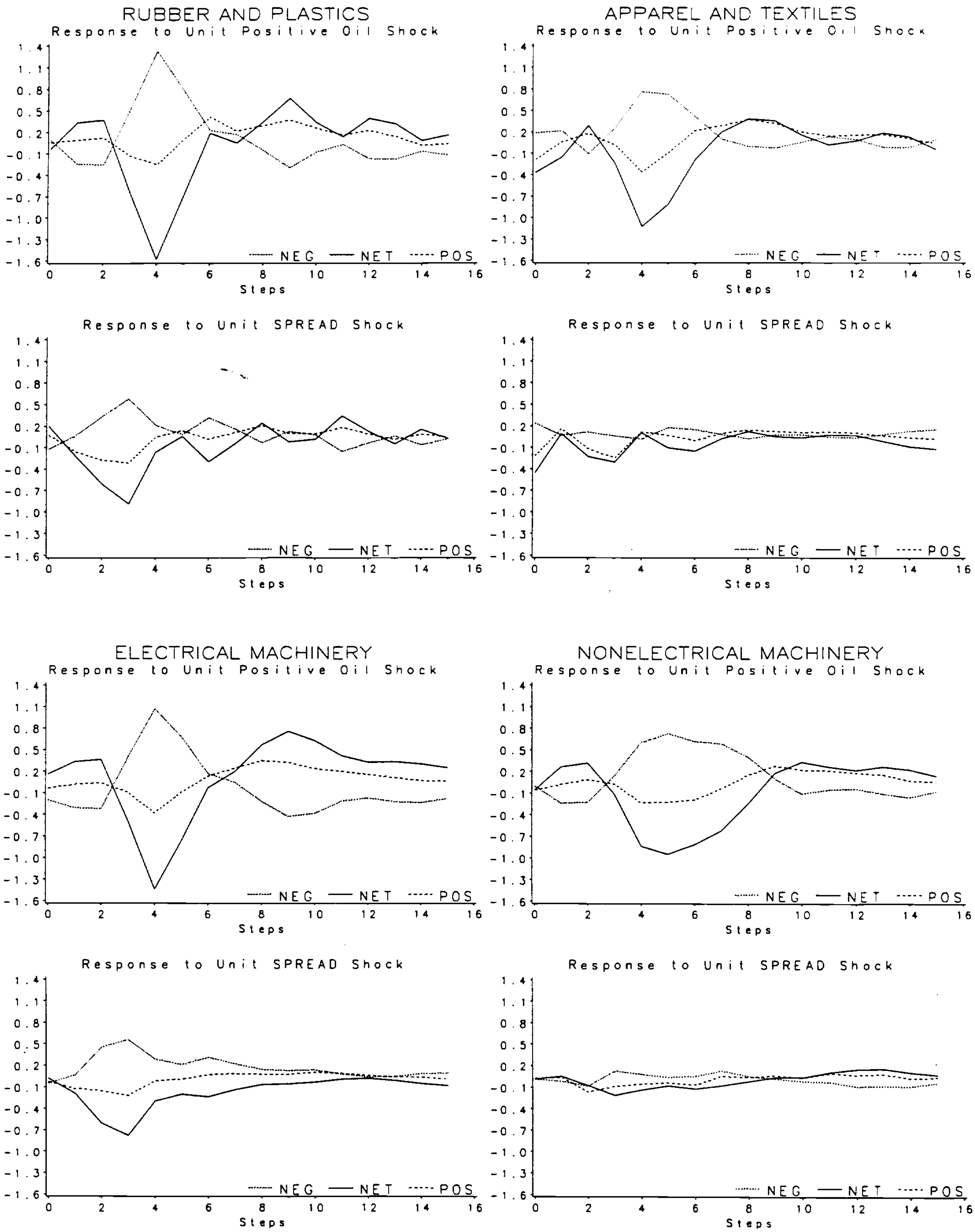


Figure 4 - Impulse Response Functions, Selected Sectors

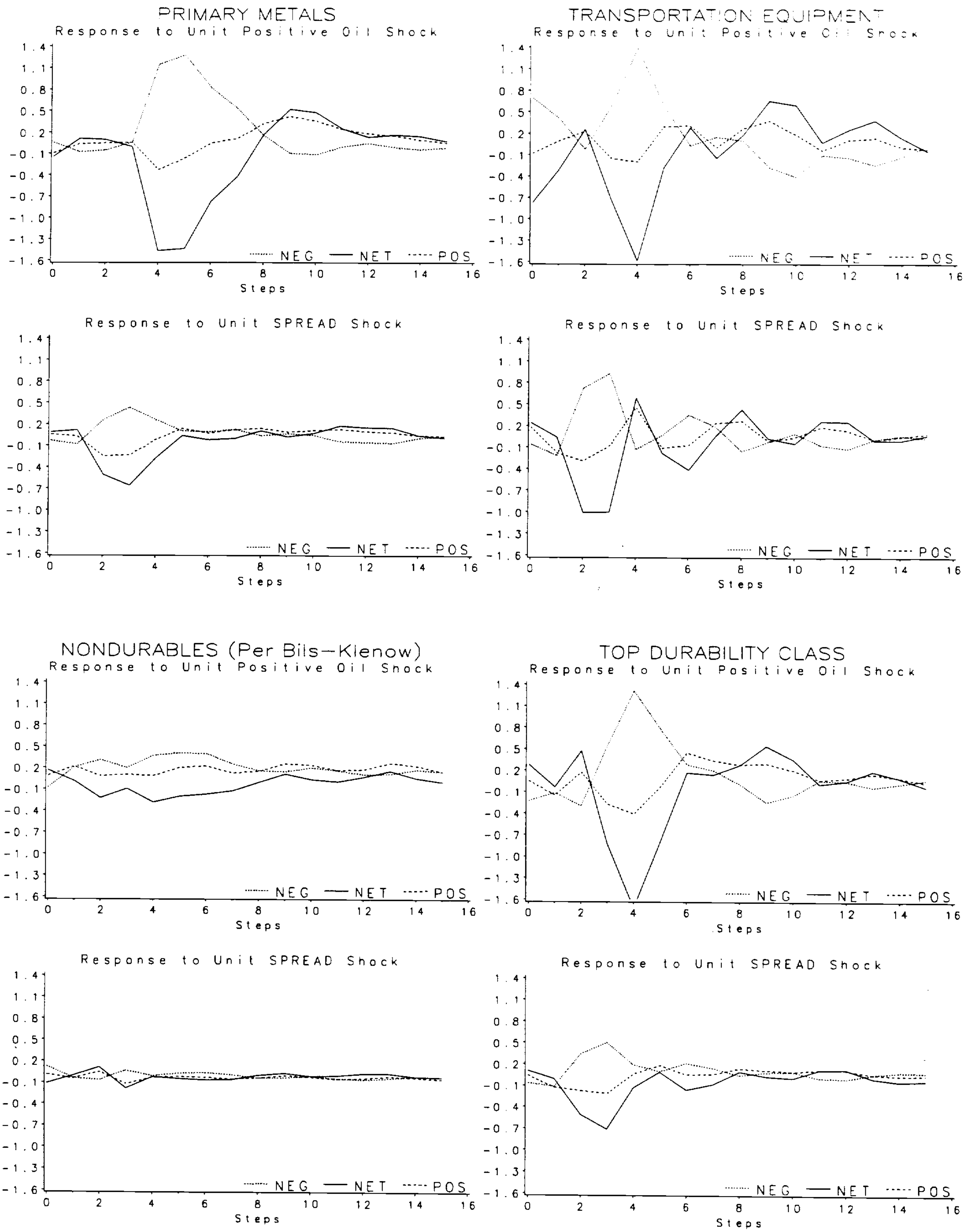


Figure 4 - Impulse Response Functions, Selected Sectors

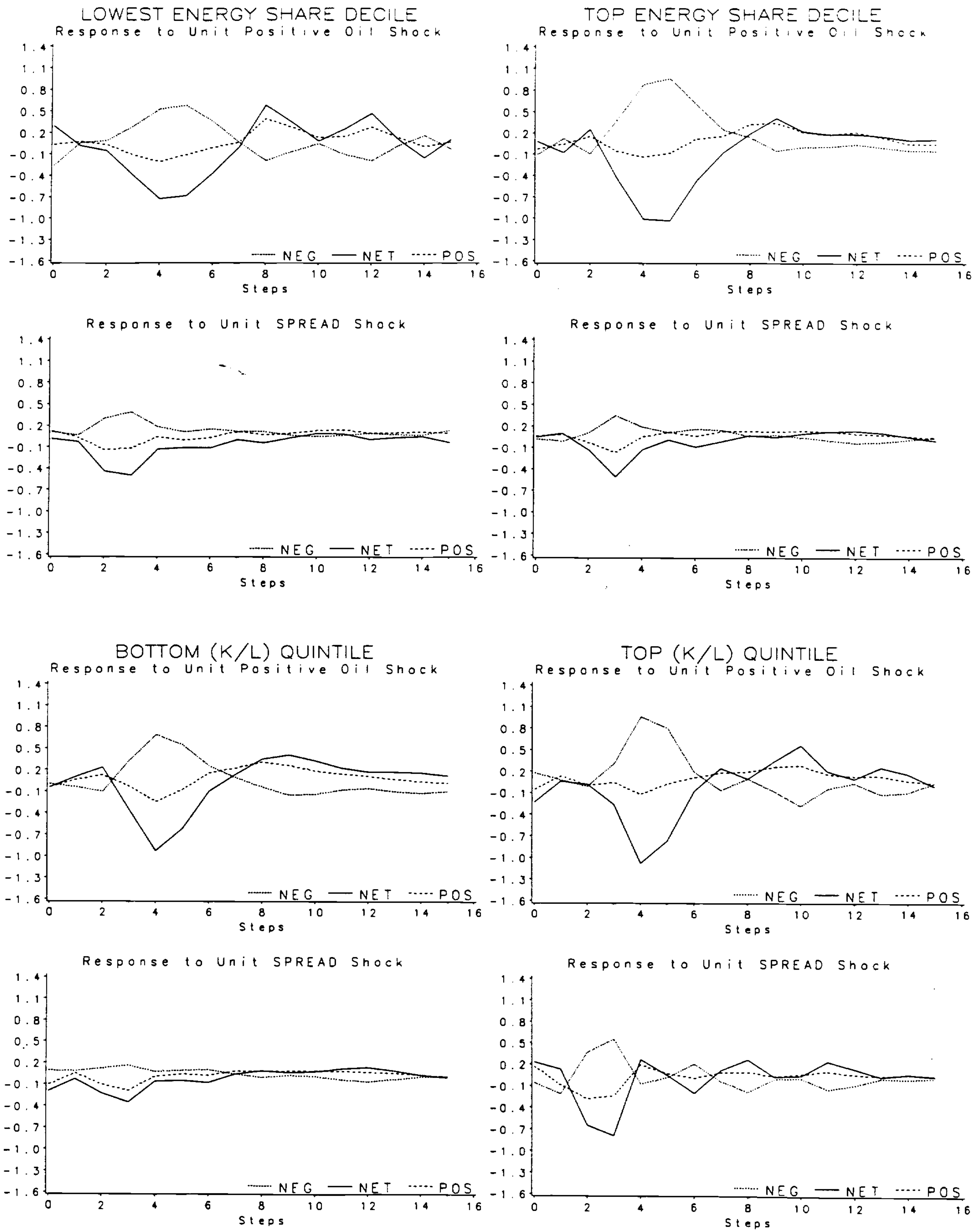


Figure 4 - Impulse Response Functions, Selected Sectors

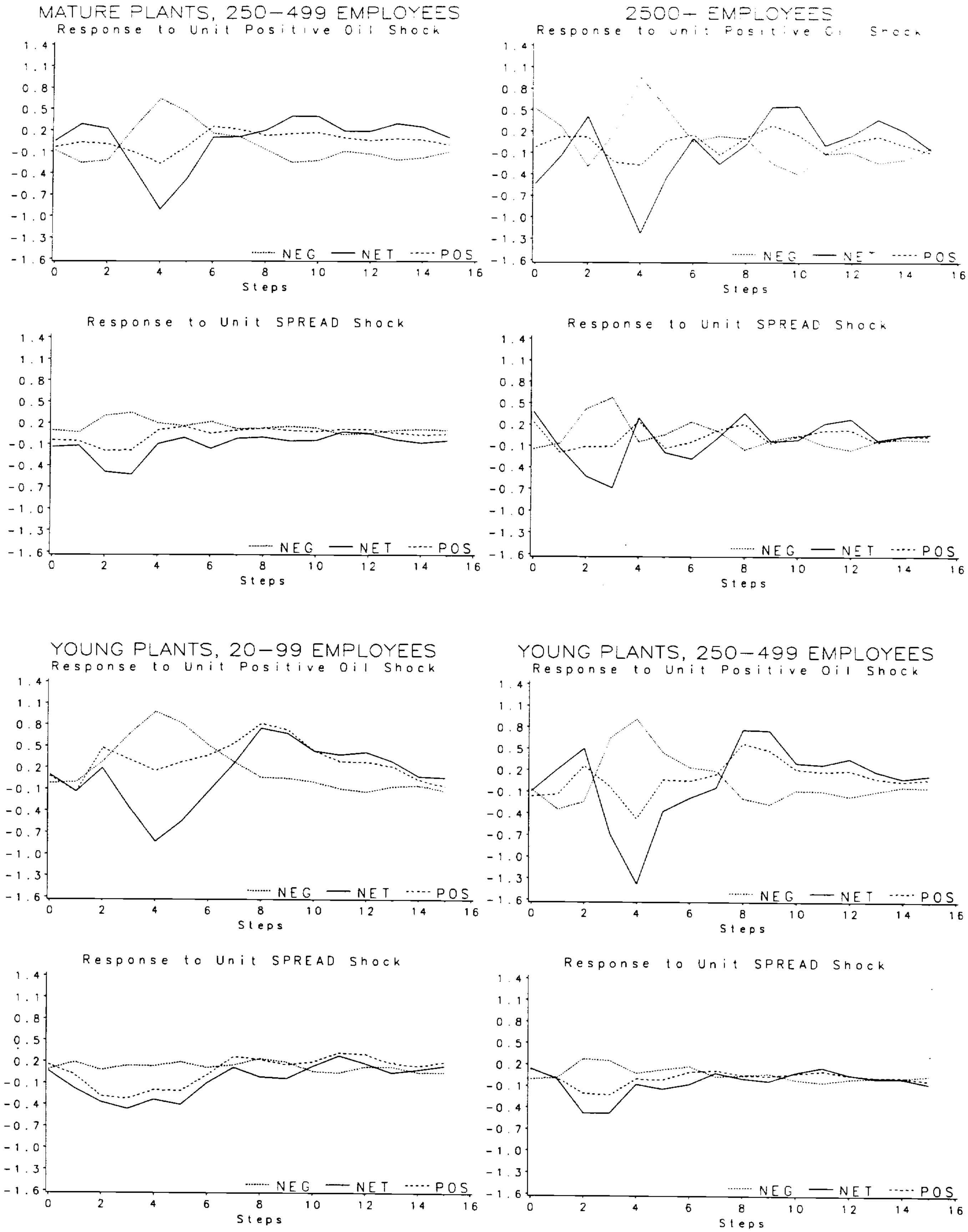
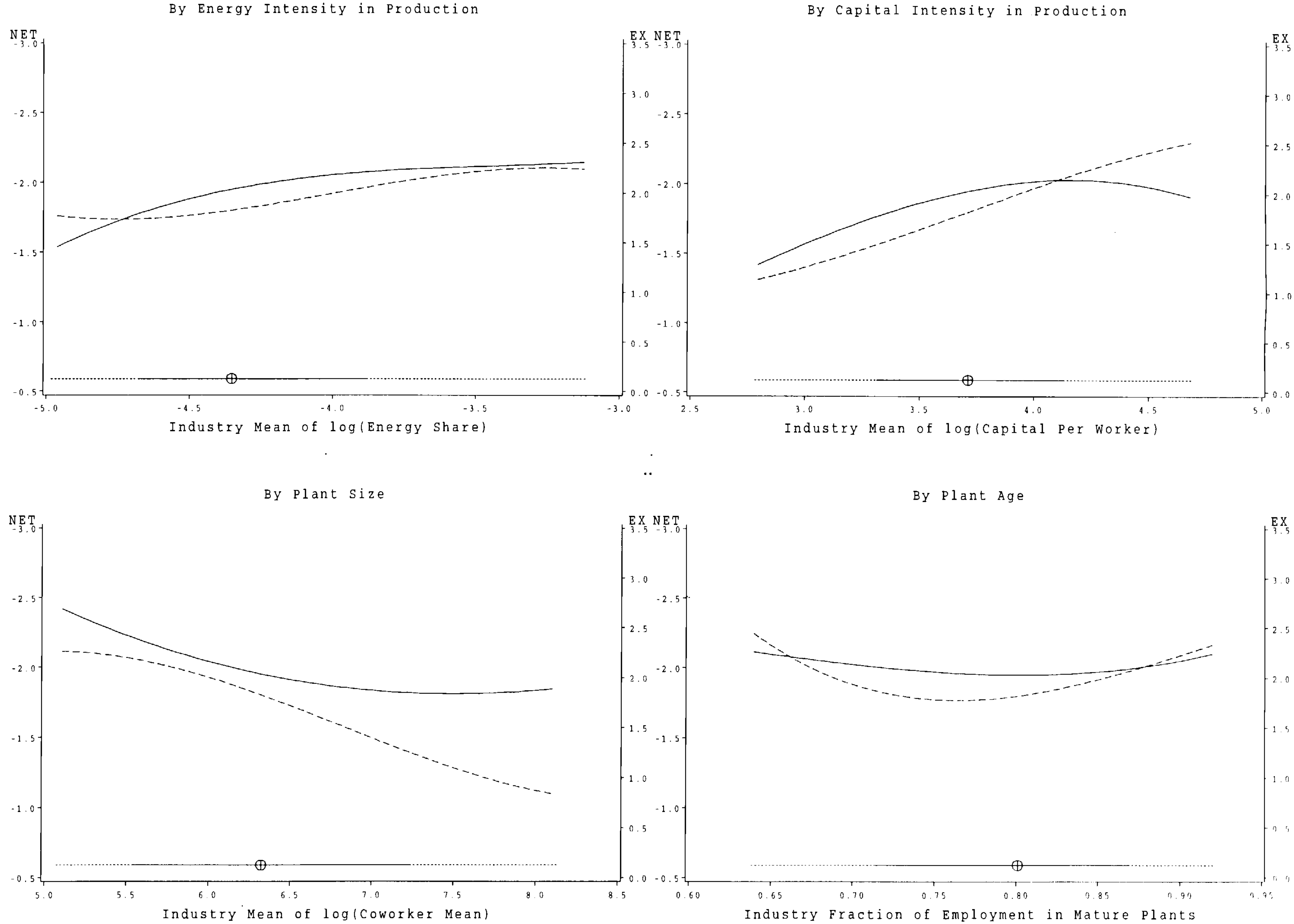
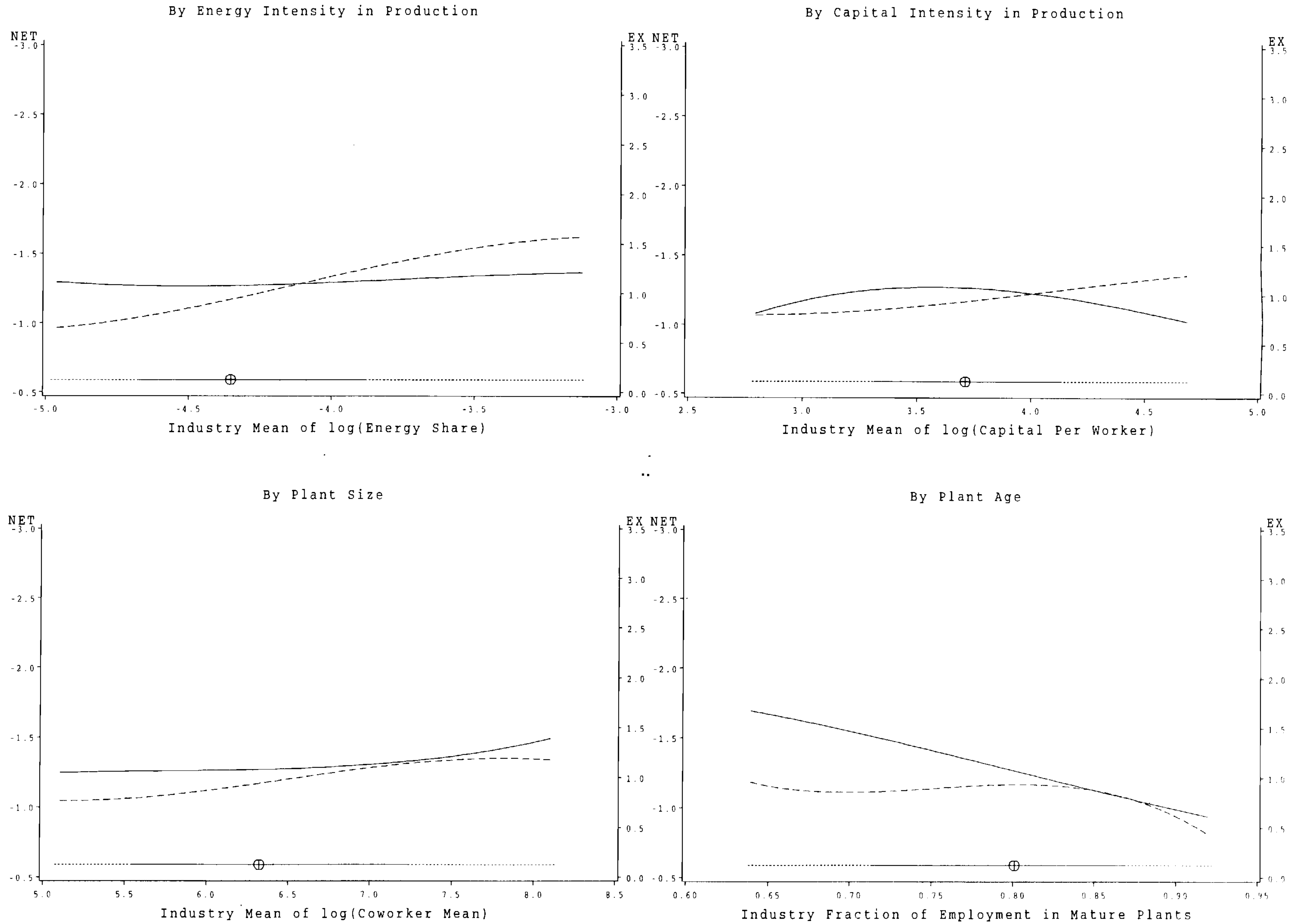


Figure 5(A). Cumulative Response to Unit St. Dev. Positive Oil Shock Net Growth Rate at Step 7 (Solid) and Excess Reallocation Rate at Step 15 (Dashed)



The line atop the horizontal axis shows percentiles 10 25 50 75 and 90. Other regressors are evaluated at medians.

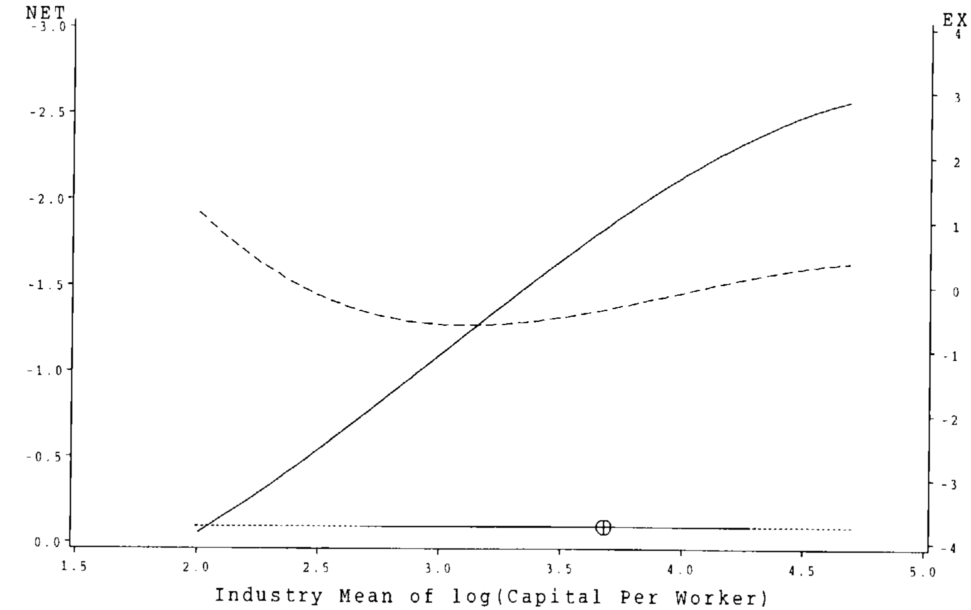
Figure 5(B). Cumulative Response to Unit St. Dev. Positive SPREAD Shock Net Growth Rate at Step 7 (Solid) and Excess Reallocation Rate at Step 15 (Dashed)



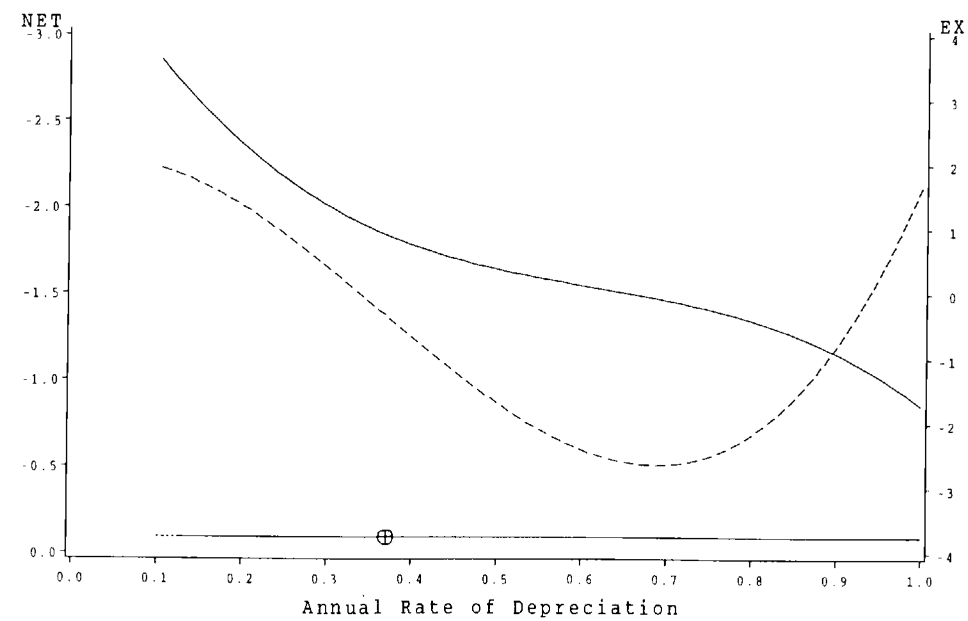
The line atop the horizontal axis shows percentiles 10 25 50 75 and 90. Other regressors are evaluated at medians.

Figure 6. Cumulative Response to Unit St. Dev. Positive Oil Shock

By Capital Intensity in Production



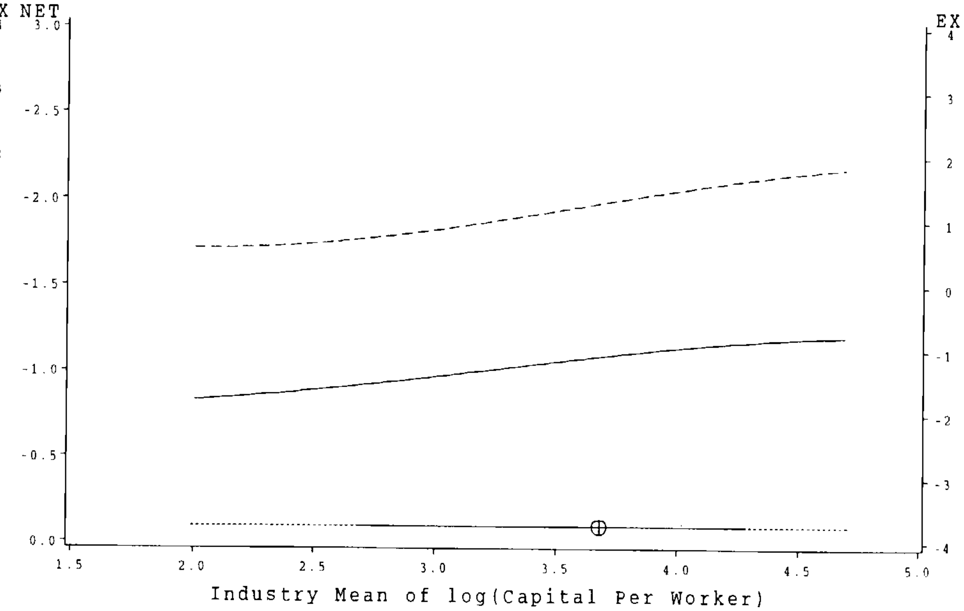
By Durability of Output



Estimated from 106-industry sample containing Bils-Klenow durability measure

Cumulative Response to Unit St. Dev. Positive SPREAD Shock

By Capital Intensity in Production



By Durability of Output