Cyclical Implications of the Declining Manufacturing Employment Share

By Andrew J. Filardo

Over the last 35 years, the U.S. economy has created service sector jobs at a faster pace than manufacturing sector jobs. Not only has this trend led to a significant shift in the composition of the labor force from manufacturing to services, but it has also fundamentally changed the characteristics of the average workplace. The typical worker now is increasingly likely to be a white-collar employee in an office than a blue-collar worker on an assembly line. This typical worker is also more likely to have had more formal education and use computer technology, and is less likely to be unionized.

Some economists have argued that the ongoing structural shifts from manufacturing employment to services employment may have had the additional consequence of smoothing the business cycle. A smoother cycle would be welcomed and would yield several benefits. The economy would grow more stably and would provide a more predictable backdrop for working, saving, and investing.

This article investigates whether the shift from manufacturing to services employment has muted the business cycle. The first section lays out the arguments supporting the view that a shift from manufacturing to services smooths business cycles. The second section compares the predictions of this view with the data from the last 35 years. The third section offers an explanation for the discrepancies between the theory and the empirical evidence. The article concludes that the declining manufacturing employment share may have substantially changed the workplace but has had little impact on the smoothness of the business cycle.

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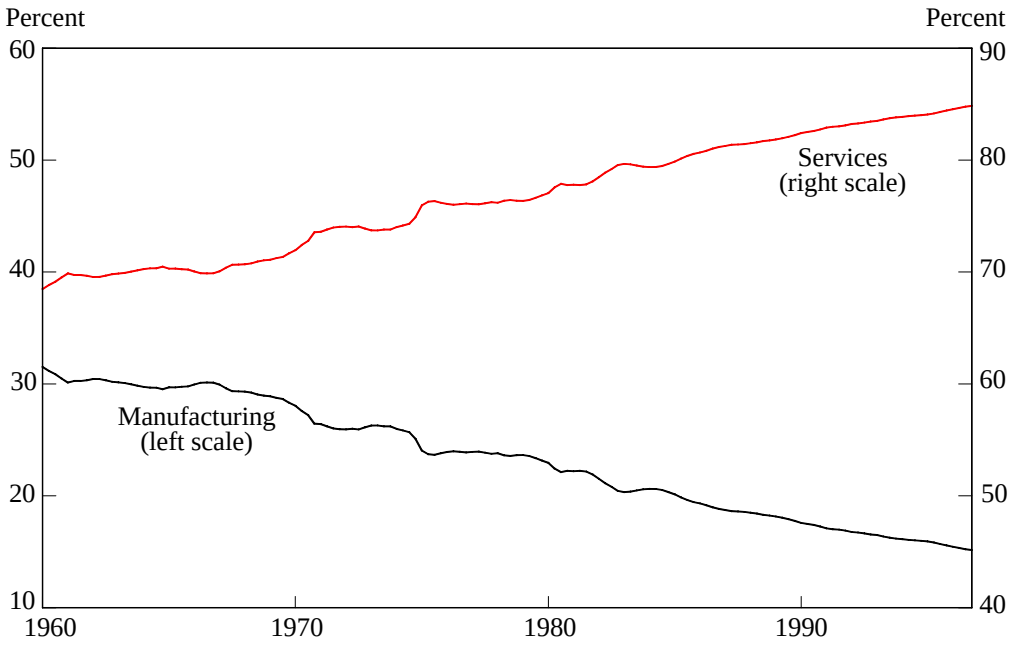
I. HOW CAN THE DECLINING MANUFACTURING EMPLOYMENT SHARE AFFECT BUSINESS CYCLES?

Labor is the key ingredient used to produce the nation's output, accounting for roughly two-thirds of all production costs.[1] Thus, it is no surprise that fundamental changes in the labor force potentially have far-reaching implications for the economy.

This section examines why recent shifts in the labor force from manufacturing to services may have altered the business cycle. The section first documents the shifts of jobs from manufacturing to services.[2] The section then discusses why the shifts might be expected to mute the business cycle. Four differences between

Chart 1
EMPLOYMENT SHARES



Note: Both lines represent sectoral employment as a share of nonfarm payroll employment.
Source: Bureau of Labor Statistics and author's calculation.

manufacturing and services help explain why the employment shift might smooth aggregate output fluctuations, thereby affecting the lengths of expansions and recessions and the depths of recessions.

The declining manufacturing employment share

The economic history of the United States is an ongoing tale of structural changes in sectoral composition. During the last half of the 19th century and the first half of the 20th century, U.S. industrialization drew labor resources from the farm into the cities. At first, most of the employment flowed into factories, building the nation's industrial base. Slowly, however, as cities became the centers of economic activity and the demand for services rose, providers of services such as public transportation, sanitation, and department stores began to employ a larger share of the urban labor force.

Since 1960, the process of workplace restructuring has continued unabated. Employees have increasingly found more jobs in office buildings than on factory floors, dramatically changing the composition of the American work force (Chart 1). Manufacturing's share of total nonfarm employment has dropped steadily from a third of the nonfarm labor force in 1960 to roughly 15 percent in 1996. At the same time,

the share of service sector employment has swollen to 85 percent.

Why might the declining manufacturing employment share smooth the business cycle?

Such a dramatic shift in the manufacturing employment share raises the possibility of a more stable business cycle. The idea behind this shifting share view is that if a sizable portion of the work force shifts from manufacturing, which is a relatively volatile sector, to services, a much less volatile sector, then overall aggregate activity would be smoothed. Four differences between manufacturing and services help explain why manufacturing employment has been more volatile, and thus more recession-prone, than services employment.

First, manufacturing sector activity is more volatile and recession-prone than services sector activity because manufactured goods are more likely than services to be subject to pent-up demand. Pent-up demand builds when consumers temporarily defer purchasing new goods until they can better afford them. For example, during recessions consumers tend to defer the purchases of big-ticket manufactured items, such as new cars, refrigerators, and computers. Once the recession is over, consumers rush to make their purchases, causing a boom in manufacturing activity and thus in manufacturing employment. This process can accentuate swings in economic activity, contributing to a weaker economy during a recession and to a stronger economy during an expansion. Services, on the other hand, are less likely to generate significant pent-up demand because they are less likely to be deferred in a recession. For example, the demand for haircuts, doctors' services, and tax accounting are much less sensitive to the state of the business cycle than big-ticket items.

Second, manufacturing is more volatile and recession-prone than services because manufactured goods are easier to store. While the ability to store goods in the form of inventories helps firms to smooth their production and employment, it sometimes leaves the manufacturing sector vulnerable to unexpected changes in demand. For example, when firms are caught producing goods at a normal pace at the outset of a recession, they quickly find themselves with surplus inventories. If times continue to be bad, firms must eventually slow production, not only because the demand for their products has fallen but also because excess inventories must be worked off. Thus, the buildup of unwanted inventories can help intensify economic downturns. In fact, manufacturing inventories, especially inventories for durable goods, have traditionally played a dominant role in cyclical fluctuations (Filardo 1995). In contrast to manufactured goods, service sector goods such as haircuts or heart surgery simply cannot be stored. Thus, services are less subject to inventory-induced swings.

Third, manufacturing is more volatile and recession-prone than services because the demand for manufactured goods is more vulnerable to shifts in foreign demand. About 80 percent of nonagricultural exports from the United States are goods, and the bulk are manufactured goods.[3] Thus, fluctuations in exchange rates and foreign business cycles lead to greater instability of activity in manufacturing than in services.[4]

Finally, manufacturing sector activity is more volatile and recession-prone because manufactured goods are likely to be more capital intensive than services. For example, producing automobiles and refrigerators requires large capital investments, such as high-tech lathes and metal stamping equipment. Haircuts and lawn services, in contrast, require shears and simple cutting implements. Because large capital investments are more interest rate sensitive, they are

more likely to fluctuate as interest rates move up and down during the cycle. Thus, manufactured goods tend to be more cyclical than services.

Taken together, these four differences between manufacturing and services help explain why employment is more cyclically sensitive in manufacturing than in services. Chart 2 shows the difference in the variability of manufacturing and service employment has been large and quite persistent since 1960. According to the shifting share view, the substantial decline in the manufacturing employment share suggests that business cycles should have become increasingly more muted since 1960.[5]

Implications for expansions and recessions of the sectoral employment shift

In addition to reducing the volatility of economic activity, sectoral employment shifts potentially smooth the business cycle in two other ways. First, the sectoral shifts might reduce the frequency of recessions. A recession occurs when economic activity slows sufficiently to cause the absolute level in activity to contract. So, according to the shifting share view, as activity moves from the volatile manufacturing sector to the less volatile services sector, sharp downturns in economic activity would occur less frequently, prompting fewer recessions.[6] With expansions less likely to be interrupted by contractions, expansions would be longer.

Second, sectoral employment shifts might also reduce the depth, and thus the severity, of recessions. If economic activity has become smoother because of structural shifts from manufacturing to services, downturns in the economy would become shallower on average than in the past. The shallower downturns might also tend to produce shorter recessions because the economy could more quickly return to normal if the downward momentum were less severe.[7]

Taken together, the structural shifts in employment since the 1960s may have reduced the volatility of economic activity, thereby lengthening expansions, shortening recessions, and reducing the depth of recessions. The 1982-90 expansion and the current expansion that started in 1991 lend credence to this view. The former expansion was the longest peacetime expansion on record. The current expansion, which has been remarkably solid and well balanced, is now the second longest peacetime expansion on record. In addition, the 1990-91 recession was shorter than many past recessions and is considered milder than the 1981-82 recession.[8]

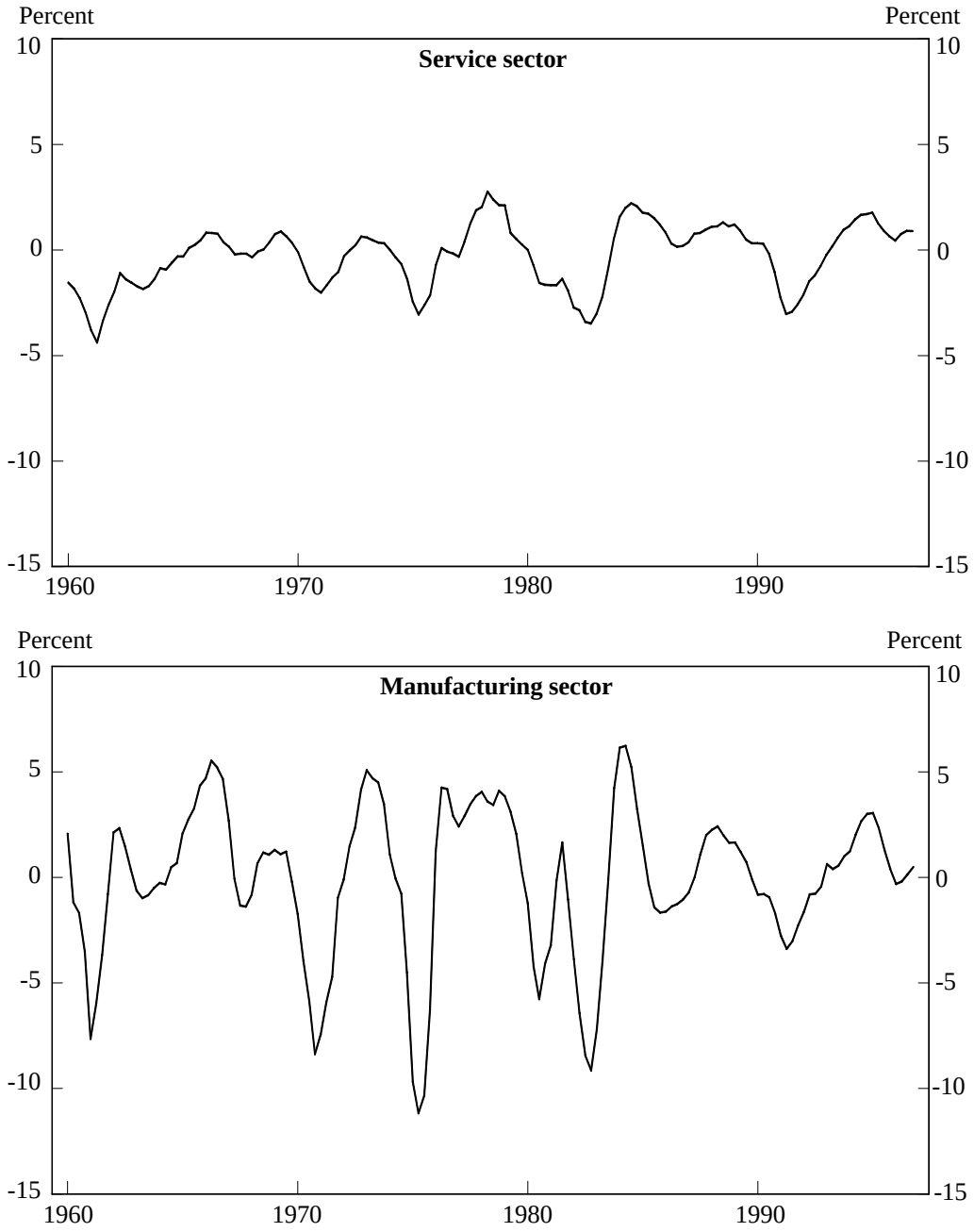
II. HAS THE SHIFTING EMPLOYMENT SHARE MUTED THE BUSINESS CYCLE?

While business cycle developments since 1982 appear to support the shifting share view, a more systematic statistical analysis of the entire post-1960 period raises questions about the link between shifting employment shares and business cycle volatility. Previous research for the most part has compared the pre-WWII and post-WWII periods. This article focuses instead on changes within the period from 1960 to 1996, when the manufacturing employment share declined so dramatically. The shifting share view suggests that output volatility should have declined as well. Moreover, along with the decline in output volatility, expansions should have become longer and recessions should have become shorter and shallower.

Has manufacturing's declining share of employment reduced output volatility?

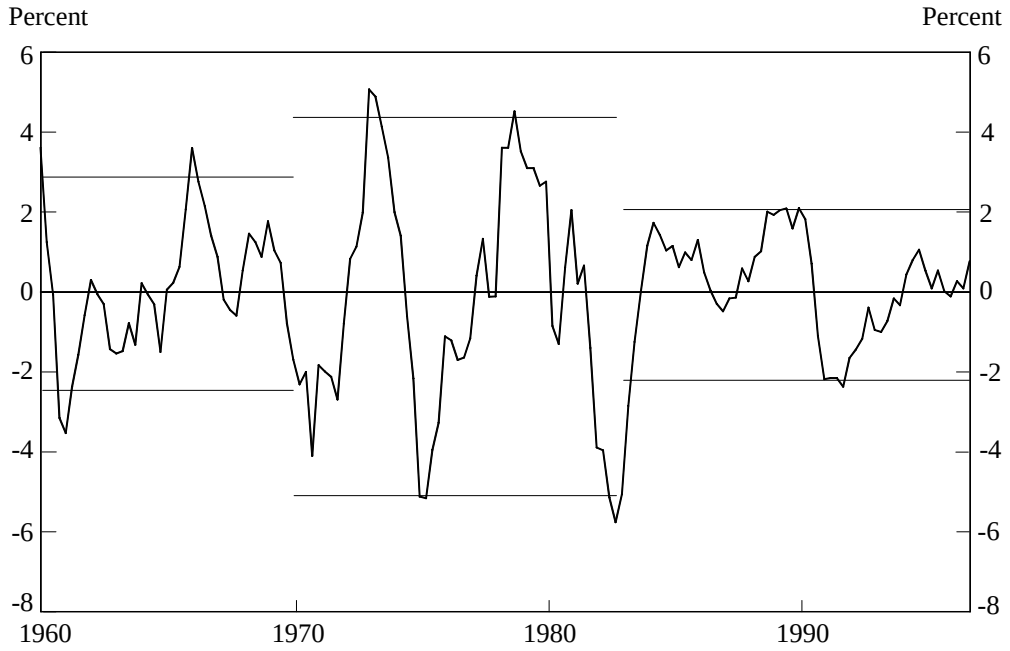
One way to test the shifting share hypothesis is to look at deviations of aggregate output, as measured by GDP, from its trend. If the business cycle has become progressively smoother, this measure of volatility should exhibit a downward trend.

Chart 2
SECTORAL EMPLOYMENT VARIABILITY



Note: Each panel displays the growth in sectoral employment (quarter over same quarter year-ago) minus the average growth rate from 1960:Q1 to 1996:Q4.
Source: Bureau of Labor Statistics and author's calculation.

Chart 3
VOLATILITY PATTERN IN THE BUSINESS CYCLE



Note: Volatility is measured as percentage deviation of real nonfarm GDP from its Hodrick-Prescott trend (with smoothing parameter set at 1600). Bands are 90 percent regions for 1960:Q1 to 1969:Q4, 1970:Q1 to 1982:Q4, and 1983:Q1 to 1996:Q4.
Source: Bureau of Economic Analysis and author's calculation.

Chart 3 shows that the deviations of detrended GDP have not shrunk since 1960. Three distinct volatility regimes characterize the data. The first regime is a low-volatility period from 1960 to 1969. The second regime is a high-volatility period from 1970 to 1982. The third regime is another low-volatility period from 1983 to 1996. The low-high-low pattern clearly fails to follow a straight-line decline in volatility.[9]

One possible reason why this volatility measure does not support the shifting share view is that other economic developments during the sample period may have obscured the decline in output volatility. In particular, the 1970-82 period represents a time when the economy was buffeted by several disruptive economic shocks, such as the large oil price increases in 1973-74 and 1979, rising inflation throughout the period, and the productivity slowdown that began in the early 1970s. Appendix A offers a measure of volatility that controls for the influence of such economic factors. Still, the conclusion from Chart 3 remains valid because deviations of detrended GDP have not shrunk since 1960 even after accounting for a variety of economic factors.[10] In other words, the shift in the manufacturing share does not seem to be obviously linked to a reduction in output volatility.

Empirical evidence on durations and depths of business cycle phases

It is possible that the shift in employment share may have had a more subtle impact on the business cycle than can be captured in simple volatility measures. Perhaps the shift affected the average duration, or length, of expansions and recessions and reduced the depths of the typical recessions. This section uses various methods to explore these possibilities.

Have expansions lengthened and recessions shortened? An implication of the shifting share view is that expansions should have become increasingly longer and recessions increasingly shorter after 1960.[11] Simply looking at changes in the monthly duration of expansions and recessions since 1960, however, shows no clear trends consistent with the shifting share view in expansion and recession durations (Chart 4). To be sure, the current expansion has been relatively long, and the last recession was relatively short. But from 1960 to 1990, durations of expansions have clearly not become longer and recessions have clearly not become shorter. For example, the longest expansion occurred early in the 1960s and the shortest occurred in the 1980s. Recessions in the 1960s and early 1970s were shorter than those in 1973-75 and 1981-82.

The lack of a trend toward longer expansions and shorter recessions, however, does not necessarily contradict the shifting share view. Many factors other than employment shifts may have affected the duration of expansions and recessions, perhaps obscuring an underlying tendency for employment shifts to lengthen expansions and shorten recessions.

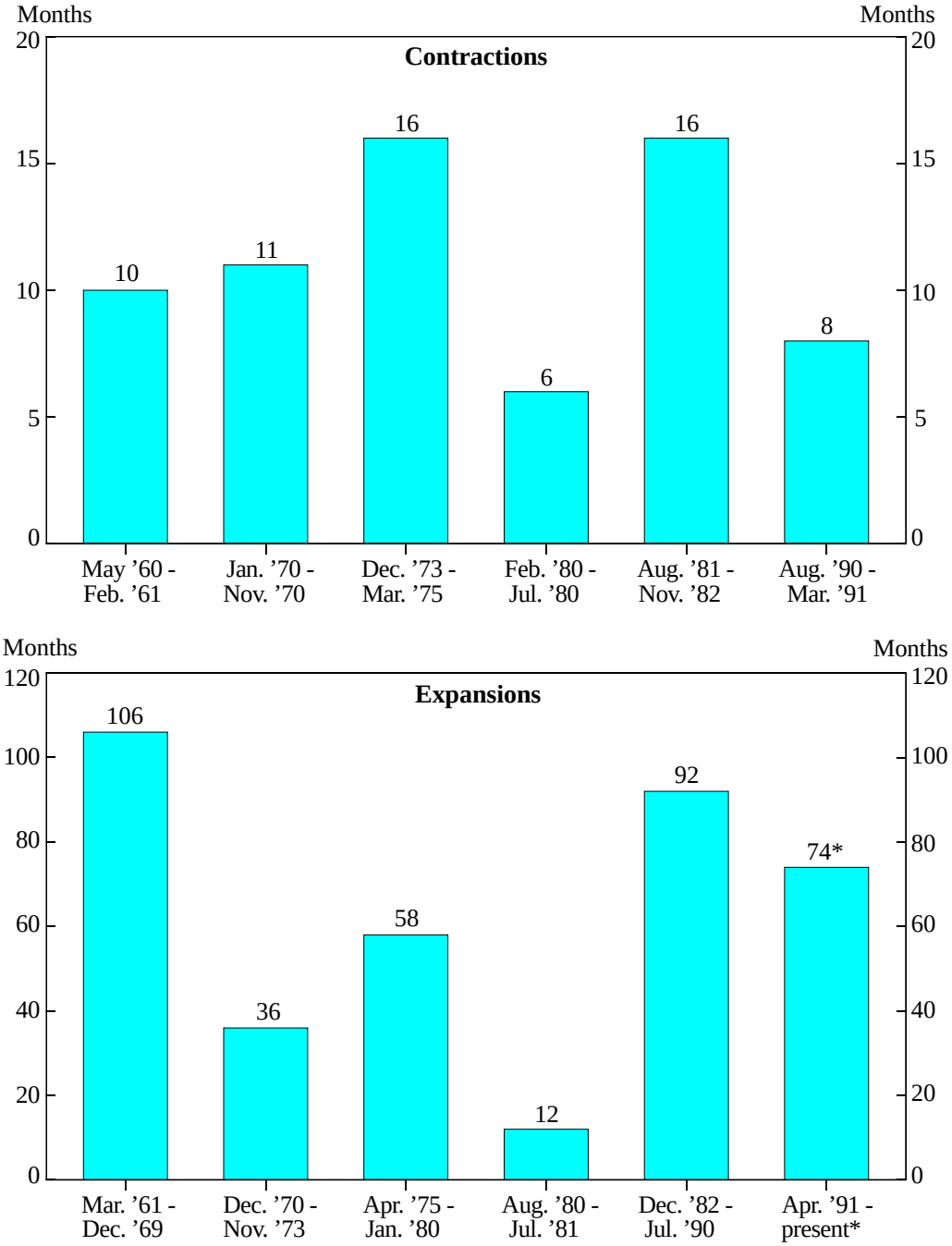
Nevertheless, more sophisticated estimates of the relationship between the manufacturing share and the duration of expansions and recessions still do not find a trend toward longer expansions and shorter recessions. The key determinants of durations in this approach are two probabilities.[12] One probability gives the odds that the economy will stay in an expansion, given it is in an expansion. The other probability gives the odds that the economy will remain in a recession, given it is in a recession. An advantage of this approach is that it allows these probabilities to change over time as economic conditions change—for example, as the manufacturing share declines. Hence, this approach can be used to test the validity of the shifting share view. Holding other things equal, if the probability of remaining in an expansion rises as the manufacturing employment share falls, the average duration of expansions would rise, thus confirming the shifting share view. Similarly, the view would be confirmed if the probability of remaining in a recession declines, other things equal, as the manufacturing employment share falls.

The regression analysis in Appendix B estimates and tests such a probabilistic framework of expansion and recession durations. The regression model contains a parameter which measures the statistical association between the declining manufacturing employment share and the probabilities that determine expansion and recession durations. The main result from the statistical tests in Appendix B is that the declining manufacturing employment share does not seem to statistically alter the probabilities associated with expansions and recessions. Thus, the evidence does not suggest that the shifting employment share has caused expansions to have lengthened or recessions to have shortened in the post-1960 period. In short, this analysis provides further evidence that the shifting employment share has not altered the smoothness of the business cycle.

Have recessions become shallower? Empirical evidence on the shallowness of recessions

Chart 4

BUSINESS CYCLE DURATIONS



* Length to date. Peak has not yet been reached.

Source: National Bureau of Economic Research.

Table 1

SHALLOWNESS OF RECESSIONS

Peak-to-trough dates	Percent deviation from previous peak	Percent deviation from trend
1960:Q1 - 1961:Q1	-2.7	-3.5
1969:Q4 - 1970:Q4	-.1	-4.1
1973:Q4 - 1975:Q1	-4.6	-5.1
1979:Q4 - 1980:Q2	-2.4	-.8
1981:Q2 - 1982:Q4	-2.6	-5.7
1990:Q2 - 1991:Q1	-2.7	-2.2

Note: Trend measured using the Hodrick-Prescott filter on real GDP (with a smoothing parameter of 1600). Peak and trough dates are from the NBER.

offers another measure of whether the shifting employment share has reduced the volatility of business cycles since 1960. If the steady decline in the relative importance of manufacturing employment has smoothed business cycles, then, all else the same, business cycle troughs would tend to be higher and peaks lower. Thus, recessions would be shallower. However, two measures of the depths of recessions fail to reveal evidence that recessions are becoming increasingly more shallow.

The first measure estimates the drop in economic activity from the peak to the trough of the business cycle. The first column of Table 1 reports the peak-to-trough percentage declines in the last six recessions. The recent 1990-91 recession saw real GDP decline a relatively large 2.7 percent. This decline was at least as large as the 1960 recession, smaller than the early 1970s recession, and similar to the 1979-80 and 1981-82 recessions. This peak-to-trough measure indicates that recessions do not seem to have become shallower.

This measure, however, may be biased toward finding no change in the shallowness of recessions because the underlying trend growth rate of the economy slowed in the mid-1970s. The peak-to-trough measure includes both a trend component and a business cycle component. If the trend were constant, changes in the measure over time would reflect only changes in the business cycle, and the measure would be unbiased. But, with the trend growth rate slowing in the mid-1970s, the peak-to-trough measure lumps together changes in recession depths due both to cyclical forces as well as to the slower trend. This slower trend has made recessions since the mid-1970s appear deeper for a given cyclical swing (around trend) than recessions earlier in the period.[13] As a result, the estimates in Table 1 may provide misleading evidence about the shallowness of recessions when comparing episodes before and after the mid-1970s.[14]

The second measure of the shallowness of recessions estimates the size of a drop in economic activity, adjusting for changes in the trend. The

second column in Table 1 reveals that this measure shows no clear decline in the shallowness of recessions since 1960. In fact, except for the 1979-80 recession, recession depths steadily increased in severity during the first three decades in the sample.[15]

Overall, the statistical evidence in this section does not support the view that a declining share of manufacturing employment has muted the business cycle. The substantial decline in the share has not fundamentally altered the volatility of economic activity, the durations of expansions and recessions, or the severity of recessions.

III. EXPLAINING THE APPARENT CONTRADICTION

How can fundamental restructuring of the nation's employment have had no perceptible impact on the business cycle? This section examines three factors that help explain the apparent contradiction between the shifting employment share view and the empirical evidence on the business cycle. The most significant factor explaining the apparent contradiction is that productivity trends in manufacturing and services have diverged since the 1960s.[16] The shifting share view ignores this factor and thus overstates the importance on output of the relative decline in the number of manufacturing employees. Two other factors also offer an explanation: the trend toward greater outsourcing and the changing cyclical nature of services. Both factors lead to an overstatement of the effects on output of the manufacturing employment shift. Taken together, all three factors raise questions about the validity of the shifting share view.

Productivity growth and manufacturing's output share

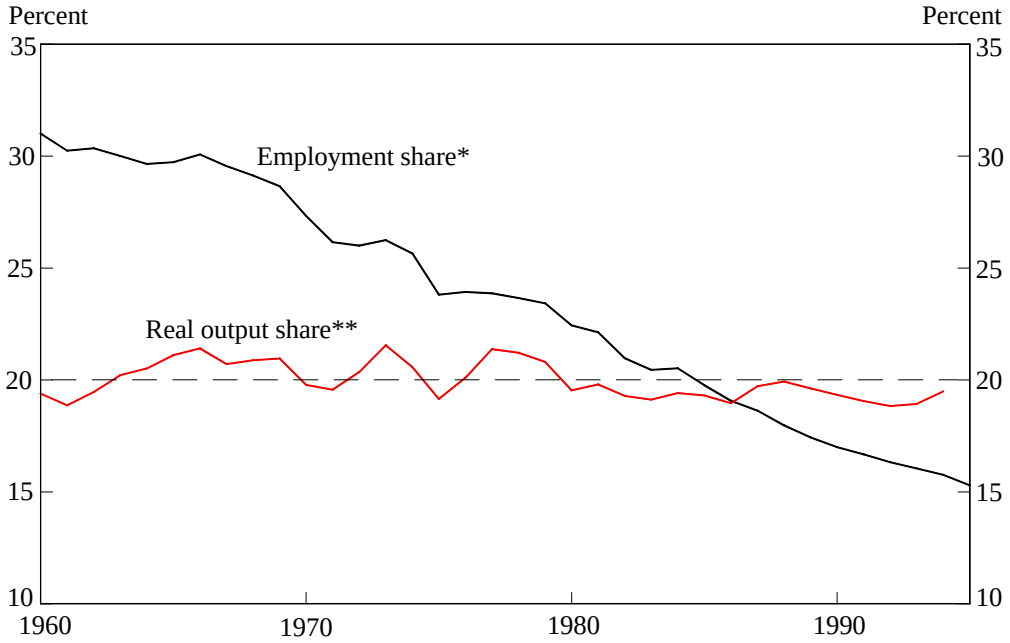
The shifting share view asserts that a decline in the manufacturing employment share smooths aggregate employment fluctuations, which in turn smooth aggregate output fluctuations. This view would be correct if a smaller share of the labor force were also producing a smaller share of total output. This implicit assumption, however, is not consistent with the evidence. In fact, because manufacturing productivity has increased dramatically, the manufacturing sector has continued to be as important to total economic activity today as it was 25 years ago.

Since 1960, the manufacturing sector has prospered. Manufacturing industries have racked up strong productivity gains by altering their output mix, investing heavily in new equipment, and adopting new, more efficient management practices.[17] Manufacturing productivity since 1960 has grown 2.9 percent annually, while nonfarm business productivity has risen only 2.0 percent annually.[18] Moreover, since 1980, manufacturing productivity has edged up to a 3.0 percent annualized rate of growth, while total nonfarm business productivity growth has slowed to a 1.1 percent rate. These data imply that manufacturing productivity growth has been much stronger than services productivity growth, especially since 1980.[19]

The cumulative effects of such strong productivity growth in manufacturing—especially in durables manufacturing—have translated into large output gains. The average manufacturing worker in 1996 accounted for 190 percent more output than in 1960, while durables manufacturing workers accounted for 235 percent more output.[20] In contrast, the average worker in the overall economy accounted for just 104 percent more output in 1996 than in 1960.

Such rapid productivity growth in manufacturing has also caused manufactured goods to become relatively less expensive than all other goods in the economy. Manufacturing industries

Chart 5
MANUFACTURING'S SHARE OF OUTPUT AND EMPLOYMENT



* Manufacturing employment as a percent of nonfarm payroll employment.
** Manufacturing output (measured by Gross Product Originating) as a percent of real GDP less agriculture, forestry, and fisheries.
Note: Because a consistent Gross Product Originating (GPO) by industry series is unavailable, the author has constructed an approximate series. From 1960 to 1987, real manufacturing GPO (1982 fixed-weighted) was spliced with real manufacturing GPO (1987 fixed-weighted) from 1988 to 1991. 1992-94 real manufacturing GPO (chain-weighted) is then spliced with the earlier data. The output share series that is graphed above approximates the real output share on a 1987 fixed-weighted basis.
Source: Bureau of Economic Analysis, Bureau of Labor Statistics, and author's calculation.

are able to produce more efficiently than the rest of the economy, causing the supply of manufactured goods to grow. In fact, that supply has consistently outpaced demand. Consequently, the relative price of manufactured goods has fallen steadily, about 1.4 percent each year, for a cumulative drop of 50 percent since 1960.[21] The lower relative prices have enticed consumers to maintain their strong demand for manufactured goods.

In short, the smaller share of the labor force employed in manufacturing has not significantly affected the amount of output. Chart 5 shows the real manufacturing output and employment shares.[22] Except for the slight decline after 1980, manufacturing's output share has remained fairly close to 20 percent since 1960.[23]

The stable manufacturing output share suggests a partial explanation for the lack of empirical

association between the manufacturing employment share shift and business cycle volatility. Because the economy has not been shifting its output share from the high-volatility manufacturing sector to the low-volatility services sector, there is no reason to expect smoother economic output.[24] Thus, the divergence of the manufacturing and services productivity trends has been sufficiently large to help explain why the shift of manufacturing employment to services employment has not muted the business cycle.

This evidence suggests that the shifting share view of a smoother business cycle is significantly flawed and may cause some analysts to draw erroneous conclusions about the economy. Analysts who overlook divergent productivity trends will place too much emphasis on labor force shifts. The large decline in the relative price of manufactured goods and the fairly stable output share indicate how important the growth in manufacturing productivity has been.

Other contributing factors

Although growth in manufacturing productivity explains much of the apparent contradiction between the shifting share view and the empirical evidence, it does not explain it all. Despite rapid growth in manufacturing productivity, the output share of manufacturing since 1980 has still drifted below its long-term average. Outsourcing and the changing nature of services may help explain why manufacturing's declining employment share has not translated into a more muted business cycle even in the 1980s and 1990s.

Trend toward outsourcing. The shifting share view potentially overstates the economic significance of the employment shift from manufacturing to services because some of the employment flows have been due to outsourcing. Outsourcing is the business practice of downsizing the manufacturing work force by farming out services such as business, repair, and maintenance services to service sector firms.

Shifting employment shares resulting from outsourcing do not fundamentally change the nature of economic activity. For example, a manufacturing company may decide to eliminate its legal department of 100 employees and purchase legal services from a law firm. The decision would reduce manufacturing employment by 100 and increase services employment by 100. While the manufacturing employment share would decline, output would not be affected. The same amount of manufacturing output and legal services would be produced both before and after the outsourcing.[25] Moreover, the same number of employees are used to produce the same output; only the name of the payor on paychecks would be different. Thus, while outsourcing may affect bookkeeping entries, it does not necessarily alter economic output, the cyclicality of aggregate employment, or the volatility of business cycles. The size of this outsourcing effect can be quite large. Lebow and Sichel, for example, have found that outsourcing can account for 10 percent of the volatility reduction often attributed to shifting sectoral employment.[26]

This evidence suggests another reason the shifting share view is flawed. The shifting share view fails to account for outsourcing and thus overstates the economic effect of the shifting employment shares.

Changing nature of services. The shifting employment share view may also overstate the significance of the shifting employment shares because services are becoming more cyclically sensitive. Wyckoff argues that services, such as financial services, are increasingly taking on three characteristics that have traditionally been more typical of recession-prone manufactured goods.

First, services are becoming more prone to inventory fluctuations because new information technologies are making it easier to store services. For example, in the past, tax advice could only be provided by accountants who were generally able to offer a fixed number of tax interviews per month. Clients who needed to use knowledge of the tax code had to wait in a queue to access the knowledge through an accountant, thereby spreading across time the purchases of accounting services during periods of strong demand. Now, however, interactive software programs allow such knowledge to be stored on the shelves of computer software stores. These computer programs allow taxpayers to purchase accounting services when needed, and complete the tax forms at their own convenience on their personal computers. In other words, taxpayers can now purchase accounting services off-the-shelf just like a manufactured good. Moreover, as information and communication technologies become more widespread, the ability of services firms to inventory their products is accelerating.[27]

Second, services are becoming more capital intensive and thus more sensitive to interest rate fluctuations. Services industries are serving the needs of their clients by using state-of-the-art communication and information technologies, such as sophisticated phone systems and high-speed computers which are quite capital intensive. As service providers become more capital intensive, their production is more likely to speed up when interest rates rise and to slow down when interest rates decline.

Finally, services are becoming more exportable and thus more sensitive to the economic conditions and whims of foreign consumers and investors. The increased globalization of financial markets has helped boost U.S. financial service exports. When exports become a more important share of a sector's activity, however, that sector becomes more vulnerable to exchange rate fluctuations and foreign business cycles.

The increased cyclicality of services suggests that the shifting share view has overstated the effect of the recent employment shifts on the smoothness of the business cycle. As the manufacturing and services cycles have become more similar, the effect of shifting employment on the cycles has become smaller.[28] In the extreme, if services have become as cyclically sensitive as manufacturing, employment shifts between the two sectors would have no effect on business cycle volatility.

Evidence from the 1990-91 recession supports the view that services are becoming somewhat more cyclical. Services employment during this period was relatively more cyclical than it had been in the past. Prior to 1981, service sector employment grew throughout the cycle, even in recessions. Since then, however, services employment has actually fallen in recessions. The decline during the recession was less surprising in 1981-82 than in 1990-91. In the earlier recession, services employment's decline was accompanied by a fairly large manufacturing employment drop, reflecting the severity of the recession. But, in the 1990-91 recession, manufacturing employment fell at its smallest rate (in the post-1960 period) while services fell at its largest rate.[29] To be sure, one recessionary episode does not prove that services are significantly more cyclical. But the recent recession suggests that the cyclical nature of services may be changing.

IV. SUMMARY

Since the 1960s, the U.S. work force has continued its transition from manufacturing to services. This development raises the prospect that the business cycle has become smoother because services tend to be more recession-

proof than manufacturing. However, this article presents evidence that casts doubt on the view that the shift from manufacturing employment to services employment has smoothed the cycle.

The apparent contradiction between the shifting employment share view and the empirical evidence can be explained largely by diverging sectoral productivity trends. Since 1960, manufacturing output has remained stable at about one-fifth of the economy. This stable output share reflects the fact that manufacturing productivity growth has outpaced productivity growth in the rest of the economy. Also contributing to the explanation of the apparent contradiction are the trend toward outsourcing and the changing cyclical nature of services.

In conclusion, this article provides several reasons why the shifting share view is inadequate to explain cyclical trends in the economy since 1960. Therefore, if the manufacturing sector remains as healthy as it has since the 1960s, there is little reason to believe that future shifts in employment shares will mute the business cycle.

APPENDIX A

ADJUSTED MEASURES OF CYCLICAL VOLATILITY

This appendix describes the statistical analysis used in the article to adjust the volatility of the business cycle for oil price, fiscal policy, and monetary policy shocks. The estimates will highlight the shock-adjusted measures of volatility and the effects of manufacturing's shifting share on the estimates.

Regression models and data

The statistical model uses three separate regression equations: one for real GDP, one for manufacturing employment, and one for service sector employment. To explain the changes in these three dependent variables, three independent variables and their lags are included in the regression equations. The variables capture oil prices, fiscal policy, and monetary policy. The oil price variable is one recently advocated by Hamilton (1996). Oil price increases are expected to affect irreversible investment decisions much more potently than oil price declines. And because oil prices tend to be quite volatile over short periods of time, the oil price variable is measured as the percentage change of the price of oil relative to the maximum price over the past four quarters. The fiscal policy variable is measured by the change in the cyclically adjusted federal budget deficit deflated by the PCE deflator. The cyclically adjusted measure is the fitted values of the federal budget deficit from a regression with four lags of the deviations of the unemployment rate from its Hodrick-Prescott trend. The monetary policy measure is the real federal funds rate (effective federal funds rate less PCE inflation).

Adjusted volatility results

The results of the three regressions are found in Table A1. The residuals from the three regressions confirm the graphical impressions in Charts 2 and 3. Chart A1 shows a low-high-low-volatility pattern. The volatility bands reveal low-volatility regimes in the 1960-69 and 1984-96 periods and a relatively high-volatility regime in the 1970-83 period. Moreover, data confirm the assumption that manufacturing employment is more volatile than services employment. Chart A2 shows that after correcting for the oil price increases, fiscal policy, and monetary policy, the growth rate of manufacturing employment exhibits more volatile behavior than services employment.

These adjusted series for output and sectoral employment corroborate the evidence in the text. The decline in the manufacturing employment share is not consistent with the low-high-low volatility pattern in the data. Correcting the volatility measure for oil price increases, cyclically adjusted fiscal policy, and monetary policy does not alter this conclusion.

Table A1

REGRESSION RESULTS

Output regression:

$$GDP_t = \sum_{i=1}^{4} \beta_{i,O}\, Oil_{t-i} + \sum_{i=1}^{4} \beta_{i,D}\, Deficit_{\,t-i} + \sum_{i=1}^{4} \beta_{i,R}\, RFF_{t-i} + \varepsilon_t$$

Manufacturing employment regression:

$$MFG_t = \sum_{i=1}^{4} \beta_{i,O}\, Oil_{t-i} + \sum_{i=1}^{4} \beta_{i,D}\, Deficit_{\,t-i} + \sum_{i=1}^{4} \beta_{i,R}\, RFF_{t-i} + \varepsilon_t$$

Services employment regression:

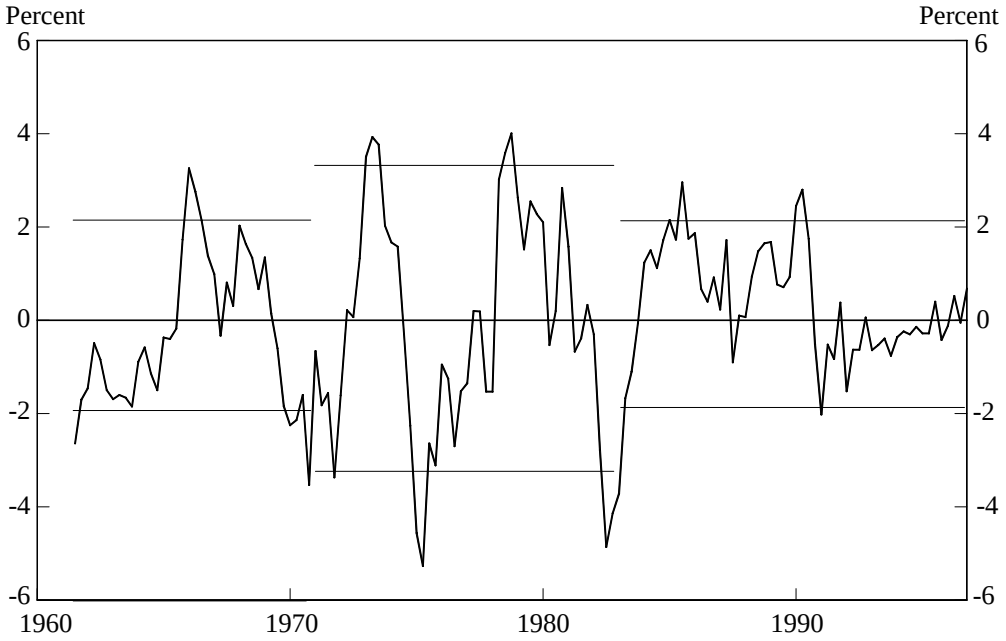
$$Serv_t = \sum_{i=1}^{4} \beta_{i,O}\, Oil_{t-i} + \sum_{i=1}^{4} \beta_{i,D}\, Deficit_{\,t-i} + \sum_{i=1}^{4} \beta_{i,R}\, RFF_{t-i} + \varepsilon_t$$

	Marginal significance and explanatory power of oil prices and policy variables		
	Real GDP	Manufacturing employment	Services employment
	Marginal significance level		
Lagged oil prices	.05	.00	.00
Lagged deficit	.15	.06	.65
Lagged federal funds rate	.01	.00	.01
	Percent of variation explained in each equation		
R^2	.19	.31	.39

Note: The tests give the probability that the information variables (lagged net oil price increases, fiscal deficit deflated by the PCE deflator, and real federal funds rate) are jointly significant. A probability value close to zero suggests that the information variables are important to explain the variation in the dependent variable (deviation of real GDP from Hodrick-Prescott trend, growth rate of manufacturing employment, and growth rate of services employment). The R^2 gives the explanatory power of the information variables.

Chart A1

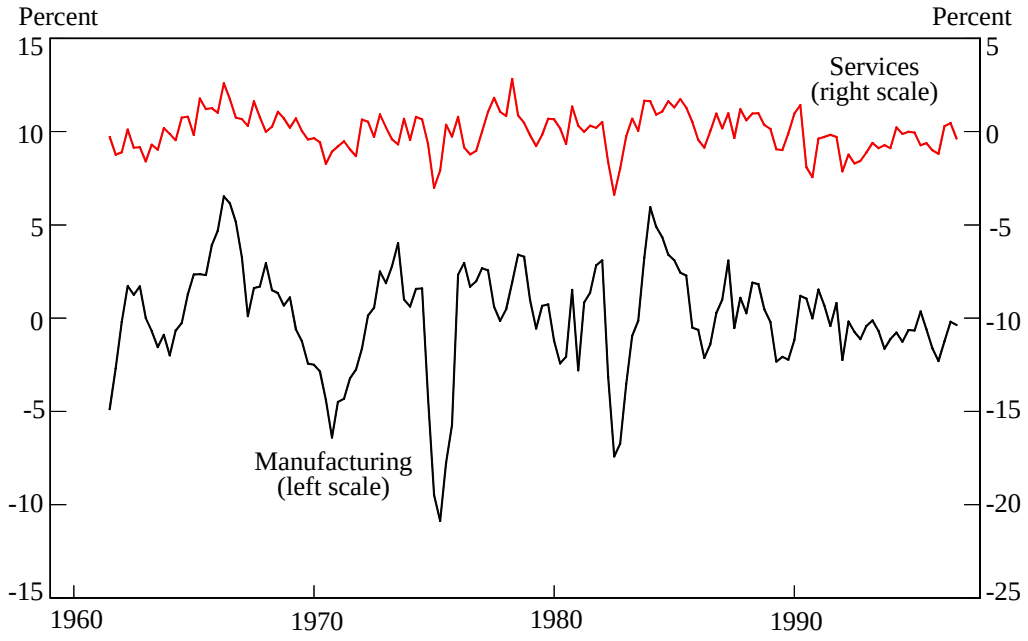
REGRESSION-ADJUSTED VOLATILITY PATTERN IN THE BUSINESS CYCLE



Note: Adjusted volatility is measured as percentage deviation of real nonfarm GDP from its Hodrick-Prescott trend not explained by the regression discussed in Appendix A1.
Source: Bureau of Economic Analysis and author's calculation.

Chart A2

REGRESSION-ADJUSTED SECTORAL EMPLOYMENT VOLATILITY



Note: Adjusted volatility is measured as quarter over same quarter year-ago growth rate of sectoral employment not explained by the regression discussed in Appendix A1.
Source: Bureau of Labor Statistics and author's calculation.

APPENDIX B

PHASE DURATIONS AND SHIFTING MANUFACTURING EMPLOYMENT SHARES

This appendix describes the estimation methods used in this article to test for the statistical association between the declining manufacturing employment share and lengths of business cycle episodes. The tests will highlight the statistical significance of the article's findings.

Estimating changes in mean durations of expansions and recessions

Simple, yet meaningful measures of the durations of business cycle expansions and recessions are hard to find. Typical statistical methods such as average lengths and their standard deviations are not well suited to analyze expansion and recession, or phase, data. Phase durations do not appear to hover around a fixed length that might be thought of as a mean duration. Rather, the durations of phases tend to settle into a range, or central tendency. For example, since 1960 there have been six expansions, which have varied in length from 12 to 106 months with little apparent tendency to gravitate toward the simple average of 63 months.

Economists have avoided the drawbacks of these simple statistics by using more sophisticated methods, technically referred to as hazard methods. Hazard methods attempt to measure the range of phase lengths by estimating the probability that expansions and recessions will end. If the probability that a phase will end falls, then the central tendency of phase lengths will rise. If the probability that a phase will end rises, the central tendency of phase lengths will fall. In previous business cycle research, the hazard methods have proven useful in investigating questions about whether expansions die of old age and whether pre-WWII expansion and recession lengths are statistically different (Diebold and Rudebusch, Sichel).

Model and results

Extending Sichel's hazard model for business cycle durations, this article incorporates the effects of a declining manufacturing employment share. The relationship between the probability that a phase will end and the employment share is described in a linear form:

$$\log(\mu) = \log(\mu_0) + \beta_1 \, MFG_i \, ,$$

where $\log(\mu)$ is a factor that directly affects the probability that a phase will end. If $\log(\mu)$ rises, then the probability that a phase will end rises. If $\log(\mu)$ falls, then the probability that a phase will end falls. $\mathrm{Log}(\mu_0)$ is a constant term that measures the time-invariant contribution to the probability of exiting a phase. β_1 measures the association between the declining employment share and probability that a phase will end. MFG_i

is the average manufacturing employment share in the *i*th phase (expansion or recession) in the sample. Since the manufacturing share trends downward over the sample, a positive β_1 means that over time log(μ) will fall and thus the central tendency of phases will lengthen. If, on the other hand, β_1 is negative, then over time log(μ) will rise and thus the central tendency of phase durations will shorten.

Table B1 reports the estimation results for this model using the NBER business cycle chronologies from 1854-1996, using the full sample and subsampling before and after 1960. The manufacturing share data after 1939 come from the Bureau of Labor Statistics; the prior data come from interpolation of decennial estimates (see Kendrick and *Historical Statistics of the United States*). The first two columns of estimates provide limited statistical evidence that the declining manufacturing employment share has affected the probability of exiting expansions and recessions. The evidence is stronger for expansions than for contractions.

One possible problem with the inferences using this specification is that the manufacturing employment share trends downward over the sample. Previous research has shown that a simple time trend helps to explain the duration data. Moreover, this article focuses on results for the post-1960 period. Rewriting the equation for log(μ) to account for the possible change in behavior from the pre-1960 period to the post-1960 period yields the following model:

$$\log(\mu) = \log(\mu_0) + \beta_{60-} D_{60-} MFG_i + \beta_{60+} (1 - D_{60-}) MFG_i + \beta_{trend}\, i,$$

where D_{60-} is an indicator variable that is 1 before 1960 and 0 after 1960, and *i* is the index on the expansion and recession phases.

The estimates of the coefficients on the post-1960 period variable are statistically insignificant from zero, including or excluding the trend. The statistical insignificance provides evidence that the declining manufacturing employment share has not affected the central tendencies of expansion and recession lengths since 1960. Thus, recent expansions and recessions have not been particularly long or short in a statistical sense.

Table B1

IMPACT OF DECLINING MANUFACTURING EMPLOYMENT SHARE ON PHASE LENGTHS

	Full sample		Pre-1960 and post-1960 subsamples			
	Excluding trend		Including trend		Excluding trend	
	Expansion	Recession	Expansion	Recession	Expansion	Recession
μ_0	.40	1.42	1.24	.53	.99	15.25
	(.74)	(3.26)	(2.47)	(1.72)	(1.85)	(30.91)
β_{MFG}	.08	.14				
	(.04)	(.05)				
β_{60-}	–		.00	.06	-.00	.04
			(.07)	(.08)	(.06)	(.08)
β_{60+}	–		.02	.08	.03	-.01
			(.05)	(.09)	(.04)	(.05)
β_{trend}	–		1.93	.06		
			(.37)	(.04)		

Summary statistics

Average length	Full sample	Pre-1960	Post-1960
Expansions	36 months	30 months	62 months
Recessions	17 months	19 months	11 months

Note: Standard errors of parameters are in parentheses.
Source: NBER and author's calculation.

ENDNOTES

[1] The contribution of employment to the nation's output is about twice the size of capital's contribution.

[2] The service sector includes (ordered by size of employment from high to low) services (business, health, and educational services), wholesale and retail trade, government, FIRE (finance, insurance, and real estate), transportation, and public utilities.

[3] The data show that exports are relatively more important for activity in manufacturing than in services. The exports of goods and services data reveal that four-fifths of nonagricultural exports were goods and one-fifth were services in 1995. Moreover, this difference may be understated because the service sector is larger than the manufacturing sector.

[4] Of course, it is a theoretical possibility that trade may help to smooth the demand for manufactured goods if changes in domestic demand were offset by changes in foreign demand. However, research on international business cycles finds that international business cycles are roughly synchronized (Mitchell; Gerlach and Klock; Filardo and Gordon 1994).

[5] This article investigates whether shifting employment share is consistent with the 1960-96 period. Earlier research claimed to have found evidence that structural employment shifts could mute the cycle (Fuchs; Zarnowitz; Zarnowitz and Moore). Thus, as the economy became more services oriented, overall economic activity stabilized. Zarnowitz wrote in a paper published originally in 1981: "At this point, substantial moderation of the U.S. business cycle when compared with the pre-World War II patterns became quite apparent, and the important question was what accounts for the change and how lasting it would be. Of the domestic factors, one that is well documented and most probably important is the shift in the industrial composition of employment from cyclically highly sensitive sectors such as manufacturing, mining, and construction to relatively recession-proof sectors such as trade, services, and finance" (1992, p. 92).

[6] In this article, the concept of a recession is a decline in the level of economic activity (a "classical" recession), not simply a slowdown in the rate of growth (a "growth" recession).

[7] Of course, it is possible that shallower recessions may be associated with longer recessions. If the rate of economic readjustments (or "cleansing" effects of recessions) are positively related to the depth of a recession, then the shallower the recession is, the slower firms will restructure, and the slower the economy will turn around. Holding constant the rate of readjustment, however, the shallower the recession is, the shorter recessions will tend to last.

[8] The current expansion has already entered its seventh year—making it seven quarters shy of being the longest peacetime expansion and 12 quarters of being the longest expansion on record. Expansion (and recession) lengths are based on NBER turning points. The NBER, the official arbiter of U.S. business cycle chronologies, has officially compiled business cycle turning point dates back to 1854.

[9] The end points for the regimes were picked visually. Slight changes in the end points do not alter the conclusions.

[10] Formal statistical tests confirm the qualitative impressions from Chart 3. Pair-wise comparisons of the variances between regimes show that the variance in the 1960s period is statistically less than the variance in the 1970s and early 1980s period but is not statistically different from the variance in the 1983-96 period. The variance in the middle period was statistically larger than the variance in the last period. The tests used the 5 percent significance level. Moreover, the variance tests yield similar results for the regression-adjusted data in Chart A1 in Appendix A.

[11] Expansions and recessions were longer and recessions were shorter before 1960 than after 1960. First, the average duration of expansions rose from 30 months before 1960 to 63 months afterward; conversely, recession durations declined from an average of 19 months in the earlier period to 11 months in the later period. Second, expansion durations were somewhat more variable and recession durations less variable in the post-1960 period. One way to measure the variability is to look at the spread between the longest and shortest business cycle episodes during the periods. For example, the difference between the minimum and maximum lengths of expansions expanded from 70 months before 1960 to 94 months afterward. The difference for recessions shrank from 58 months before 1960 to ten months afterward.

[12] The approach that models the probabilities is technically called the hazard approach, and is discussed in Appendix B. Previous research has shown the usefulness of this approach in the study of business cycles. Diebold and Rudebusch, for example, used a hazard approach to

estimate the probability that business cycles end of "old age." Sichel has extended the approach to allow the probabilities to be a function of economic information.

[13] To see why the peak-to-trough statistic is a biased measure of shallowness, imagine an economy that experiences a cyclical slowdown in two different periods—one period with a zero growth rate trend and another with a faster growth rate trend. In the trendless period, the slowdown causes a recession because output will fall. In contrast, the same-sized slowdown will cause a smaller drop in output during the faster trend period because the slowdown is offset by the upward momentum of the trend. If the trend is strong enough, the slowdown may be completely offset, resulting in no decrease in the level of activity, and hence no recession as measured from peak to trough.

[14] From 1960 to 1973, real GDP growth averaged 4.4 percent. Since then, the average has fallen to 2.8 percent. The change in the trend may affect the peak-to-trough estimates. However, it should also be noted that despite the drop, statistical evidence of the change is not unambiguous. Christiano, for example, finds little evidence of a statistically significant decline in the growth rate of aggregate output. Using more up-to-date data does not change his conclusion (author's calculation).

[15] The results are robust to various trend specifications. In addition to the Hodrick-Prescott trend specification, linear trends that allow for break points and knot points were estimated.

[16] Productivity measures the amount of output per hour that is accounted for by the average employee.

[17] In the 1980s, some economists and policymakers argued that American manufacturing was on the decline. The terms "deindustrialization" and "hollowing out of our industrial base" were the topics of many policy conferences and the subject of policy concern. These concerns arose in a period when several highly visible manufacturing industries were facing economic distress. For example, in the 1980s the automobile industry was in a chronic slump, as were steel and machine tool industries. By the end of the 1980s, however, there was little doubt that manufacturing industries were strong and well poised for the 1990s.

[18] Nonfarm business productivity and manufacturing productivity data are readily available. Service sector productivity is much harder to measure. See Griliches for more details of the problem.

[19] Manufacturing and nonfarm business productivity are the more commonly reported productivity measures. Services productivity is typically not reported because of measurement issues. Kozicki addresses these measurement issues and argues that services productivity may be poorly measured. However, there is little debate that manufacturing productivity has been growing much faster than services productivity.

[20] Total factor productivity has also been quite strong in manufacturing industries, suggesting that technological innovations have continued to benefit manufacturing. Total factor productivity measures the part of labor productivity that is not explained by the use of capital and labor.

[21] The relative price was measured by the ratio of the implicit deflator of manufacturing to GDP less agriculture, forestry, and fisheries. The data up to 1987 were calculated using 1982 fixed-weighted measures; after 1987, growth rates from the 1992 chain-weighted data were used.

[22] Note that the output share is measured in real terms. Nominal manufacturing output as a share of total nominal GDP has, in fact, declined. However, the strong relative price declines of manufacturing goods relative to the price of GDP have kept the real output share fairly close to its long-term average.

[23] The stable output share refutes the claim that the U.S. economy in the 1980s was "deindustrializing." The manufacturing sector as measured by the output share has remained healthy.

[24] There is good reason to believe the output share plays a more important role in determining business cycles than the employment share. Business cycles are fundamentally defined by fluctuations in aggregate output. For example, the NBER recession dates roughly correspond to a simple rule of thumb that a recession occurs when there have been at least two consecutive quarters of negative real GDP growth, not two quarters of negative employment growth.

[25] It should be noted that outsourcing may have a subtle relationship to the manufacturing output share. Despite the shifting employment share, outsourcing does not directly affect the manufacturing output share. Under national income and product accounting, manufacturing output is measured by the sector's value added. Value added is the difference between the value of the product produced less the value of the inputs. In the example of the manufacturing firm and its legal services, the manufacturing value added does not depend on the provider of the services. Regardless of whether the firm produces the legal services internally or buys them from a law firm, the value of manufactured output net of legal services is the same. Because value

added does not change, outsourcing does not have a direct effect on the manufacturing output share.

[26] Outsourcing, however, may have two indirect effects on the aggregate output. First, outsourcing may indirectly affect value added because outsourcing may lead to a more efficient allocation of inputs. Firms undertake outsourcing because they believe that internally produced services can be purchased less expensively from the service sector. For example, legal costs will fall if law services can be produced more efficiently in the service sector. If legal services are produced more efficiently so that the manufacturing firm only needs to use 90 lawyers instead of the 100 employed internally, manufacturing value added would rise. Second, shifting internally produced services in manufacturing to the service sector may cause manufacturing value added to rise and service sector value added to fall because of measurement problems (Griliches and Siegel). These indirect efficiency effects tend to cause the manufacturing output share to increase, but evidence from Griliches and Siegel suggests that the indirect effects of outsourcing on efficiency (as measured by total factor productivity) are quite small.

[27] Wyckoff cites the growth of program trading, telemedicine, and tax and legal software programs as good examples of how knowledge codification is becoming increasingly widespread. Even though data on the economic size of codification are difficult to ascertain, Bayar and Montagnier cite that computer-related services account for a third of the spending on information technologies, with packaged software being a large and growing segment of the market.

[28] Wyckoff also argues that manufacturing industries are increasingly becoming more service-like as they reduce inventory levels using just-in-time inventory techniques and as they customize the output.

[29] In the 1960-80 recessionary periods, the average growth for services employment was 1 1/4 percent and the average decline for manufacturing employment was 7 1/4 percent. In the 1981-82 recession, services and manufacturing employment declined 0.15 and 11 percent, respectively. In the 1990-91 recession, services employment fell 0.42 percent while manufacturing employment fell only 3.4 percent.

[30] The parametric hazard function used in this analysis is of the Weibull form. It also allows for truncation and censoring (Sichel).

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