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Abstract

Major shifts in employment between industries and between firms within industries usually accompany recessions. Although this observation suggests that exogenous changes in the optimal allocation of labor are an important source of aggregate employment fluctuations, the macroeconomic significance of such shocks has remained unknown. This paper empirically assesses the role of reallocation shocks for cyclical employment fluctuations, and investigates the relationship between inter- and intrasectoral employment flows. In an analysis of total employment and the share employed in manufacturing, we find that reallocation shocks account for the majority of the variance in employment shares and dispersion, while aggregate shocks' contribution is modest. The two shocks' impact on aggregate employment is sensitive to the identifying assumptions. However, under two of the three methods considered reallocation shocks account for over half of the variance in total employment. Including a measure of reallocation between firms in the manufacturing sector diminishes the effects of the intersectoral reallocation shocks on total and manufacturing employment, largely at the expense of the shocks to intrasectoral allocation. Together, the two reallocation shocks account for roughly half of the variance in total employment growth. We also find that permanent shifts of the employment allocation out of manufacturing depress job creation while increasing job destruction; by contrast, increases in employment reallocation between manufacturing establishments are associated with increases in both creation and destruction.

1 Introduction

The volume of employment flows, both between broadly defined sectors and between establishments within an industry, is large, highly variable, and tends to increase during recessions. Lilien's observation (1982) that the dispersion in sectoral employment growth

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rates could account for much of the variance in the unemployment rate drew attention to the cyclical behavior of reallocation between industries. A great deal of subsequent research has examined the flow of workers between sectors, and the cyclical properties of those flows; see Davis (1987) and Loungani and Rogerson (1989).

More recently, the much larger flow of workers between establishments within the same sector has become the focus of a distinct line of empirical investigation. Using quarterly observations of plant level employment, Davis and Haltiwanger (1990; 1992) showed that the reallocation of jobs within manufacturing is negatively correlated with employment growth in that sector.

The evidence from these and similar studies has received a variety of interpretations. Lilien (1982) and Davis and Haltiwanger (1990; 1992) suggest that job reallocation is countercyclical because exogenous shifts in the optimal allocation of labor, reallocation shocks, cause a considerable fraction of employment variation. In contrast, Abraham and Katz (1986) argue that the countercyclical behavior of employment growth dispersion is an artifact of sectors' differing sensitivities to aggregate fluctuations. The feedback between aggregate and sectoral employment fluctuations makes it hard to disentangle the effects of reallocation shocks, and as a result, the macroeconomic significance of these shocks has remained an open question. This paper addresses that issue by estimating the impact of reallocation shocks on sectoral and total employment under a variety of identifying assumptions.

We begin by considering only intersectoral reallocation shocks. To distinguish these shocks from disturbances of an aggregate nature, we impose alternative identifying assumptions on dynamic time series models of total employment and its distribution across sectors. One identifying assumption puts aggregate employment ahead of manufacturing's employment share in a Wold causal chain, yielding a model in which reallocation shocks do not contemporaneously affect total employment — merely its distribution. Under this identification scheme, reallocation shocks account for a clear majority of changes in manufacturing's employment share, but explain only a small fraction of aggregate employment fluctuations.

This naive identification scheme clearly does violence to the sectoral shifts hypothesis, which views labor reallocation as potentially significant source of contemporaneous disturbances to total employment. We pursue a second approach drawing on Lilien's observation that aggregate employment fluctuations are often associated with permanent changes in the allocation of labor across sectors. This suggests an identification scheme in which reallocation shocks alone account for the stochastic trend in manufacturing's employment share, analogous to the long-run restrictions used by Blanchard and Quah (1989) and King and Watson (1993). Under this assumption, reallocation shocks account for nearly all of the variance in manufacturing's employment share and almost half of the variance in total employment.

Our third approach to estimating the effects of reallocation shocks relies on changes in the price of crude petroleum. Assuming, in the spirit of Loungani (1986), that changes in the oil price affect aggregate employment to the extent that they generate employment reallocation allows us to identify the model without reliance on purely time series restrictions. The results obtained under this assumption are highly consistent with those from the model identified via the long-run restriction: aggregate shocks have an insignificant effect on manufacturing's employment share in the long run, and reallocation shocks account for roughly half of the variance in total employment.

The empirical results of the first section, which focus exclusively on the distribution of employment across sectors, appear to support the idea that intersectoral reallocation shocks play an important role in aggregate employment fluctuations. They do not, however, account for the countercyclical variation of *intra*sectoral reallocation. Some of the shocks responsible for shifts in the allocation of labor across sectors may also lead to changes in its distribution between firms within an industry.

The U.S. steel industry provides an example of this phenomenon. After 1980, its total employment fell dramatically; at the same time, production shifted from large scale integrated mills to smaller mini-mills. If the steel industry's experience is representative of other sectors', the countercyclical employment reallocation within industries may merely be a symptom of changes in the sectoral job allocation. However, shocks which affect the allocation of labor within a sector, but leave the sectoral composition unchanged, may be also be an important source of employment variation.

To assess the importance of intrasectoral reallocation shocks, we include Davis and Haltiwanger's (1990; 1992) measure of gross employment flows within the manufacturing sector in our analysis. The first model puts intrasectoral job reallocation last in the Wold causal ordering, preventing intrasectoral shocks from contemporaneously affecting either total employment or its sectoral allocation. This change does not substantially change our earlier results. The second model constrains intrasectoral shocks from permanently affecting total employment or its sectoral allocation. In this case, we find that intersectoral reallocation shocks account for much less employment variance than when the analogous restrictions were imposed on the model without the gross flow measure: intersectoral and intrasectoral reallocation shocks respectively account for 9% and 46% of total employment variance.

The model containing measures of both intra- and intersectoral employment flows also allows us to examine the interaction between the two types of reallocation. Shocks that permanently reduce manufacturing's share of employment have only modest effects on the flow of workers within the manufacturing sector: job creation falls and job destruction rises, leaving their sum, the measure of reallocation, relatively unchanged. In contrast, reallocation shocks increase both job creation and job destruction. Their effect on job destruction is larger than for creation, however, resulting in a temporary employment contraction.

2 Intersectoral reallocation

The movement of workers between different sectors in the economy is one important dimension of labor reallocation. A growing body of theoretical research attempts to model mechanisms in which moving workers between sectors generates aggregate fluctuations; see, for example, Hamilton (1988b), Greenwood, MacDonald, and Zhang (1996), and Phelan and Trejos (1995). Empirical work, starting with Lilien (1982) has convincingly documented a correlation between measures of reallocation and aggregate employment. However, assessing the macroeconomic effects of reallocation raises an important identification issue: does reallocation generate aggregate employment fluctuations, or does the causality run in the other direction?

After an initial description of the data, this section takes up the identification question and assesses the role of reallocation shocks under three distinct identification schemes. In our preferred specification, in which reallocation shocks are responsible for persistent shifts in employment shares, these shocks account for roughly half of the variance in total employment. A model identified via oil shocks yields similar results. The contribution of reallocation shocks is much smaller in "atheoretical" system identified from a short-run restriction on the relationship between aggregate and sectoral employment fluctuations. Nonetheless, even under this implausible restriction, reallocation shocks account for over one quarter of total employment fluctuations in a model that includes seven sectors' employment shares.

2.1 Description of the data

Figure 1 plots the evolution of employment shares in the U.S. for ten 1-digit industries, calculated from payroll employment data. The distinct trends in most industries' shares are evidence of a great deal of secular reallocation, which has significantly altered the composition of employment over the past 40 years. The change has been especially pronounced in manufacturing, where the combined shares of durable and nondurable manufacturing fell from nearly 35 percent in 1954 to 17 percent in 1994. The service sector absorbed much of manufacturing's loss, with its share of employment rising from 12 to 27 percent over the same period.

Figure 1 also shows that employment shares do not evolve smoothly; instead, industries' relative growth rates vary a great deal through time. To describe this phenomenon, Lilien (1982) proposed using a dispersion index based on the share-weighted squared differences between sector i's employment growth, $\Delta \ln N_{i,t}$, and total employment growth, $\Delta \ln N_t$,

$$\hat{\sigma}_t = \left[\sum_i \frac{N_{i,t-1}}{N_{t-1}} (\Delta \ln N_{i,t} - \Delta \ln N_t)^2 \right]^{0.5} ,$$

as a measure of intersectoral labor reallocation. Versions of Lilien's dispersion index have been widely used to proxy for the effects of employment reallocation on the unemployment rate; examples are Davis (1987), Neumann and Topel (1991), and Rissman (1993). Versions of $\hat{\sigma}_t$ based on 24-month centered moving averages of employment growth appear in figure 2. The solid line plots the dispersion index based on one-digit SIC code disaggregation, and the dashed line plots an index based on a two-sector breakdown between manufacturing and nonmanufacturing.

Much of the variation in employment shares visible in figure 1 occurs in and around recessions, marked by the shaded areas. These changes in employment shares also impart a cyclical pattern to the dispersion of employment growth, as originally documented by Lilien (1982). It was this cyclical behavior, and specifically dispersion's correlation with the unemployment rate, that generated interest in sectoral shocks as a potential source of aggregate fluctuations.

The similarity of the two-sector dispersion index to the more finely disaggregated 1-digit version shows that shifts between manufacturing and nonmanufacturing employment account for most of the cyclical variation in employment growth dispersion. This is to be expected, since manufacturing industries typically suffer the largest absolute employment declines during recessions. To simplify matters, therefore, most the empirical work in the paper deals with reallocation between manufacturing and nonmanufacturing employment.

Figure 1: **Employment shares in one-digit industries**

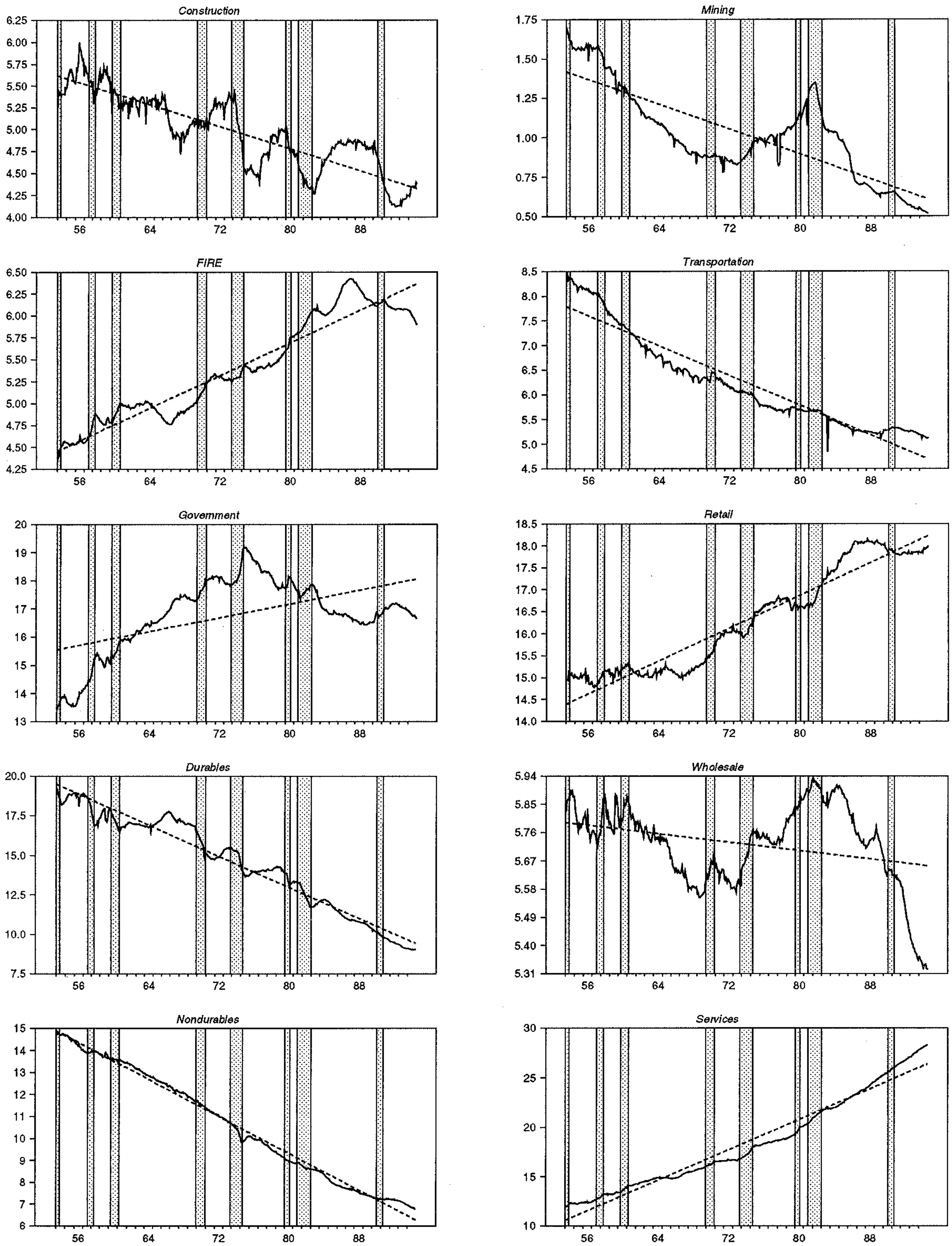


Figure 2: **Dispersion indices, ten- and two-sector**

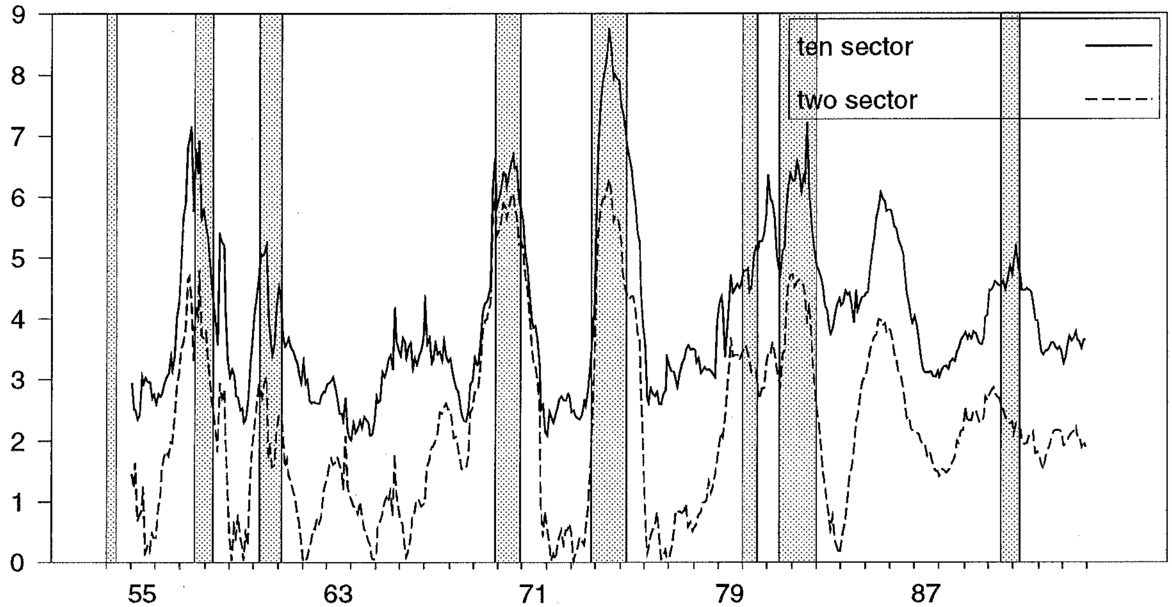


Table 1: **Unit root tests for log labor shares**

Industry	ADF $\hat{\tau}^{\tau}$ t-statistics	95 % Confidence intervals for largest AR root	
Manufacturing	−3.17	0.94	1.01
Durable	−2.01	0.97	1.01
Nondurable	−2.10	0.97	1.01
Nonmanufacturing			
Construction	−3.75	0.92	0.99
FIRE	−1.34	0.99	1.01
Mining	−1.02	0.99	1.01
Transportation	−1.50	0.99	1.01
Wholesale	−0.46	1.00	1.01
Retail	−2.58	0.96	1.01
Government	−1.77	0.98	1.01
Services	−1.73	0.98	1.01

Notes: The regressions are estimated with 12 lags on monthly data from 1955:2 through 1994:12. Confidence intervals are from Stock (1991).

A more subtle feature of industries' employment shares is that most appear to be subject to infrequent, highly persistent shifts. The unit root tests reported in table 1 confirm this impression; with the exception of construction, the confidence intervals for the largest autoregressive root include unity. As noted by Lilien and carefully documented by Loungani and Rogerson (1989), these permanent shifts are often associated with recessions. In the case of durable manufacturing, for example, recessions are often associated with permanent reductions in its employment share. This stairstep-like pattern is typically even more pronounced at finer (e.g., two-digit) levels of disaggregation. Other sectors, retail and wholesale trade, for example, enjoy what look like permanent increases in their employment shares during some recessions.

2.2 Identifying intersectoral reallocation shocks

Any attempt to assess the empirical importance of labor reallocation must confront the problem of distinguishing reallocation shocks from purely aggregate disturbances. As Abraham and Katz (1986) noted, differences in industries' sensitivities to aggregate fluctuations will induce variation in industries' labor shares, and potentially account for the correlation between dispersion and the unemployment rate documented by Lilien (1982). Neumann and Topel's (1991) proposed solution was to use a low-pass filter to isolate persistent changes in sectors' employment shares, and they used the dispersion index calculated from these long-run shifts as a proxy for intersectoral reallocation. Rissman (1993) adopted a similar procedure in assessing the effect of reallocation on the natural rate of unemployment.

Our approach differs from the dispersion literature in several important respects. First, instead of using dispersion as a summary measure of reallocation, it models the relationship between aggregate and sectoral employment explicitly using dynamic time series models. This allows us to be precise about the assumptions used to distinguish reallocation from aggregate shocks, and to examine the results' sensitivity to alternative identifying assumptions. Furthermore, in contrast to Neumann and Topel's method, our multivariate approach exploits information in the covariation between sectors' employment shares and aggregate employment.[1]

As indicated by the unit root tests in table 1, log employment shares are treated as difference-stationary, providing a convenient way to model persistent sectoral shifts. Let-

[1] A more subtle distinction is that the dispersion approach, both positive *and* negative shocks to a sector depress aggregate employment growth by generating labor reallocation. In our framework, the response of employment is symmetric; if a negative shock to an industry decreases aggregate employment growth, a positive shock will increase it.

ting n_t represent the logarithm of total employment and w_t represent the logarithm of manufacturing's employment share, we model the relationship between Δn and Δw using a vector autoregression (VAR),

$$\begin{bmatrix} \Delta n_t \\ \Delta w_t \end{bmatrix} = \begin{bmatrix} 0 & \lambda_{nw} \\ \lambda_{wn} & 0 \end{bmatrix} \begin{bmatrix} \Delta n_t \\ \Delta w_t \end{bmatrix} + \begin{bmatrix} A_{nn}(L) & A_{nw}(L) \\ A_{wn}(L) & A_{ww}(L) \end{bmatrix} \begin{bmatrix} \Delta n_{t-1} \\ \Delta w_{t-1} \end{bmatrix} + \begin{bmatrix} u_t \\ v_t \end{bmatrix}, \quad (1)$$

where u_t and v_t are mutually and serially uncorrelated aggregate and reallocation shocks.[2]

The λ_{wn} and λ_{nw} coefficients capture the contemporaneous effects of aggregate and sectoral shocks on manufacturing's employment share and total employment, respectively. To measure the persistent effects of the two shocks, we will also examine the long-run multipliers: γ_{nw}, defined as

$$\gamma_{nw} = \frac{\lambda_{nw} + A_{nw}(1)}{1 - A_{nn}(1)} ,$$

is the long-run response of total employment to a reallocation shock that generates a permanent increase of 1% in manufacturing's employment share. The long-run response of manufacturing's employment share to aggregate shocks, γ_{wn}, is defined analogously.

Having already assumed the shocks to be orthogonal to one another, equation 1 requires one additional assumption for identification. One possibility is just to set $\lambda_{nw} = 0$, yielding a short-run "triangular" model with total employment ordered ahead of manufacturing's share.[3] Reallocation shocks extracted from this model are changes in manufacturing's share that are uncorrelated with total employment growth. While this may seem like a plausible practical definition, its assumption that reallocation shocks do not affect total employment contemporaneously runs counter to the spirit of the sectoral shifts hypothesis. We present results from this model in order to provide a lower bound on the importance of reallocation shocks, and to illustrate the sensitivity of the results to the identifying assumptions.

A more defensible assumption is that aggregate shocks have no long-run effect on manufacturing's share, i.e., $\gamma_{wn} = 0$. Aggregate shocks identified in this manner capture only those factors that affect employment in each industry proportionally in the long run.[4] Under plausible restrictions, monetary policy, shifts in labor supply, and neutral technology shocks as in Greenwood MacDonald and Zhang (1996) match this description. In our model, as in Trejos and Phelan (1995), reallocation shocks account for the stochastic trends in employment shares. The advantage of this scheme is that both impact multipliers can be estimated,

[2]The model is equivalent to one expressed in terms of the growth rate of total and manufacturing employment.

[3]This is equivalent to a Choleski decomposition of the covariance matrix of VAR residuals.

[4]This assumption is not entirely innocuous, however. Theories of "reallocation timing" suggest that transitory, aggregate shocks may associated with permanent changes in industries' sizes.

which allows richer short-run dynamics between sectoral and aggregate employment.

The disadvantage of these schemes is that both rely heavily on the time series properties of the two series for identification. Moreover, because they are just-identified models, both fit the data equally well. We therefore pursue a third identification scheme that amounts to using oil shocks to instrument for the contemporaneous change in manufacturing's employment share.

Oil shocks are included in the analysis by augmenting equation 1 with the change in the price of crude petroleum, Δz_t,

$$\begin{bmatrix} \Delta z_t \\ \Delta n_t \\ \Delta w_t \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & \lambda_{nw} \\ \lambda_{wz} & \lambda_{wn} & 0 \end{bmatrix} \begin{bmatrix} \Delta z_t \\ \Delta n_t \\ \Delta w_t \end{bmatrix} + \begin{bmatrix} A_{zz}(L) & A_{zn}(L) & A_{zw}(L) \\ A_{nz}(L) & A_{nn}(L) & A_{nw}(L) \\ A_{wz}(L) & A_{wn}(L) & A_{ww}(L) \end{bmatrix} \begin{bmatrix} \Delta z_{t-1} \\ \Delta n_{t-1} \\ \Delta w_{t-1} \end{bmatrix} + \begin{bmatrix} e_t \\ u_t \\ v_t \end{bmatrix}, \qquad (2)$$

where the oil shock, e_t, is orthogonal to the other two disturbances. Excluding Δz_t from the equation for Δn_t says that oil price fluctuations affect total employment only to the extent that they generate reallocation between sectors, a hypothesis advanced by Loungani (1986).[5] This restriction exactly identifies the model without imposing any restrictions on the multipliers relating aggregate and sectoral employment, and allows oil price shocks to be used as instruments for the t-dated change in manufacturing share in the employment equation.

Besides this key identifying assumption, we impose two additional restrictions on equation 2. First, because oil price shocks' contemporaneous impact on employment is very small, we set $A_{nz}(L) = 0$, allowing us to use lagged values of oil shocks as additional instruments. Second, like Hamilton (1983), we find that oil prices are not Granger-caused by either employment at conventional significance levels. Consequently, we set $A_{zn}(L) = A_{zw}(L) = 0$.[6]

2.3 Results: two sector

The instrumental variables procedure described in King and Watson (1993) was used to estimate equation 1 under the $\lambda_{nw} = 0$ and $\gamma_{wn} = 0$ assumptions. The model was estimated

[5] By contrast, Hamilton's (1988b; 1988a) view is that oil shocks affect the economy primarily through aggregate demand.

[6] These restrictions yield a model which is not, strictly speaking, a VAR.

on monthly data from 1955:12 through 1994:12, with 12 lags on each variable.[7]

The first line of table 2 reports the estimated short- and long-run multipliers from the model in which reallocation shocks have no contemporaneous effect on total employment. Aggregate shocks' estimated impact on manufacturing's share is large: a shock that increases total employment by 1% generates a 0.8% increase in manufacturing's share (that is, a 1.8% increase in manufacturing employment). The long-run effect of the aggregate shock are also large and statistically significant. The estimated γ_{wn} implies that a shock that permanently increases total employment by 1% also raises manufacturing's share by 0.6%. By contrast, manufacturing shocks have virtually no long-run effect on aggregate employment under this identification scheme.

Not surprisingly, the short-run triangular system attributes relatively little variance in total employment to the sectoral reallocation shocks. As reported in the first two lines of table 3, reallocation shocks account for only 6% of the variance in employment growth.[8] Even so, 59% of the variance in manufacturing's share is assigned to the manufacturing shock; the aggregate shock accounts for the remaining 41%. Thus, even under the identifying assumption most hostile to reallocation shocks, intersectoral reallocation is the primary source of shifts in manufacturing's employment share.

Figure 3 displays decompositions of the two variables' fluctuations into the portions attributable to aggregate and sectoral shocks. The top two panels are from the short-run recursive decomposition. This confirms the variance decomposition results: manufacturing shocks' contributions to aggregate employment are minor. Although aggregate shocks are responsible for some of the "cyclical-looking" fluctuations in manufacturing's share, manufacturing shocks account for a fair amount of the variation in and around recessions, as well most of the low-frequency movements.

A very different picture emerges when aggregate shocks are constrained to have no long-run impact on manufacturing's employment share, as reported on the third and fourth lines of table 2. Now, the estimates of λ_{nw} and γ_{nw} indicate very large effects of reallocation shocks on total employment in short- and long run. A 1% positive shock to manufacturing's share increases total employment by 0.5% within the month, and a permanent 1% shock

[7] Mining employment, which had shrunk to less than half of one percent of total employment, was excluded from the analysis.

[8] A Monte-Carlo procedure was employed to construct the confidence intervals around the impulse variance decompositions. Each estimated VAR was simulated, drawing disturbances from the residuals' empirical distribution. The VAR was then reestimated using the simulated data. The procedure was repeated 1000 times, tabulating the variance decompositions from each simulation. The standard errors are then computed from this distribution.

Table 2: **Estimated multipliers from two-sector models**

Identification scheme	Estimated multipliers: Short-run λ_{wn}	Short-run λ_{nw}	Long-run γ_{wn}	Long-run γ_{nw}
Short-run: $\lambda_{nw} = 0$	0.80	0	0.56	−0.24
	(0.06)		(0.13)	(0.41)
Long-run: $\gamma_{wn} = 0$	−0.45	0.50	0	0.78
	(0.60)	(0.15)		(0.29)
Oil shock	−0.30	0.40	−0.28	0.73
	(0.14)	(0.13)	(0.48)	(0.20)

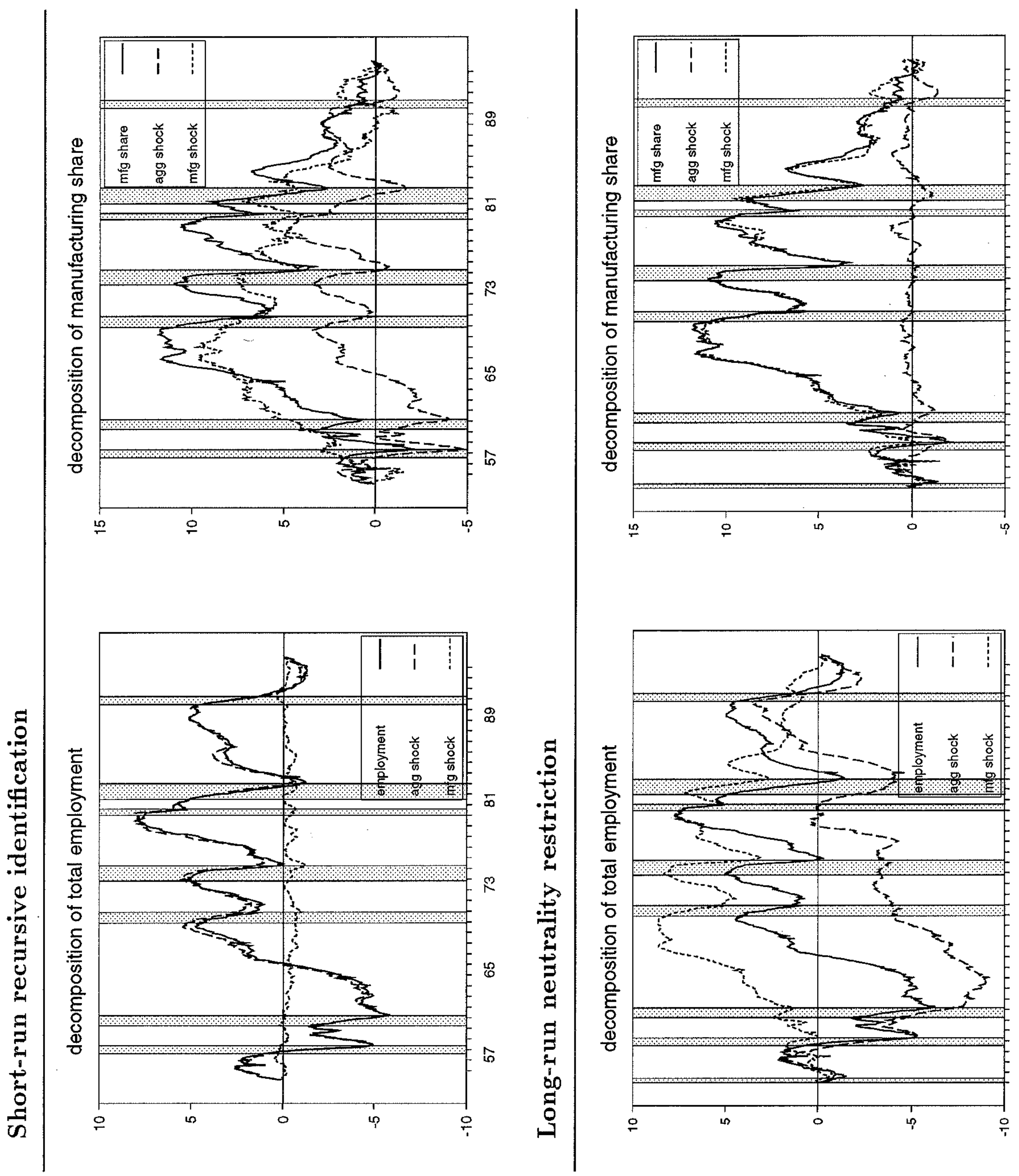
Notes: The regressions are estimated with 12 lags on monthly data from 55:2 through 94:12 (60:2 through 85:12 for the oil shock system) using the instrumental variables procedure in King and Watson (1993). Standard errors are in parentheses; those for the γ coefficients are computed via the delta method.

Table 3: **Variance decompositions from two-sector models**

Identification scheme	Shock	Variance share, 24-month horizon (%): Total empl.		Mfg. share		Mfg. empl.	
Short-run: $\lambda_{nw} = 0$	Reallocation	6	(2)	59	(4)	25	(3)
	Aggregate	94		41		75	
Long-run: $\gamma_{wn} = 0$	Reallocation	51	(18)	92	(8)	88	(10)
	Aggregate	49		8		12	
Oil shock	Oil	10	(5)	14	(6)	15	(6)
	Reallocation	43	(23)	80	(23)	77	(26)
	Aggregate	47	(23)	6	(23)	8	(26)

Notes: Parentheses contain standard errors computed via monte-carlo with 1000 draws. See also notes to table 2.

Figure 3: **Historical decompositions from two-sector models**



raises total employment by almost 0.8% in the long run.

The variance decompositions in the third and fourth lines of table 3 reflect reallocation shocks' prominent role under the long-run $\gamma_{wn} = 0$ restriction. Reallocation shocks now account for just over half of the variance of total employment, and nearly all of the variance in manufacturing's share. Aggregate shocks now contribute only 8% to the variance of the share (and slightly more to that sector's employment growth). The historical decompositions plotted in the lower two panels of figure 3 graphically illustrate reallocation shocks' contribution.

The final two rows of table 2 report the estimated multipliers from the model identified assuming oil shocks affect the economy through their reallocative effects. Twelve lags of the oil price were included, and the price used was the Producer Price Index (PPI) for crude petroleum deflated by the overall PPI.[9] The incorporation of oil prices raises a further empirical issue. As Hooker (1995) showed, the relationship between oil prices and economic activity documented by Hamilton (1983) disintegrated after the collapse of oil prices in early 1986, a development Hamilton (1995) attributed to a sharp increase in the volatility of oil prices.[10] This paper finesses the issues raised by these findings by limiting the oil shock analysis to the pre-1986 period.

The estimated multipliers from the oil shock system are very similar to those obtained earlier under the long-run restriction over the longer sample. In particular, the estimated γ_{wn}, which describes long-run effect of aggregate shocks on manufacturing's employment share is statistically insignificant, providing independent support for the long-run identifying assumption. Reallocation shocks' long run effects are large: a shock generating 1% permanent increase in manufacturing's share leads to a 0.7% increase in aggregate employment. The variance decompositions reported in table 3 are also similar to those from the $\gamma_{wn} = 0$ model, with reallocation and oil shocks together accounting for over half of the variance of total employment.[11]

2.4 Results: seven sector

Analyzing only shifts in employment between manufacturing and nonmanufacturing sectors clearly misses a great deal of the intersectoral reallocation. To see whether the results change with a slightly finer level of disaggregation, we also estimated a seven-sector version

[9] The results were not sensitive to the choice of deflator.

[10] In the same paper, Hamilton argued that applying a nonlinear filter to oil prices changes to remove the volatility restores the pre-1985 relationship.

[11] Interestingly, oil shocks affect employment with a very long lag; their full impact isn't felt for 18 to 24 months.

Table 4: **Variance decompositions from seven-sector models**

Identification scheme	Sector	Aggregate shocks' contribution to variance, 12-month horizon (%)			
		Growth		Share	
Short-run	Total employment	73	(4)		
	Sectoral employment				
	Manufacturing	59	(4)	35	(2)
	Construction	28	(3)	17	(3)
	FIRE	15	(5)	48	(4)
	Transportation	13	(2)	3	(1)
	Trade	29	(4)	17	(3)
	Government	70	(4)	27	(4)
Long-run	Total employment	18	(10)		
	Sectoral employment				
	Manufacturing	6	(4)	9	(6)
	Construction	8	(6)	7	(5)
	FIRE	13	(8)	13	(7)
	Transportation	7	(5)	7	(4)
	Trade	8	(5)	15	(9)
	Government	10	(6)	24	(11)

Notes: Parentheses contain standard errors computed via monte-carlo. The regressions include a dummy variable for the August 1983 strike in the transportation sector. See also notes to tables 2 and 3.

of equation 1 by augmenting the model to include five other employment shares: construction; fire, insurance and real estate (FIRE); transportation; wholesale and retail trade; and government. Services is the residual sector.[12] The model is again estimated under both the short-run and long-run identification schemes.[13] When we include these extra sectors, we find that reallocation shocks account for even more of the variance of total employment than in the two-sector results.

Variance decomposition results from the extended model appear in table 4. Aggregate

[12] As in the earlier work, mining employment is excluded.

[13] In the absence of a natural ordering, the sectoral shocks are left unorthogonalized, and we do not report the effects of shocks to individual sectors.

shocks now account for only 73% of overall employment fluctuations, compared with 94% in the two-sector model; the remaining 27% of the total represents the combined effects of the sectoral shocks. Aggregate shocks generally account for a moderate amount of variation in most other sectors' employment shares; manufacturing growth, not surprisingly, is especially sensitive. Reallocation shocks' contribution is larger still under the assumption that aggregate shocks leave shares unchanged in the long run. Now, aggregate shocks account for only 18% of total employment, leaving the remaining 92% for the effects of reallocation. In this model, fluctuations in individual sectors' employment shares are almost entirely the result of reallocation shocks.

2.5 Summary

How important are intersectoral reallocation shocks for overall employment fluctuations? The variance decompositions reported above vary widely, and depend on the assumptions used to distinguish their effects from aggregate shocks'. The smallest effects are found in models in which reallocation shocks are implausibly constrained to have no contemporaneous effects on total employment. When reallocation shocks are defined as those shocks responsible for persistent shifts in employment shares, they account for over half of the variance in total employment in the two-sector breakdown. A distinct identification scheme using oil shocks as instruments yields similar results. Moving to a more disaggregated industry breakdown increases the significance of reallocation shocks; even under the short-run triangular identification scheme, they account for over one-fourth of aggregate employment variance.

3 Intrasectoral reallocation

Focusing exclusively on the reallocation of labor between sectors ignores a much larger flow of workers between establishments in the same industry. Using census year employment observations from the longitudinal research dataset, Dunne, Roberts, and Samuelson (1989) documented the tremendous heterogeneity of establishment growth within manufacturing industries: at any given time, many establishments are hiring workers while many others are letting them go. This heterogeneity persists whether the industry's total employment is increasing or decreasing.

Using quarterly observations from the Annual Survey of Manufacturing panel, Davis and Haltiwanger (1990; 1992) found that within-industry employment reallocation dwarfs industries' net employment change. From the second quarter of 1972 through the last quarter of 1988, manufacturing employment decreased by an average of 0.3% per quarter. This decrease was achieved by destroying an average of 5.5% of the positions in manufacturing each quarter, and creating new positions at different establishments at the rate of 5.2% per quarter. They also showed that the pace of within-industry reallocation is both volatile and highly countercyclical. Their measure of intra-industry reallocation, the sum of positions created and positions destroyed divided by manufacturing employment (SUM), has a standard deviation of 1.6%, and has a correlation with net employment growth of -0.57%[14].

Together, the cyclicality of within-industry labor reallocation and the influence of sectoral shocks on total employment raises the question of whether shocks to the allocation of labor across industries is an important source of cyclical fluctuations. The observed countercyclical behavior of SUM is suggestive, but inconclusive: as the shift from integrated to mini-mills in the U.S. steel industry illustrates, shocks affecting the sectoral allocation of employment can also affect its allocation across establishments.

3.1 The data

The use of SUM introduces two new data issues. First, the availability of the gross flow data used to construct SUM is limited to quarterly observations covering the 1972Q2 through 1988Q4 period. Furthermore, the series' timing is nonstandard: the first quarter of each year begins in November of the previous year.[15] To construct comparable measures of sectoral and total employment growth, therefore, we aggregate the monthly data to match the timing of the data underlying SUM.

The countercyclicality (and large volume of) of within-manufacturing reallocation size is clearly visible in figure 4, which plots the three series used in the analysis below. The three major recessions in the sample were associated with peaks in SUM. Fluctuations in SUM since 1985 seem largely unrelated to net employment changes, however.

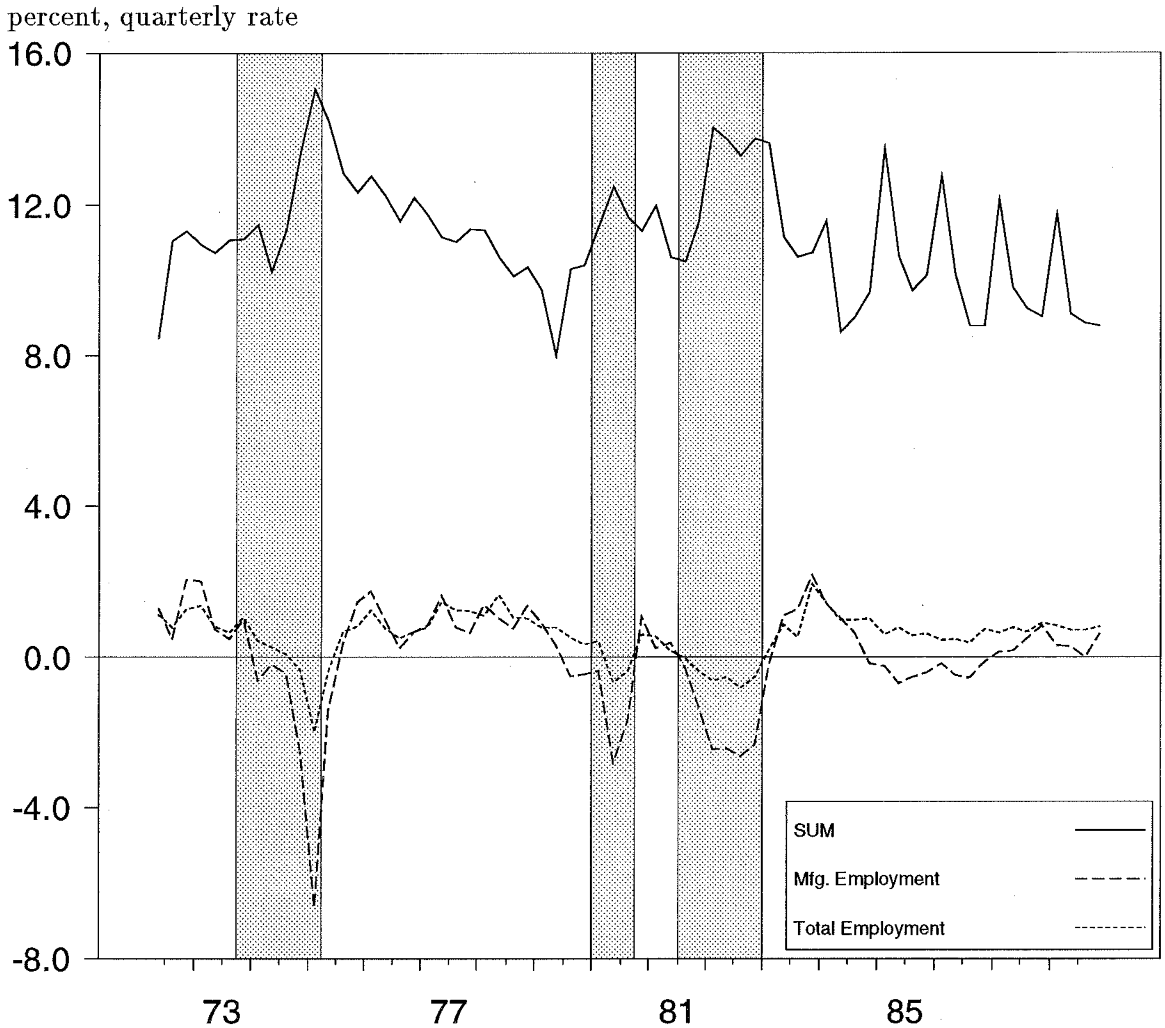
3.2 Identifying inter- and intrasectoral reallocation shocks

To disentangle intersectoral from intrasectoral reallocation shocks, we add Davis and Haltiwanger's SUM measure of within-manufacturing reallocation (denoted s below) to time series models similar to those used earlier for examining the relationship between sectoral

[14]These figures are from tables 2.1 and 5.1 of Davis, Haltiwanger, and Schuh(1995)

[15]Details the timing issues appear in the technical appendix of Davis, Haltiwanger, and Schuh.(1995)

Figure 4: **Gross and net employment changes**



and total employment:

$$\begin{bmatrix} \Delta n_t \\ \Delta w_t \\ s_t \end{bmatrix} = \begin{bmatrix} 0 & \lambda_{nw} & \lambda_{ns} \\ \lambda_{wn} & 0 & \lambda_{ws} \\ \lambda_{sn} & \lambda_{sw} & 0 \end{bmatrix} \begin{bmatrix} \Delta n_t \\ \Delta w_t \\ s_t \end{bmatrix} +$$
$$\begin{bmatrix} A_{nn}(L) & A_{nw}(L) & A_{ns}(L) \\ A_{wn}(L) & A_{ww}(L) & A_{ws}(L) \\ A_{sn}(L) & A_{sw}(L) & A_{ss}(L) \end{bmatrix} \begin{bmatrix} \Delta n_{t-1} \\ \Delta w_{t-1} \\ s_{t-1} \end{bmatrix} + \begin{bmatrix} u_t \\ v_t \\ h_t \end{bmatrix}. \qquad (3)$$

As before, additional assumptions are required to identify the model, and distinguish the two kinds of reallocation shocks from each other, and from the aggregate shocks. One approach is to extend the short-run identification scheme used earlier, and assume that intrasectoral reallocation shocks do not contemporaneously affect aggregate or sectoral employment; setting $\lambda_{nw} = \lambda_{ns} = \lambda_{ws} = 0$ yields a just-identified model. A second approach is to build on the long-run identification scheme, and restrict intrasectoral shocks to have no permanent impact on total employment or its sectoral allocation. Here, we have $\gamma_{wn} = \gamma_{ns} = \gamma_{ws} = 0$. (As in the bivariate case, the restrictions on the multipliers are easily imposed via restrictions on the autoregressive representation.) The model is again estimated using the instrumental variables procedure of King and Watson (1993).

3.3 Results without gross flows

Incorporating SUM into the analysis requires changing the frequency, sample period, and temporal aggregation of the data. To see whether these changes affect the earlier results, we re-estimated the bivariate models on the modified data set: both over the full 1954 to 1994 sample, and over the shorter 1972 to 1988 sample. Table 5 presents estimates of the models's short- and long-run multipliers, and table 6 presents the variance decompositions.

These estimates' similarity to those based on the monthly data confirms that the results are not particularly sensitive to sample, frequency, or the change in the aggregation of the monthly observations. With only two exceptions, the multipliers' estimates are very little changed. One is the estimate of λ_{wn} in the $\lambda_{nw} = 0$ model. Here, although the magnitudes differ, neither is significantly different from zero at conventional significance levels. The only other exception is the larger estimate of γ_{nw} estimated under the $\gamma_{wn} = 0$ restriction — reflecting, perhaps, the very large shrinkage in manufacturing's employment share during this period. The variance decompositions are also very similar. The main difference is the larger share of the variance of total employment growth attributed to reallocation shocks over the 72–88 period. Over the shorter sample, they account for 74% of the variance in total employment growth at four quarters, but only 43% in the full sample.

Table 5: **Estimated multipliers, quarterly data without gross flows**

Identification scheme and sample	Estimated multipliers: Short-run λ_{wn}	Short-run λ_{nw}	Long-run γ_{wn}	Long-run γ_{nw}
Short-run: $\lambda_{nw} = 0$	1.08	0	0.63	−0.63
Sample: 54:1–94:4	(0.08)		(0.14)	(0.62)
Short-run: $\lambda_{nw} = 0$	1.10	0	0.56	−0.87
Sample: 72:2–88:4	(0.16)		(0.19)	(1.53)
Long-run: $\gamma_{wn} = 0$	−0.19	0.55	0	0.77
Sample: 54:1–94:4	(0.64)	(0.12)		(0.32)
Long-run: $\gamma_{wn} = 0$	−1.07	0.58	0	1.20
Sample: 72:2–88:4	(2.23)	(0.23)		(0.59)

Notes: The regressions are estimated with 4 lags on quarterly data over the sample indicated using the instrumental variables procedure in King and Watson (1993). Standard errors are in parentheses; those for the γ coefficients are computed via the delta method.

Table 6: **Variance decompositions, quarterly data without gross flows**

Identification scheme and sample	Shock	Variance share, 4-quarter horizon (%)					
		Total empl.		Mfg. share		Mfg. empl.	
Short-run: $\lambda_{nw} = 0$	Reallocation	3	(3)	37	(6)	13	(3)
Sample: 54:1–94:4	Aggregate	97		63		87	
Short-run: $\lambda_{nw} = 0$	Reallocation	7	(5)	41	(10)	20	(7)
Sample: 72:2–88:4	Aggregate	93		59		80	
Long-run: $\gamma_{wn} = 0$	Reallocation	43	(19)	95	(7)	84	(12)
Sample: 54:1–94:4	Aggregate	57		5		16	
Long-run: $\gamma_{wn} = 0$	Reallocation	74	(23)	84	(14)	87	(15)
Sample: 72:2–88:4	Aggregate	26		16		13	

Notes: Parentheses contain standard errors computed via monte-carlo computed via monte-carlo with 1000 draws. See also notes to table 5.

3.4 Results with gross flows

Having demonstrated that the quarterly dataset yields results similar to those based on monthly data, we now include SUM in the model, and allow intrasectoral reallocation shocks to affect aggregate and sectoral employment. This change has a major effect on the results: in the model identified via long-run restrictions, the role of intersectoral reallocation is greatly reduced, and a large share of aggregate employment fluctuations is attributed to within-industry shocks.

Tables 7 and 8 report the long- and short-run multipliers and the variance decompositions for two alternative models that incorporate intrasectoral reallocation. Appending SUM to the end of the short-run system changes few of the substantial conclusions from the bivariate model. As before, aggregate shocks have a significant positive short-run effect on manufacturing's share. The long run impact is positive, but its estimated magnitude is much less than in the system without SUM. In the short run, SUM decreases following positive aggregate and reallocation shocks. With the exception of SUM, the intrasectoral reallocation shocks account for very little of any variable's variance. The decomposition of the variables' remaining variance between aggregate and intersectoral reallocation shocks is largely unchanged.

By contrast, including intrasectoral reallocation shocks significantly changes the system identified via long-run restrictions. The estimated variance decompositions illustrate this most forcefully. In the model without gross flows, intersectoral reallocation shocks accounted for 74% of total employment growth's variance, but only 9% in the trivariate model with SUM. When gross flows are included, the intrasectoral shock accounts for 46% of employment's variance, and the share attributed to the aggregate shock increases to 44% (compared to 26% in the model without SUM).

Intrasectoral reallocation shocks also have a large impact on the level of manufacturing employment and its share of total employment, accounting for a slight plurality of manufacturing employment's variance, roughly the same fraction of the variance of manufacturing's share as the intersectoral shock. Furthermore, since "own" shocks account for the vast majority of SUM's variance, the pace of intrasectoral reallocation appears to be largely unaffected by aggregate or intersectoral shocks. The point estimates of the variance decompositions have large standard errors, so they should be interpreted with caution. Nevertheless, they strongly suggest that disturbances which change the allocation of employment across establishments within manufacturing have a substantial impact on total employment and its sectoral composition.

Table 7: **Estimated multipliers, quarterly data with gross flows**

Identification scheme	Estimated multipliers							
	Short-run						Long-run	
	λ_{wn}	λ_{ws}	λ_{nw}	λ_{ns}	λ_{sw}	λ_{sn}	γ_{wn}	γ_{nw}
Short-run	1.05	0	0	0	−0.51	−0.53	0.29	−0.90
	(0.15)				(0.22)	(0.35)	(0.41)	(0.76)
Long-run	−0.07	−0.50	0.19	−0.48	0.28	1.12	0	0.20
	(0.96)	(0.30)	(0.32)	(0.25)	(0.70)	(1.91)		(0.60)

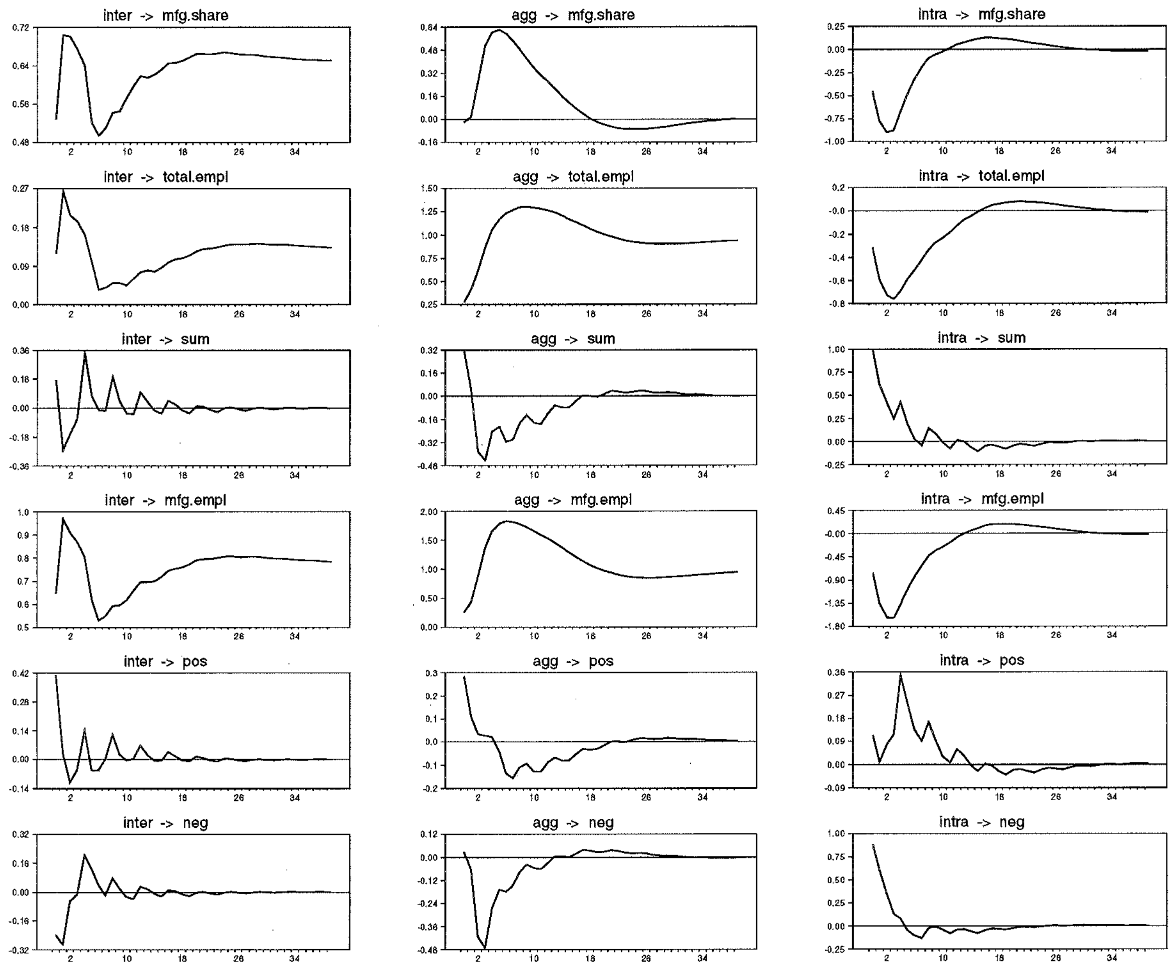
Notes: Parentheses contain standard errors. The sample is 1972:2 through 1988:4. See also notes to table 5.

Table 8: **Variance decompositions, quarterly data with gross flows**

Identification scheme	Shock	Variance share, 4-quarter horizon (%)							
		Total empl.		Mfg. share		Mfg. empl.		Sum	
Short-run	Intersectoral	11	(7)	47	(10)	25	(8)	11	(7)
	Intrasectoral	3	(4)	3	(4)	3	(4)	41	(10)
	Aggregate	86	(9)	50	(10)	72	(10)	48	(11)
Long-run	Intersectoral	9	(17)	42	(20)	26	(20)	6	(12)
	Intrasectoral	46	(20)	42	(18)	48	(19)	73	(13)
	Aggregate	44	(20)	16	(13)	26	(15)	20	(12)

Notes: Parentheses contain standard errors computed via monte-carlo. The sample is 1972:2 through 1988:4. See also notes to table 5.

Figure 5: **Impulse response functions of gross job creation and destruction**



The estimated multipliers illustrate the different impacts of intersectoral and intrasectoral reallocation shocks on the employment variables. In the short run, an intrasectoral shock which causes SUM to increase 1% in the short run decreases both total employment and manufacturing's share by about 0.5%. The estimated multipliers are not estimated with much precision, however, and they are significant only at the 10% level. Intersectoral shocks' effects are smaller and even less precisely estimated. A shock that generates a 1% increase in manufacturing's share leads to a 0.2% increase in total employment within the quarter, and a 0.3% increase in SUM. Neither effect is statistically significant at the 10% level.

To further illustrate the impact of reallocation shocks on employment in the model, figure 5 plots the responses to one-standard-deviation positive realizations of each of the three shocks. It also plots the responses of job creation, POS, and job destruction, NEG, which are related to the variables included in the model through the following identities:

$$\begin{aligned} \mathrm{POS}_t &= (\Delta w_t + \Delta n_t + \mathrm{SUM}_t)/2 \\ \mathrm{NEG}_t &= (\Delta w_t + \Delta n_t - \mathrm{SUM}_t)/2 \ . \end{aligned}$$

Table 9 contains the variance decompositions for the job creation and destruction measures.

As the short-run multipliers indicated, intrasectoral reallocation shocks increase SUM and decrease both total employment and manufacturing's share, implying a decrease in manufacturing employment. The impulse response function shows that this decrease is persistent, with the trough in total employment coming five quarters after the impulse.

The responses of job creation and destruction to intrasectoral shocks are qualitatively very different from their responses to the other two disturbances. Both the aggregate and intersectoral shocks cause job creation and destruction to move in *opposite* directions. To expand employment, job creation increases and job destruction decreases. In contrast, the intrasectoral disturbance causes job creation and destruction to move in the *same* direction. Shock that increase intrasectoral reallocation cause job destruction to increase immediately; job creation begins to rise after two quarters, and it reaches its peak six quarters following the shock.

The comovement of POS and NEG in response to intersectoral reallocation shocks also helps also helps account for the countercyclical behavior of job reallocation. Shocks that decrease intrasectoral reallocation reduce both job creation and destruction. Because job destruction falls by more than job creation, manufacturing employment also rises. The result is an employment boom accompanied by an "ossification" in the allocation of employment among establishments.[16]

The impulse responses suggest that job creation and destruction play very different roles in the adjustment of employment to reallocation shocks. The variance decompositions underscore this point. Intrasectoral shocks account for most of job destruction's variance over a four quarter horizon, but intersectoral shocks account for most of job creation's. It appears that the manufacturing sector increases total employment in the long run by adding new jobs, while it increases it in the short run primarily by halting the destruction of old jobs.

[16] In an analysis similar in spirit to ours, Davis and Haltiwanger (1994) estimate a VAR in manufacturing's net employment growth and SUM. They identify reallocation shocks by constraining the short run multipliers so that job creation and destruction both move in the same direction following a shock. These results complement theirs by finding an identical characterization of reallocation shocks under different identifying assumptions.

Table 9: **Variance decompositions of gross job creation and destruction**

Identification scheme	Shock	Variance share, 4-quarter horizon (%)			
		Creation		Destruction	
Long-run	Intersectoral	60	(18)	8	(16)
	Intrasectoral	10	(13)	70	(17)
	Aggregate	30	(17)	22	(14)

Notes: Parentheses contain standard errors computed via monte-carlo. The sample is 1972:2 through 1988:4. See also notes to table 5.

3.5 Summary

Incorporating SUM into our empirical analysis reinforces the conclusion that reallocation shocks account for a large fraction of employment fluctuations, but it alters their characterization. Intrasectoral reallocation shocks account for a much larger fraction of total employment variance than intersectoral shocks. Furthermore, the employment responses to the two reallocation shocks are qualitatively different. As the variance decompositions of job creation and destruction indicate, a permanent sectoral reallocation away from manufacturing is accomplished by slowing the creation of new jobs and increasing the destruction of old jobs. In contrast, within-manufacturing reallocation begins by raising destruction and, after a delay, raising creation. We also find that movements in SUM are largely driven by intrasectoral reallocation shocks.

4 Conclusions

The covariance between employment and the pace of its reallocation across sectors and establishments is well established. The analysis in this paper has shown that, subject to plausible identifying assumptions, this covariance implies that exogenous disturbances to the economy's optimal allocation of employment, reallocation shocks, account for a large fraction of employment variance. This is true whether we constrain the analysis to only consider shocks which change the sectoral allocation of labor or whether we expand the analysis to also include shocks which change the allocation of labor among establishments within a sector.

Rogerson (1987), Greenwood and Huffman (1988), and Greenwood, MacDonald, and

Zhang (1996), and Phelan and Trejos (1995) have all studied the implications of persistent shifts in the sectoral allocation of labor for business cycle fluctuations. Our analysis underscores the relevance of this work, but it also highlights a potential source of employment fluctuations of equal or greater magnitude: shifts in the optimal allocation of employment across establishments within a sector. Caballero and Hammour (1994), Campbell (1995), Mortensen and Pissarides (1994), and Zhang (1995) have all modeled the interaction of within-industry employment reallocation with fluctuations of total employment. Our characterization of intersectoral and intrasectoral reallocation shocks refines the observations motivating the theoretical research of reallocation and business cycles and provides a potentially useful benchmark for their evaluation.

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