# DO SECTORAL SHIFTS MATTER? – THE PARADOXICAL CASE OF CYCLICAL EMPLOYMENT FLUCTUATIONS

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Forschungsbericht/
Research Memorandum No. 285
October 1991

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Revised version of paper presented at the July 1991 meetings of the Western Economic Association in Seattle, session on "How Well Do Labor Markets Work?" where Price Fishback and Joshua Rosenbloom provided helpful suggestions. Also many thanks, but no blame, to John Pencavel, Thomas Macurdy, Steven Durlauf, Victor Fuchs, Thomas Kniesner, Robert Earle, Joshua Rosenbloom, Larry Levin, Frank Howland, Bill Sundstrom and Carol Rapaport for discussions of earlier versions.

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**Abstract**

This study analyzes the impact of intersectoral shifts on aggregate cyclical employment behavior in the post-World War II United States. Although services-producing industries have significantly lower cyclical employment fluctuations than do goods-producing industries, the large shifts from goods to services have not resulted in any discernable change in aggregate behavior. To explain this paradox of the seeming irrelevance of industrial composition, this paper analyzes the complex relationship between aggregate and industry fluctuations, demonstrating that previous work on the topic of aggregation has omitted an important component of the relationship. A decomposition of the change in aggregate behavior into all of its disaggregate components reveals that sectoral shifts would have reduced aggregate employment fluctuations, although for surprising reasons different from the simple story, had changes in other components not offset the compositional effect of the shifts.

## Section 1: Introduction

In 1968, Victor Fuchs wrote that "one of the most intriguing aspects of the development of a service economy is the prospect it offers of increasing stability over the business cycle."[1] Fuchs observed that services compared to goods-producing sectors tend to have smaller fluctuations in both output and employment, but larger fluctuations in productivity over the reference cycle. The clear implication was that the on-going shifts in the industrial composition of the economy could lead to smaller cyclical fluctuations of aggregate output and employment.

Twenty years later, the sectoral shifts have gone much farther than those observed by Fuchs. As a proportion of total employees on non-agricultural payrolls, employees of goods-producing industries fell from .42 to .35 between 1948 and 1968; by January 1988 this ratio had fallen to .24. And recent research (Earle, 1988) has confirmed the large differences in the cyclical behavior of much more disaggregated industries, including the result that on average employment in goods industries fluctuates much more over the cycle (measured as fluctuations in industry output) than it does in services industries.

Yet the predictions of increased stability have failed to come true. Although it is too early to report on the recession of 1990-91, the recessions of the 1970's and 80's were much more severe than those of the 1950's and 60's; this apparent trend towards more volatile cyclical behavior has been a central issue for research and policy. Moreover, as this paper will show, the relationship between the fluctuations of aggregate output and employment has been approximately constant over the post-war period: for a given deviation from trend in output, employment responded about the same in the 1970's and 1980's as it did in the 1950's and 1960's. The aggregate elasticity of

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[1] P.158. Other early observers of differences in cyclical behavior between the goods sector and the services sector include Burns (1960) and Creamer (1956). In Fuchs and Burns, and in this paper, "Goods" includes mining, manufacturing and construction and excludes agriculture, while "Services" includes transportation, communication, utilities, trade, finance, insurance, and real estate (FIRE), and service industries and excludes government. Creamer uses a tripartite division into goods, services, and distributive industries, where the latter category includes transportation, utilities and trade.

employment with respect to output thus seems to be immune to transformation of the underlying industrial composition of the economy.

The purpose of this paper is to explain this incongruity between the aggregate and industry cyclical employment elasticities. What could account for the apparent paradox? A first possibility is that the behavior of individual goods and services industries might not have been constant over time. Perhaps services employment has become more sensitive to the cycle and goods employment less so, or perhaps the degree of employment fluctuation increased in all or a significant fraction of industries over this period. The sectoral shifts could have been offset by changes in the behavior of industries and of whole sectors.

Second, the relationship between the individual and aggregate cycles might have changed. If, for instance, industries with large employment fluctuations have become more pro-cyclical, that is, movements of their output have become more closely associated with movements in aggregate output so that they account for more of the aggregate cycle, then it would appear that aggregate cyclical employment fluctuations have increased, if there were no change in individual industry behavior or in industrial composition. This factor could have thus offset the effect of the compositional shift.

Third, the connections between the results from estimation of the same relationship at the aggregate level and the disaggregated level are generally quite complex. For the case of cyclical employment fluctuations, part of the connection arises from the possibility of association between the aggregate cycle and movements of industry employment not accounted for by the industry cycle. Employment in one industry could move systematically with output in another: for instance, when automobile output rises, steel employment may increase in anticipation of future demand. These inter-industry relationships form part of the connection between aggregate and disaggregate measures of cyclical fluctuation; the patterns of these relationships might have changed over the post-war period so as to offset the compositional effect.

Finally, the characterization of broad sectors of the economy might mask a great diversity of behavior at a more disaggregated level. The simple story about the average behavior of goods versus service sectors and the shifts between them might be too simple. A finer disaggregation could reveal, for instance, that those service industries that have expanded the most are characterized by more rather than less cyclical fluctuation of employment or that the same is true among those relatively few goods industries that grew over this period. Clearly, individual industries within the aggregate sectors have had different experiences of growth or decline.

This paper explores these four explanations, using the most disaggregated output and employment data available that cover the entire private economy. As I will demonstrate, the four explanations are exhaustive but not mutually exclusive: each could account for part of the relationship between the cyclical behaviours of aggregate and industry labor markets. Which factor(s) are relatively important has implications for forecasting future cyclical employment behavior, for research on the determinants of cyclical fluctuations in labor markets, and for the question of the usefulness of examining only aggregate data when analyzing business cycles.

Additionally, this paper considers the problem that certain kinds of measurement error may lead to an upward bias on estimates of employment-output elasticities for disaggregated industries and to some extent also for the aggregate, because the aggregate data are the sum of the industry data. If these industries have grown at a different rate than the total economy, then changes in the aggregate relationship would be partly an artifact of this measurement error. Before proceeding to an analysis of the other explanations, I eliminate those industries from the analysis which could thus bias the analysis.

Section 2 documents the existence of this paradox, presenting evidence first of differences between the goods and the services sectors in cyclical employment behavior, which is measured as the elasticity of employment with respect to a cyclical indicator, taken to be movements in output in individual industries. Together with the further evidence of inter-sectoral shifts from goods to services in the postwar period, the regularity that goods employment fluctuates more over the cycle than does services employment implies that a reduction in aggregate cyclical employment fluctuation should have been observed over this period.

The section then addresses the question whether there have indeed been changes in aggregate cyclical employment behavior, measured as the elasticity of aggregate employment with respect to aggregate output. The puzzling result is that aggregate cyclical employment behavior has been quite constant. The possibility that detectable measurement error plays an important role in these results is considered and rejected. Moreover, the aggregate measure of employment variability is much larger than the average of the industry measures. Explaining the role of composition therefore requires a rigorous specification of the connection between aggregate and disaggregate measures of cyclical employment variability.

Section 3 formally develops the accounting relationship between the fluctuation of disaggregated industry employment over the industry output cycle and the fluctuation of aggregate employment over the aggregate output cycle. I demonstrate that the accounting relationship consists of the four factors cited above and derive an explicit framework within which the contribution of each to the aggregate can be measured. With the aid of this framework, it is possible to conduct an interesting experiment: holding the other components constant, if the only change in the economy after 1969 had been its industrial composition, how would aggregate cyclical employment behavior have differed? In other words, what would an observer (such as Fuchs) have forecast for the future behavior of aggregate employment fluctuations, if he or she had known the precise relationship between the behavior at the industry level and in the aggregate?

Accounting for change (or lack thereof) in aggregate cyclical employment volatility requires consideration of changes in all the components of the aggregate. Section 4 therefore derives and measures a decomposition of change in the aggregate in terms of these components. The results explicitly demonstrate the often acknowledged but poorly understood perils of drawing inferences about the relationship between the aggregate and disaggregate, and therefore about compositional effects. Conclusions and broader implications are adduced in Section 5.

## Section 2: The Paradox

I adopt a standard approach to the measurement of the cyclical fluctuation of a variable: the degree of fluctuation is not measured in absolute terms but relative to a cyclical indicator; the cyclical indicator is defined as deviations of output from its trend. The cyclical employment elasticity[2], the relationship of movements in employment about its trend to this output cycle, is then a measure of the magnitude of cyclical employment fluctuation.

Defining $l_t$ as the proportional change and $l_t^*$ as the trend growth of employment ($L_t$), and $x_t$ as the proportional change and $x_t^*$ as the trend growth of output ($X_t$) in time period t, the cyclical employment elasticity, ß, is defined by

(1) $l_t - l_t^* = ß(x_t - x_t^*) + u_t,$

where the $u_t$ are movements of employment not accounted for by this decomposition of the trend and cycle. Estimating this relation is clearly impossible without identifying the trends; among a number of simple ways is to assume they are constant over time, so that $l^* = l_t^*$ and $x^* = x_t^*$, which allows us to identify and calculate ß by ordinary least squares estimation of

(2) $l_t = \alpha + ßx_t + u_t,$

where $\alpha = l^* - ßx^*$ is the trend growth in employment relative to output.

Interindustry differences in cyclical employment behavior can be established by estimating (2) at the most disaggregated level possible for each industry separately:

(3) $l_{it} = \alpha_i + ß_i x_{it} + u_{it},$

where $l_{it}$ is the proportional growth in the employment of industry i from period t-1 to period t, $x_{it}$ is the proportional industry output growth, and the parameters are interpreted analogously to those in (2) with $ß_i$ representing the elasticity of industry employment with respect to industry output.[3] This measure of industry-level fluctuations thus uses industry-specific cyclical

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[2]See Kniesner and Goldsmith (1987) for a review of the literature and Earle (1988) for estimates of cyclical elasticities for many labor market variables including hours of work and real and nominal compensation, for the aggregate economy and for industries, and with two different data sets.

[3]Certainly more complicated and general versions of this equation could be calculated, in particular allowing the trend to be time-dependent or considering the possibility of lagged adjustment of $l_{it}$ to $x_{it}$. The series could be explicitly divided into stationary and non-stationary components, although the use of first-differences of output and employment (in equations (2) and (3)) implies this would probably be a minor adjustment. There may also be possibilities for more efficient estimation if the $u_{it}$ are not independently and identically distributed across industries. The results from applying some of these techniques are reported in Earle (1988); as they generally differed only slightly, only the results from estimating the most parsimonious specification (3) are reported here.

indicators: the industry cycles, measured by changes in industry outputs, are taken as given, and the $\beta_i$ measure how much industry employment changes in response.

Table 1 displays the results from ordinary least squares estimation of the $\beta_i$ in equation (3) over the 1948-85 period for the most disaggregated data available across the entire economy.[4] Two employment concepts are distinguished: "persons engaged in production" ($L_t$ for the aggregate and $L_{it}$ for industries), defined as the sum of full-time equivalent employees and self-employed persons, and "full-time and part-time employees" ($E_t$ and $E_{it}$). Both $L_t$ and $E_t$ are the simple sums of their respective industry components. Results for the two employment measures appear in the columns labelled "L (Persons) Elasticity" and "E (Employees) Elasticity"). The estimates range across industries from roughly zero to one with a mean of .45 and a standard deviation of .30.

Clearly, there are large interindustry differences in cyclical employment behavior, but a test for the statisticalsignificance of the differences among industries can also be performed by pooling the data and allowing $\alpha$ and $\beta$ to vary across industries. An F-test on the joint significance of these industry effects finds them statistically significant at the one percent level.

Notice the industries with elasticity estimates very close to one, such as SIC 60, 61, 62, 67, 76, and 82. These are among the industries with measurement error problems, whereby output is measured using labor input, especially employment. For those industries, these measures of cyclical employment fluctuation are therefore rather meaningless.

A glance at the table indicates that goods-producing industries (up to SIC 39) on average have higher elasticities than do services-producing (SIC 40

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[4]The data are drawn from the National Income and Product Accounts and contain 60 private industries, at roughly the two and three-digit level of the SIC. Not only is output the most disaggregated available, this data set also contains the longest consistent time series available for employment at this level of disaggregation. Unfortunately, industry output is available only on an annual basis, so all the relationships in this paper are estimated with annual data. Aggregate output ($X_t$ at time = t) is real Gross Product Originating (GPO) in the domestic private sector; it is of course appropriate to exclude Rest-of-World Product. Industry output ($X_{it}$) is GPO or value-added for the industry, with $X_t = \Sigma_i X_{it}$.

## Table 1

**Cyclical Elasticities of Employment (L and E), 1948 to 1985**
**And Employment (L) and Output (X) Shares in 1950 and 1980**
**By Industry (Private Sector)**

| SIC INDUSTRY | L (PERSONS) ELASTICITY | E (EMPLOYEES) ELASTICITY | L SHARE IN 1950 | L SHARE IN 1980 | X SHARE IN 1950 | X SHARE IN 1980 |
|---|---|---|---|---|---|---|
| 1.0 Farms | -.037 | -.116 | 0.120 | 0.032 | 0.057 | 0.023 |
| 7.0 Forestry and Fisheries | 0.745 | 0.911 | 0.005 | 0.009 | 0.006 | 0.004 |
| 10.0 Metal Mining | 0.587 | 0.582 | 0.002 | 0.001 | 0.002 | 0.001 |
| 11.0 Coal Mining | 0.581 | 0.591 | 0.009 | 0.003 | 0.011 | 0.005 |
| 13.0 Oil and Gas | 0.451 | 0.483 | 0.005 | 0.007 | 0.056 | 0.041 |
| 14.0 Non-metallic Minerals | 0.319 | 0.314 | 0.002 | 0.002 | 0.002 | 0.002 |
| 15.0 Construction | 0.580 | 0.716 | 0.067 | 0.068 | 0.098 | 0.059 |
| 20.0 Food Products | 0.044 | 0.009 | 0.035 | 0.021 | 0.025 | 0.021 |
| 21.0 Tobacco | 0.120 | 0.131 | 0.002 | 0.001 | 0.005 | 0.003 |
| 22.0 Textile Mill Products | 0.401 | 0.356 | 0.024 | 0.010 | 0.005 | 0.006 |
| 23.0 Apparel | 0.618 | 0.543 | 0.024 | 0.015 | 0.009 | 0.007 |
| 24.0 Lumber and Wood | 0.542 | 0.549 | 0.018 | 0.010 | 0.008 | 0.007 |
| 25.0 Furniture | 0.589 | 0.577 | 0.007 | 0.006 | 0.005 | 0.004 |
| 26.0 Paper Products | 0.257 | 0.254 | 0.009 | 0.009 | 0.010 | 0.009 |
| 27.0 Printing and Publishing | 0.202 | 0.217 | 0.016 | 0.015 | 0.015 | 0.013 |
| 28.0 Chemicals | 0.152 | 0.142 | 0.012 | 0.014 | 0.010 | 0.018 |
| 29.0 Petroleum, Coal Products | -.009 | 0.006 | 0.004 | 0.003 | 0.011 | 0.010 |
| 30.0 Rubber and Plastic | 0.569 | 0.559 | 0.006 | 0.009 | 0.004 | 0.007 |
| 31.0 Leather | 0.404 | 0.389 | 0.008 | 0.003 | 0.004 | 0.002 |
| 32.0 Stone, Clay and Glass | 0.536 | 0.528 | 0.011 | 0.008 | 0.010 | 0.008 |
| 33.0 Primary Metal | 0.520 | 0.507 | 0.023 | 0.014 | 0.038 | 0.017 |
| 34.0 Fabricated Metal | 0.735 | 0.719 | 0.022 | 0.020 | 0.021 | 0.019 |
| 35.0 Machinery | 0.624 | 0.621 | 0.025 | 0.031 | 0.025 | 0.031 |
| 36.0 Electric Equipment | 0.744 | 0.731 | 0.019 | 0.026 | 0.008 | 0.023 |
| 37.1 Motor Vehicles | 0.451 | 0.447 | 0.016 | 0.010 | 0.018 | 0.012 |
| 37.2 Transportation Equipment | 0.829 | 0.833 | 0.009 | 0.014 | 0.010 | 0.014 |
| 38.0 Instruments | 0.647 | 0.639 | 0.005 | 0.009 | 0.004 | 0.008 |
| 39.0 Miscellaneous Manuf. | 0.306 | 0.276 | 0.008 | 0.006 | 0.005 | 0.004 |
| 40.0 Railroad Transportation | 0.422 | 0.408 | 0.027 | 0.006 | 0.025 | 0.010 |
| 41.0 Local and Interurban | 0.221 | 0.195 | 0.008 | 0.004 | 0.019 | 0.003 |
| 42.0 Trucking and Warehousing | 0.408 | 0.471 | 0.014 | 0.018 | 0.012 | 0.019 |
| 44.0 Water Transportation | 0.346 | 0.350 | 0.004 | 0.003 | 0.004 | 0.003 |
| 45.0 Air Transportation | 0.343 | 0.357 | 0.002 | 0.006 | 0.002 | 0.008 |
| 46.0 Pipelines | -.071 | -.071 | 0.001 | 0.000 | 0.001 | 0.002 |
| 47.0 Transportation Services | 0.520 | 0.512 | 0.001 | 0.003 | 0.004 | 0.003 |
| 48.1 Telephone and Telegraph | 0.708 | 0.701 | 0.013 | 0.013 | 0.008 | 0.026 |
| 48.3 Radio and TV Broadcasting | 0.135 | 0.137 | 0.001 | 0.002 | 0.001 | 0.003 |
| 49.0 Electric, Gas, Sanitary | -.043 | -.028 | 0.011 | 0.010 | 0.016 | 0.031 |
| 50.0 Wholesale Trade | 0.213 | 0.256 | 0.055 | 0.068 | 0.060 | 0.078 |
| 52.0 Retail Trade | 0.301 | 0.327 | 0.156 | 0.176 | 0.117 | 0.105 |
| 60.0 Banking | 0.977 | 0.895 | 0.008 | 0.019 | 0.015 | 0.021 |
| 61.0 Other Credit Agencies | 0.998 | 0.913 | 0.003 | 0.007 | 0.001 | 0.002 |
| 62.0 Security, Commodity Brokers | 1.001 | 1.010 | 0.001 | 0.003 | 0.003 | 0.004 |
| 63.0 Insurance Carriers | 0.293 | 0.196 | 0.011 | 0.015 | 0.010 | 0.010 |
| 64.0 Insurance Agents, Brokers | -.051 | 0.040 | 0.004 | 0.007 | 0.007 | 0.006 |
| 65.0 Real Estate | -.008 | 0.132 | 0.011 | 0.016 | 0.080 | 0.124 |
| 67.0 Holding and Investment | 0.995 | 0.966 | 0.000 | 0.001 | 0.001 | 0.002 |
| 70.0 Hotels | 0.250 | 0.302 | 0.012 | 0.016 | 0.008 | 0.008 |
| 72.0 Personal Services | 0.402 | 0.329 | 0.024 | 0.017 | 0.015 | 0.008 |
| 73.0 Business Services | 0.883 | 0.914 | 0.008 | 0.039 | 0.012 | 0.031 |
| 75.0 Auto Repair | 0.332 | 0.538 | 0.006 | 0.011 | 0.005 | 0.009 |
| 76.0 Miscellaneous Repair | 0.998 | 0.938 | 0.005 | 0.006 | 0.005 | 0.003 |
| 78.0 Motion Pictures | 0.225 | 0.106 | 0.004 | 0.003 | 0.006 | 0.002 |
| 79.0 Amusement, Recreation | 0.322 | 0.347 | 0.006 | 0.009 | 0.005 | 0.005 |
| 80.0 Health Services | 0.243 | 0.313 | 0.024 | 0.066 | 0.025 | 0.047 |
| 81.0 Legal Services | 0.086 | -.006 | 0.005 | 0.009 | 0.012 | 0.011 |
| 82.0 Educational Services | 1.003 | 0.774 | 0.009 | 0.016 | 0.007 | 0.007 |
| 83.0 Social Services, Membership | 0.941 | 0.891 | 0.014 | 0.030 | 0.009 | 0.011 |
| 84.0 Miscellaneous Professional | 0.555 | 0.687 | 0.005 | 0.017 | 0.008 | 0.017 |
| 88.0 Private Households | 0.840 | 0.668 | 0.033 | 0.010 | 0.015 | 0.003 |

to SIC 88). Excluding twelve industries with measurement error,[5] the average goods elasticity is about .52 and the average services is .36, for both employment measures. This establishes the basic empirical regularity of greater cyclical employment variation in goods-producing than in services-producing industries.[6]

Major industry groups (divisions) also differ systematically in this measure of cyclical employment fluctuation. Within the goods sector, construction and durables manufacturing industries have the highest average elasticity (for $L_i$, about .58 for each), while mining and non-durables are somewhat lower (.49 and .36, respectively). Within the service sector, the division of transportation, communication and public utilities and the services industry division have somewhat higher average elasticities (.37 and .42) while trade and FIRE are much lower (.17 and roughly zero). It is also clear from a glance at Table 1 that there is substantial heterogeneity within these broad sectors.

It is a commonplace that the U.S., as well as many industrialized countries, has experienced large shifts from goods to services during the post-war period. Figure 1 shows the declining output and employment share of the goods-producing sector from 1948 to 1985, and Table 1 provides the share in total $L_t$ and $X_t$ for each industry in the years 1950 and 1980. Note that the shift has been more in employment than in output. As a proportion of GNP, goods fell from .45 to .34 between 1948 and 1985, but as a proportion of total employment the goods share fell from .45 to .30. Manufactured goods (i.e., excluding mining and construction) were actually an almost constant percentage of GNP over this period. All this is of course just another way of saying that goods sectors have had higher productivity growth.

But the greater shift in output only reinforces the argument that the

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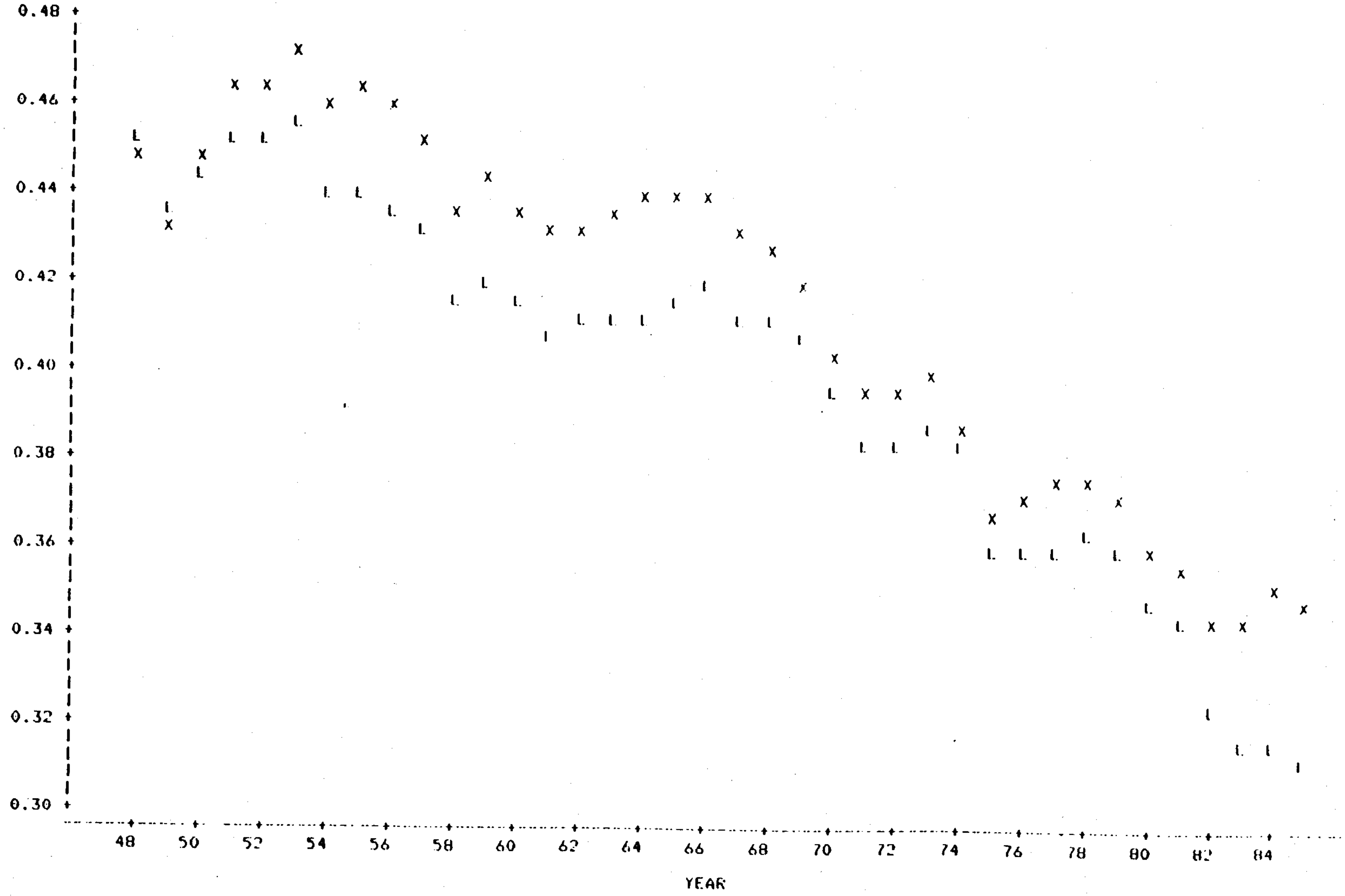
[5]SIC 1, 7, 47, 60, 61, 62, 63, 67, 73, 76, 82, 88.

[6]This is consistent with the regularity observed by Fuchs and Burns that the aggregate goods sector experiences more employment volatility than the aggregate services sector, although they employ the traditional NBER methodology whereby the cyclical amplitude of employment is measured as the difference between the growth rates of two adjacent cycle phases. Earle (1991a) employs this methodology to verify the sectoral differences in more recent data and derives the precise relationship between those (non-time-invariant) measures and the statistical measure of cyclical employment elasticity.

Figure 1   Share of the Goods-Producing Sector
in Private Non-Agricultural Output (X) and Employment (L)



sectoral shifts could be expected to lead to a lower observed employment fluctuation in the aggregate. For employment shares fell more than output shares in goods-producing industries; thus, for given industry behavior (proportionate responsiveness of employment) and changes in aggregate output, aggregate employment would respond even less.

Have aggregate cyclical employment fluctuations, in fact, diminished in the U.S.? Having confirmed the existence of the interindustry differences and shifts, it is natural to ask whether this prediction has come true. Among a number of alternative ways, the question of whether the aggregate output elasticity of employment has changed can be addressed by estimating $\beta$ in equation (2) separately for different sub-periods of the complete post-war sample.

As an example, Table 2 displays the results for 1949-1969 and 1970-1985. Choosing the break point is somewhat arbitrary: one would obviously choose the year in which the major inter-industry shifts occurred in order to perform a before-and-after comparison, if there were such a year. But as Figure 1 showed for the division of output and employment between goods and services sectors and is also true for individual industry output and employment shares, there is no single point of abrupt structural change. The late 1960's were, however, a time of particularly rapid goods-to-services shift, and the early 1970's are often considered to mark a change in other aspects of macroeconomic behavior. Moreover, the period up to 1969 corresponds roughly to Fuchs' history and the period after corresponds to his forecast. Finally, the results differed little when other central years were chosen as breakpoints.[7]

Table 2 contains results for two different aggregates: the entire private economy, and a constructed aggregate that excludes the twelve industries that seem especially prone to measurement error. The data in the remaining forty-eight industries were summed to yield constructed aggregate variables that should provide relatively bias-free measures of the employment-output relationship.

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[7]Examination of shorter periods that left gaps between the early and late years, such as 1949-58 and 1975-85 yielded the same result of no significant differences between the estimates of the aggregate elasticities.

Table 2

**Estimates of the Aggregate Output Elasticity of Employment**

| | Private Economy | | Constructed Aggregate | |
|---|---|---|---|---|
| | 1949-1969 | 1970-1985 | 1949-1969 | 1970-1985 |
| $\alpha$ | -.014 (.004) | -.000 (.004) | -.014 (.005) | -.001 (.005) |
| ß | .669 (.094) | .726 (.108) | .715 (.104) | .713 (.110) |
| $R^2$ | .73 | .76 | .71 | .75 |
| DW | 1.18 | 1.52 | 1.37 | 1.52 |
| $l_t$ | .011 | .018 | .013 | .017 |

Notes: The estimates result from the application of OLS to equation (8) in the text. Standard errors appear in parentheses. "DW" denotes Durbin-Watson statistic. Estimates with an adjustment for serial correlation appear in Table A-1 in the Appendix. "$l_t$" is mean employment growth (the dependent variable) over the estimation period.

For both aggregates, the estimated trend $\alpha$ changes from a significant -.014 in 1949-69 to an insignificant -.001 in 1970-85, consistent with the well-known decline in productivity growth. Average employment growth has risen and average output growth has fallen.

While the estimated elasticity ß seems to have actually risen slightly from 1949-69 to 1970-85 in the private economy, for the constructed aggregate, however, it is remarkably constant, differing only by about a quarter of one percent between the early and the late postwar period.[8] The excluded industries grew relatively quickly in the postwar period; because they have relatively high $ß_i$, the aggregate ß for the entire private economy has increased slightly, although the change is not statistically significant. In either case, the hypothesis that the elasticity fell from 1949-69 to 1970-85 can be rejected.

The statistical significance of any change undergone by the aggregate elasticity can be measured more precisely with a modification of equation (2)

[8]The low value for the Durbin-Watson statistic suggests there may be a problem of serial correlation in the residuals. But the results are robust to adjusting for this problem, as shown in Appendix Table A-1. Although the estimates of the coefficients and their standard errors differ slightly with the Yule-Walker first-order autocorrelation adjustment, the qualitative conclusion of no change in the aggregate elasticity is unaffected. These results hold for the employment concept E as well as L.

that allows $\beta$ to vary over time. Among a number of ways to allow $\beta$ to vary is to interact it with five-year dummy variables. But the small estimated changes in $\beta$ from period to period that result from this exercise are not statistically significant and form no discernable pattern: $\beta$ has no clear positive or negative trend. Indeed, the late 1970's and early 1980's seem to be most similar to the 1950's. The results are identical for the complete private economy and for the constructed aggregate data that excludes the industries with measurement error. Simply interacting a time trend with $\alpha$ and $\beta$ also yields the same conclusion.[9]

Moreover, it is puzzling that estimates of the aggregate $\beta$ from Table 2 should be roughly 50 percent higher than the average of the industry $\beta_i$ from Table 1 (weighted by output or employment shares or unweighted). This suggests that the relationship between the aggregate and disaggregate is complex: the aggregate is not simply a weighted average of the disaggregate. This relationship must be rigorously analyzed to evaluate the effect of compositional shifts on aggregate behavior.

## Section 3: Decomposition of Aggregate Employment Fluctuations

Resolving the paradox that shifts between sectors that are behaviorally dissimilar seem to have no effect on aggregate behavior requires a rigorous accounting of the relationship between the aggregate and the sectoral behaviors. This section employs a framework (derived and elaborated in Earle (1991b)) for explicitly identifying and aggregating all the disaggregate components of the aggregate parameter. The framework provides a natural measure of the contribution of each component of each industry to the aggregate parameter during that estimation period. I apply the framework to the two estimation sub-periods of Section 2 (1949-69 and 1970-1985) and precisely measure the reasons for the divergence of the macroparameter from

[9]For the details of these results as well as an examination of this question in the NBER reference cycle framework, see Earle (1991a). Again the results show no tendency for cyclical employment fluctuations (again relative to the size of the output cycle) to have decreased. Bowers (1980) and Zarnowitz and Moore (1986) also examine peak to trough changes of employment, the former comparing these to the contemporaneous output changes and finding weak evidence that their ratio has declined over time. But this finding does not control for the increased trend growth of employment, which is clear in the data presented in Table 2.

the average of the microparameters over each period. With this information, it is possible to simulate what would have happened if only the industrial composition of the economy had changed. Because factors other than composition also changed over this period, accounting for the actual change in the aggregate requires a decomposition into changes attributable to the changes in each component; a solution to this index number problem is derived and implemented in Section 4.

The classic work in the field of aggregation is Theil (1954), but unfortunately his results (and those in more recent work on aggregation by Stoker (1986)) depend on an orthogonality assumption that is unlikely to be satisfied in many cases. Theil's and other previous work is also concerned almost exclusively with unweighted aggregation, where a macro variable is the simple sum across individuals of the corresponding micro variable. But for many problems, including the one considered here, macro variables are weighted sums of their micro components.

The aggregation framework relates regression coefficients from ordinary least squares estimation of several equations and is precisely analogous to the treatment of the problem of omitted variables bias. Besides the equations that derive the aggregate elasticity (2) and the industry elasticities (3), two more are required.

The relationship between the industry and aggregate output cycles can be estimated from $B_i$ in

(4) $$x_{it} = A_i + B_i x_t + \epsilon_{it}$$

for each industry. This equation corresponds to Theil's "auxiliary equation," which he maintains is "entirely formal" and "void of economic meaning." (1954, p. 13) In the present context, however, the $B_i$ are readily interpretable as the degree to which output in an industry moves sympathetically with aggregate output, the extent to which the industry cycle is pro-cyclical with respect to the aggregate cycle. Countercyclical industries have negative $B_i$; highly procyclical industries have $B_i > 1$.

The responsiveness of the employment in industry i that is uncorrelated with changes in industry i's output to the aggregate of output movements in other sectors can be estimated from $D_i$ in

(5) $$u_{it} = C_i + D_i x_t + \mu_{it},$$

for all industries, where the $u_{it}$ are the estimated residuals from the calculation of the industry elasticities (3), and $\mu_{it}$ are residuals uncorrelated with $x_t$. The $D_i$ represent movements of $l_{it}$ that are independent of $x_{it}$ but associated with aggregate $x_t$. These could arise because of real inter-industry dependencies or because $x_{it}$ is an imperfect cyclical indicator. One simple example is the possibility that hiring in one industry, say steel, is based on expectations of future demand in another industry, say automobiles. An upswing in autos could then lead to an increase in steel employment before steel output rises. Another possibility is that measurement error in industry output produces a downward bias in estimates of $\beta_i$ and makes aggregate output a better cyclical indicator for industry employment than is industry output.

Whatever its source, Theil implicitly assumes away this possible interaction among micro relations. Yet it could be an important component of the aggregate-disaggregate relationship. For instance, the $D_i$ will be non-zero any time there is a time effect in the relation of $x_t$ with $l_t$ that is not perfectly correlated with $l_{it}$. Indeed, I will show that for the present case it accounts for about 30% of the entire relationship.

Because in order to be able to calculate a compositional effect the expression for $\beta$ should explicitly include employment shares, it is necessary to define the proportional change of aggregate employment from any year t-1 to year t as approximately equal to the weighted sum of proportional changes in industry employments from t to t-1 where the weights are the shares in aggregate employment in year t:

(6) $$l_t \approx \Sigma_i s_{it} l_{it}, \text{ with}$$

(7) $$s_{it} \equiv L_{it}/L_t.$$

It is convenient and, it turns out, innocuous to use the average $s_{it} \equiv s_i$ over the estimation period as the fixed weights for aggregation. Multiplying the industry elasticity equations (3) by $s_i$ and summing over industries yields

(8) $$\Sigma_i s_i l_{it} = \Sigma_i s_i \alpha_i + \Sigma_i s_i \beta_i x_{it} + \Sigma_i s_i u_{it}.$$

Substitution of equations (4), (5) and (6) into (8) yields

(9) $$l_t = \Sigma_i s_i \alpha_i + \Sigma_i s_i \beta_i (A_i + B_i x_t + \epsilon_{it}) + \Sigma_i s_i (C_i + D_i x_t + \mu_{it})$$
$$= \Sigma_i s_i (\alpha_i + \beta_i A_i + C_i) + \Sigma_i (s_i \beta_i B_i + s_i D_i) x_t + \Sigma_i s_i (\beta_i \epsilon_{it} + \mu_{it}).$$

Equation (9) expresses aggregate employment movements as a linear function of aggregate output movements as in the aggregate equation (2). Because least squares estimation is a convex problem with a unique solution, it follows directly that the estimated parameters of (2) equal those of (9):

$$(10) \qquad \alpha \approx \Sigma_i s_i(\alpha_i + \beta_i A_i + C_i),$$
$$\beta \approx \Sigma_i (s_i \beta_i B_i + s_i D_i),$$
$$\text{and } u_t \approx \Sigma_i s_i(\beta_i \epsilon_{it} + \mu_{it}).$$

These relationships are "approximate identities": the approximation results from the discrete approximation in (4) and the assumption that the $s_{it}$ are equal to the constant average $s_i$ over the estimation period. As I will demonstrate shortly, the result of estimating $\beta$, $\beta_i$, $B_i$, $s_i$, and $D_i$ for several different estimation periods is that (10) holds almost exactly, so that the approximation error is negligible. And the $D_i$, the part of the expression for $\beta$ in (10) that is relatively difficult to interpret, change little between the time periods. These results make it easier to draw conclusions from the decomposition in (10).

Equations (10) differ from Theil's fundamental Theorem 1 by the presence of the aggregation weights $s_i$ and the additional terms $C_i$, $D_i$, and $\mu_{it}$ that result from the decomposition (5) of the residuals from the industry equations into components correlated and uncorrelated with aggregate output fluctuations. As discussed in Earle (1991b), ignoring this effect, the procedure followed by Theil (1954) and Stoker (1986), would result in a constructed error term that is not independent of $x_t$, and therefore not equal to $u_t$, since least squares estimation (of (2)) constructs residuals orthogonal to the regressors (in this case, $x_t$).

Results from the estimation of every component of the decomposition of $\beta$ in (10) for two estimation periods, 1949-1969 and 1970-1985, are displayed in Table 3 and Table 4, with superscripts 1 and 2 denoting the respective periods. The $s_i$, $\beta_i$, $B_i$ and $D_i$ are shown separately for each of the forty-eight industries, as well as the products $s_i \beta_i B_i$ and $s_i D_i$. Note that this latter term is quite large, accounting for about 25-30% of the aggregate; omitting this term, as does Theil, would result in a serious underestimate of the level of $\beta$. On the other hand, this term is approximately the same across the two estimation periods, so it is less important in accounting for change in $\beta$.

**Table 3**

**Decomposition of the Aggregate Cyclical Employment Elasticity**

**1949 to 1969**

| SIC | si1 | bi1 | Bi1 | Di1 | si1*Bi1*bi1 | si1*Di1 | Industry Contribution |
|---|---|---|---|---|---|---|---|
| 10.0 | 0.002 | 0.528 | 1.893 | -.046 | 0.002 | -.000 | 0.0020 |
| 11.0 | 0.006 | 0.425 | 2.702 | -.229 | 0.006 | -.001 | 0.0051 |
| 13.0 | 0.007 | 0.596 | 1.136 | -.170 | 0.005 | -.001 | 0.0035 |
| 14.0 | 0.003 | 0.456 | 1.096 | -.022 | 0.001 | -.000 | 0.0012 |
| 15.0 | 0.080 | 0.442 | 0.727 | 0.578 | 0.026 | 0.046 | 0.0719 |
| 20.0 | 0.038 | 0.115 | 0.450 | 0.192 | 0.002 | 0.007 | 0.0094 |
| 21.0 | 0.002 | 0.243 | 0.004 | 0.072 | 0.000 | 0.000 | 0.0002 |
| 22.0 | 0.022 | 0.396 | 1.504 | 0.566 | 0.013 | 0.013 | 0.0257 |
| 23.0 | 0.027 | 0.571 | 1.092 | 0.078 | 0.017 | 0.002 | 0.0190 |
| 24.0 | 0.017 | 0.416 | 2.027 | 0.734 | 0.014 | 0.013 | 0.0271 |
| 25.0 | 0.009 | 0.570 | 1.940 | 0.322 | 0.009 | 0.003 | 0.0121 |
| 26.0 | 0.013 | 0.221 | 1.479 | 0.314 | 0.004 | 0.004 | 0.0081 |
| 27.0 | 0.020 | 0.106 | 0.289 | 0.152 | 0.001 | 0.003 | 0.0036 |
| 28.0 | 0.018 | 0.219 | 1.424 | 0.425 | 0.005 | 0.007 | 0.0130 |
| 29.0 | 0.005 | -.212 | 0.633 | 0.406 | -.001 | 0.002 | 0.0012 |
| 30.0 | 0.009 | 0.507 | 2.314 | 0.388 | 0.011 | 0.003 | 0.0141 |
| 31.0 | 0.008 | 0.230 | 1.807 | 0.194 | 0.003 | 0.002 | 0.0048 |
| 32.0 | 0.013 | 0.490 | 1.767 | 0.294 | 0.011 | 0.004 | 0.0154 |
| 33.0 | 0.027 | 0.527 | 3.616 | 0.097 | 0.051 | 0.003 | 0.0532 |
| 34.0 | 0.029 | 0.844 | 1.968 | 0.004 | 0.047 | 0.000 | 0.0476 |
| 35.0 | 0.035 | 0.748 | 2.402 | 0.094 | 0.063 | 0.003 | 0.0659 |
| 36.0 | 0.031 | 0.786 | 2.269 | 0.181 | 0.055 | 0.006 | 0.0601 |
| 37.1 | 0.017 | 0.461 | 4.417 | 0.429 | 0.035 | 0.007 | 0.0421 |
| 37.2 | 0.022 | 0.933 | 1.042 | 0.359 | 0.021 | 0.008 | 0.0287 |
| 38.0 | 0.009 | 0.756 | 1.584 | 0.130 | 0.011 | 0.001 | 0.0116 |
| 39.0 | 0.009 | 0.569 | 1.503 | 0.145 | 0.008 | 0.001 | 0.0092 |
| 40.0 | 0.022 | 0.498 | 2.218 | 0.126 | 0.025 | 0.003 | 0.0276 |
| 41.0 | 0.007 | 0.295 | 0.535 | -.084 | 0.001 | -.001 | 0.0005 |
| 42.0 | 0.021 | 0.402 | 1.326 | 0.242 | 0.011 | 0.005 | 0.0161 |
| 44.0 | 0.005 | 0.337 | 2.213 | 0.276 | 0.004 | 0.001 | 0.0052 |
| 45.0 | 0.004 | 0.342 | 0.952 | -.126 | 0.001 | -.000 | 0.0008 |
| 46.0 | 0.001 | 0.115 | 1.309 | -.232 | 0.000 | -.000 | -.0000 |
| 48.1 | 0.016 | 0.877 | 0.427 | -.192 | 0.006 | -.003 | 0.0030 |
| 48.3 | 0.002 | 0.163 | 0.366 | -.094 | 0.000 | -.000 | -.0001 |
| 49.0 | 0.013 | 0.050 | 0.081 | -.107 | 0.000 | -.001 | -.0014 |
| 50.0 | 0.074 | 0.203 | 0.785 | 0.160 | 0.012 | 0.012 | 0.0236 |
| 52.0 | 0.198 | 0.185 | 0.570 | 0.201 | 0.021 | 0.040 | 0.0606 |
| 64.0 | 0.006 | -.040 | 0.506 | -.183 | -.000 | -.001 | -.0012 |
| 65.0 | 0.014 | 0.058 | 0.123 | 0.388 | 0.000 | 0.005 | 0.0055 |
| 70.0 | 0.016 | 0.517 | 0.373 | 0.137 | 0.003 | 0.002 | 0.0053 |
| 72.0 | 0.028 | 0.392 | 0.094 | 0.076 | 0.001 | 0.002 | 0.0031 |
| 75.0 | 0.008 | 0.379 | 0.782 | -.349 | 0.002 | -.003 | -.0004 |
| 78.0 | 0.004 | 0.370 | 0.415 | 0.003 | 0.001 | 0.000 | 0.0006 |
| 79.0 | 0.007 | 0.215 | 0.218 | -.056 | 0.000 | -.000 | -.0001 |
| 80.0 | 0.039 | 0.105 | 0.019 | 0.072 | 0.000 | 0.003 | 0.0029 |
| 81.0 | 0.006 | 0.106 | -.160 | 0.079 | -.000 | 0.001 | 0.0004 |
| 83.0 | 0.025 | 0.907 | 0.075 | -.051 | 0.002 | -.001 | 0.0004 |
| 84.0 | 0.010 | 0.914 | 0.517 | 0.054 | 0.005 | 0.001 | 0.0051 |
| | ===== | ===== | ===== | ===== | ===== | ===== | ====== |
| | 1.000 | 19.33 | 56.83 | 6.028 | 0.515 | 0.198 | 0.7135 |

Notes: The decomposition is for equation (16) in the text.
The bottom row is the sum of the corresponding column.
Industry contribution = si*bi*Bi + si*Di.
The numeral 1 indicates the estimation period 1949-69.

## Table 4

## Decomposition of the Aggregate Cyclical Employment Elasticity

## 1970 to 1985

| SIC | si2 | bi2 | Bi2 | Di2 | si2*Bi2*bi2 | si2*Di2 | Industry Contribution |
|---|---|---|---|---|---|---|---|
| 10.0 | 0.001 | 0.631 | 1.768 | -.569 | 0.002 | -.001 | 0.0008 |
| 11.0 | 0.003 | 0.832 | -.163 | -.520 | 0.000 | -.002 | -.0021 |
| 13.0 | 0.007 | 1.234 | 0.220 | -.873 | 0.002 | -.006 | -.0042 |
| 14.0 | 0.002 | 0.266 | 1.666 | -.082 | 0.001 | -.000 | 0.0007 |
| 15.0 | 0.079 | 0.882 | 1.522 | 0.260 | 0.106 | 0.021 | 0.1267 |
| 20.0 | 0.027 | -.001 | 0.339 | 0.260 | -.000 | 0.007 | 0.0069 |
| 21.0 | 0.001 | 0.007 | -.003 | 0.151 | -.000 | 0.000 | 0.0002 |
| 22.0 | 0.014 | 0.401 | 1.264 | 0.826 | 0.007 | 0.012 | 0.0187 |
| 23.0 | 0.020 | 0.626 | 1.353 | 0.292 | 0.017 | 0.006 | 0.0229 |
| 24.0 | 0.012 | 0.754 | 1.883 | 0.514 | 0.017 | 0.006 | 0.0236 |
| 25.0 | 0.007 | 0.603 | 2.788 | 0.241 | 0.013 | 0.002 | 0.0144 |
| 26.0 | 0.011 | 0.268 | 1.891 | 0.259 | 0.006 | 0.003 | 0.0084 |
| 27.0 | 0.019 | 0.381 | 0.761 | 0.119 | 0.005 | 0.002 | 0.0076 |
| 28.0 | 0.017 | 0.038 | 1.476 | 0.169 | 0.001 | 0.003 | 0.0038 |
| 29.0 | 0.003 | 0.143 | 0.524 | 0.024 | 0.000 | 0.000 | 0.0003 |
| 30.0 | 0.011 | 0.639 | 2.455 | 0.357 | 0.017 | 0.004 | 0.0214 |
| 31.0 | 0.004 | 0.639 | 0.762 | 0.316 | 0.002 | 0.001 | 0.0033 |
| 32.0 | 0.010 | 0.573 | 2.199 | 0.120 | 0.013 | 0.001 | 0.0144 |
| 33.0 | 0.018 | 0.498 | 2.959 | 0.050 | 0.027 | 0.001 | 0.0274 |
| 34.0 | 0.025 | 0.633 | 2.311 | 0.082 | 0.036 | 0.002 | 0.0383 |
| 35.0 | 0.035 | 0.474 | 2.112 | 0.066 | 0.035 | 0.002 | 0.0374 |
| 36.0 | 0.031 | 0.666 | 2.055 | 0.080 | 0.043 | 0.003 | 0.0455 |
| 37.1 | 0.014 | 0.441 | 4.665 | 0.735 | 0.029 | 0.010 | 0.0388 |
| 37.2 | 0.016 | 0.476 | 1.101 | 0.475 | 0.008 | 0.008 | 0.0161 |
| 38.0 | 0.010 | 0.515 | 1.203 | 0.117 | 0.006 | 0.001 | 0.0074 |
| 39.0 | 0.007 | 0.202 | 1.489 | 0.663 | 0.002 | 0.005 | 0.0069 |
| 40.0 | 0.008 | 0.362 | 1.750 | -.170 | 0.005 | -.001 | 0.0038 |
| 41.0 | 0.005 | -.003 | 0.729 | 0.005 | -.000 | 0.000 | 0.0000 |
| 42.0 | 0.022 | 0.431 | 1.893 | 0.111 | 0.018 | 0.002 | 0.0203 |
| 44.0 | 0.003 | 0.413 | 1.122 | 0.111 | 0.001 | 0.000 | 0.0018 |
| 45.0 | 0.006 | 0.277 | 1.505 | 0.162 | 0.003 | 0.001 | 0.0037 |
| 46.0 | 0.000 | -.251 | 0.558 | -.121 | -.000 | -.000 | -.0001 |
| 48.1 | 0.016 | 0.614 | -.005 | -.216 | -.000 | -.003 | -.0036 |
| 48.3 | 0.003 | 0.035 | 0.216 | -.008 | 0.000 | -.000 | -.0000 |
| 49.0 | 0.012 | 0.033 | 0.178 | 0.058 | 0.000 | 0.001 | 0.0008 |
| 50.0 | 0.080 | 0.270 | 0.747 | 0.272 | 0.016 | 0.022 | 0.0377 |
| 52.0 | 0.210 | 0.424 | 0.889 | 0.133 | 0.079 | 0.028 | 0.1072 |
| 64.0 | 0.008 | 0.029 | 0.490 | 0.049 | 0.000 | 0.000 | 0.0005 |
| 65.0 | 0.018 | 1.244 | 0.372 | 0.110 | 0.008 | 0.002 | 0.0103 |
| 70.0 | 0.019 | 0.041 | 0.704 | 0.198 | 0.001 | 0.004 | 0.0044 |
| 72.0 | 0.021 | 0.577 | 0.487 | 0.128 | 0.006 | 0.003 | 0.0086 |
| 75.0 | 0.012 | 0.383 | 1.387 | 0.016 | 0.006 | 0.000 | 0.0066 |
| 78.0 | 0.004 | 0.049 | 0.723 | 0.471 | 0.000 | 0.002 | 0.0019 |
| 79.0 | 0.009 | 0.238 | 0.452 | 0.402 | 0.001 | 0.004 | 0.0048 |
| 80.0 | 0.073 | 0.820 | 0.035 | 0.021 | 0.002 | 0.002 | 0.0036 |
| 81.0 | 0.010 | 0.049 | 0.380 | 0.076 | 0.000 | 0.001 | 0.0009 |
| 83.0 | 0.035 | 0.972 | 0.155 | -.087 | 0.005 | -.003 | 0.0022 |
| 84.0 | 0.018 | 0.350 | 1.099 | 0.181 | 0.007 | 0.003 | 0.0103 |
| | ===== | ===== | ===== | ===== | ===== | ===== | ====== |
| | 1.000 | 20.18 | 56.47 | 6.036 | 0.555 | 0.157 | 0.7116 |

Notes: The decomposition is for equation (16) in the text.
The bottom row is the sum of the corresponding column.
Industry contribution = si*bi*Bi + si*Di.
The numeral 2 indicates the estimation period 1970-85.

The final column for each estimation period is $s_i ß_i B_i + s_i D_i$, the contribution of industry i to the aggregate ß. The sum of these contributions in the bottom row of the table yields the constructed ß in (10) that should be approximately equal to the direct estimate of ß from equation (2). Recall from Section 2, Table 2, that ß for these time intervals (using the constructed aggregates that correspond to the forty-eight industries) was estimated to be .715 and .713, which are nearly exactly equal to the constructed ß's in Tables 3 and 4, .713 and .712, respectively. This implies that the assumption of constant aggregation weights $s_i$ within the estimation period does not seriously affect inferences drawn from the decomposition.

Knowledge of the exact decomposition of the aggregate ß allows a fully controlled simulation of the effect of changing composition. Unlike the earlier experiments that held constant only one component of the aggregate-disaggregate relationship, this simulation can isolate the compositional effect. It is possible to take the viewpoint of an observer in the late-1960's, such as Victor Fuchs, and ask, "What would ß have been for the 1970-85 period had nothing changed but the employment shares of different industries?" In particular, the industry elasticities $ß_i^1$ and the parameters $B_i^1$ and $D_i^1$ are held constant at the first period level and the $s_i^2$ are taken at their average values in the second period:

(11) $ß^* \equiv \Sigma_i (s_i^2 ß_i^1 B_i^1 + s_i^2 D_i^1)$,

where $ß^*$ is the aggregate ß for 1970-85 if nothing but the $s_i$ had changed.

Table 5 shows the result of this experiment, drawing on the appropriatecolumns from Tables 3 and 4. The final column is $s_i^2 ß_i^1 B_i^1 + s_i^2 D_i^1$, the simulated contribution of industry i to the simulated aggregate $ß^*$. The sum of these contributions in the bottom row of the table therefore yields the constructed $ß^*$, which is .638. Thus, if the only component of (10) to change had been the compositional shift of the $s_i$, then the aggregate cyclical employment fluctuation would have fallen by about .07 compared to its actual value, or by about ten percent.

So the observer in 1969 would have indeed forecast a negative effect of the (assumed known) sectoral shifts on aggregate cyclical employment fluctuations. But this result depends upon the use of formula (11). As the next section shows, more simplistic calculations of the compositional effect

## Table 5

## Simulating the Compositional Effect on Aggregate Beta

| SIC | si2*Bi1*bi1 | si2*Di1 | Industry Contribution |
|---|---|---|---|
| 10.0 | 0.001406 | -0.000065 | 0.001340 |
| 11.0 | 0.003735 | -0.000746 | 0.002990 |
| 13.0 | 0.004771 | -0.001198 | 0.003573 |
| 14.0 | 0.000946 | -0.000041 | 0.000905 |
| 15.0 | 0.025404 | 0.045738 | 0.071142 |
| 20.0 | 0.001377 | 0.005140 | 0.006517 |
| 21.0 | 0.000001 | 0.000082 | 0.000083 |
| 22.0 | 0.008352 | 0.007935 | 0.016287 |
| 23.0 | 0.012568 | 0.001568 | 0.014136 |
| 24.0 | 0.010276 | 0.008949 | 0.019225 |
| 25.0 | 0.008274 | 0.002411 | 0.010685 |
| 26.0 | 0.003569 | 0.003441 | 0.007010 |
| 27.0 | 0.000572 | 0.002823 | 0.003396 |
| 28.0 | 0.005272 | 0.007181 | 0.012453 |
| 29.0 | -0.000417 | 0.001263 | 0.000847 |
| 30.0 | 0.013048 | 0.004310 | 0.017359 |
| 31.0 | 0.001686 | 0.000786 | 0.002472 |
| 32.0 | 0.009071 | 0.003077 | 0.012147 |
| 33.0 | 0.034285 | 0.001744 | 0.036028 |
| 34.0 | 0.041188 | 0.000102 | 0.041291 |
| 35.0 | 0.063062 | 0.003304 | 0.066366 |
| 36.0 | 0.056030 | 0.005683 | 0.061713 |
| 37.1 | 0.028285 | 0.005965 | 0.034250 |
| 37.2 | 0.015649 | 0.005773 | 0.021422 |
| 38.0 | 0.011967 | 0.001298 | 0.013265 |
| 39.0 | 0.006108 | 0.001036 | 0.007144 |
| 40.0 | 0.009107 | 0.001038 | 0.010145 |
| 41.0 | 0.000747 | -0.000396 | 0.000351 |
| 42.0 | 0.011711 | 0.005314 | 0.017025 |
| 44.0 | 0.002367 | 0.000875 | 0.003241 |
| 45.0 | 0.002054 | -0.000794 | 0.001260 |
| 46.0 | 0.000046 | -0.000070 | -0.000024 |
| 48.1 | 0.006057 | -0.003104 | 0.002953 |
| 48.3 | 0.000158 | -0.000250 | -0.000091 |
| 49.0 | 0.000051 | -0.001329 | -0.001278 |
| 50.0 | 0.012666 | 0.012739 | 0.025404 |
| 52.0 | 0.022246 | 0.042193 | 0.064438 |
| 64.0 | -0.000160 | -0.001457 | -0.001617 |
| 65.0 | 0.000127 | 0.006956 | 0.007082 |
| 70.0 | 0.003746 | 0.002664 | 0.006411 |
| 72.0 | 0.000776 | 0.001605 | 0.002381 |
| 75.0 | 0.003583 | -0.004218 | -0.000635 |
| 78.0 | 0.000581 | 0.000010 | 0.000591 |
| 79.0 | 0.000443 | -0.000527 | -0.000084 |
| 80.0 | 0.000145 | 0.005288 | 0.005433 |
| 81.0 | -0.000167 | 0.000776 | 0.000609 |
| 83.0 | 0.002347 | -0.001754 | 0.000593 |
| 84.0 | 0.008621 | 0.000982 | 0.009602 |
| | ========= | ========= | ========= |
| | 0.453736 | 0.184098 | 0.637834 |

Notes: This table shows the results from simulating equation (16) in the text, using the compositional shares (si2) of the second period (1970-85) and the first period (1949-69) values for bi1, Bi1 and Di1. The bottom row contains the sum of the column above it.

(e.g., that ignore the $B_i$ and the $D_i$) yield very different results.

### Section 4: Decomposition of Change in the Aggregate

The simulation results in the previous section demonstrate that, ceteris paribus, changes in industrial composition would have had a negative effect on the aggregate cyclical employment elasticity. Therefore, these changes must have been somehow offset. What else changed to offset the compositional effect?

To answer this question, it is necessary to decompose the change in $\beta$ between the two estimation periods into parts that can be ascribed to changes in each of the components of $\beta$ in (10). The decomposition must, therefore, contain a term for each component that expresses the change in that component holding the others constant. How should the other components be held constant: at the first period value, the second period value or some average of the two? The above simulation held constant the components other than the $s_i$ constant at their first period values; but in a complete accounting, this necessitates the use of second period weights on some other component.

This is an index number problem and has no single correct solution. Two desirable properties for the decomposition, however, are symmetry in the components and symmetry in the time periods. The latter is equivalent to what is sometimes called the "time reversal test": inferences drawn from the decomposition should be invariant to a reversal of the labelling of the periods.[10] Operationally, this implies that weights on a change in a component should consist of some kind of average across the two periods of the other components.

Further restricting attention to absolute changes and arithmetic means, it can be shown that the change between the estimated $\beta$ in two different estimation periods, $\beta^2-\beta^1$, where the superscripts indicate the interval of estimation, can be decomposed as follows:

[10] See Theil (1965). The Fisher "ideal" index also has this property. I am grateful to Paul David for help on this point.

$$(12)\quad \beta^2-\beta^1 = \Sigma_i\{(s_i^{\,2}-s_i^{\,1})[(\beta_i^{\,2}+\beta_i^{\,1})(B_i^{\,2}+B_i^{\,1})/4 + (D_i^{\,2}+D_i^{\,1})/2] + (s_i^{\,2}+s_i^{\,1})(\beta_i^{\,2}-\beta_i^{\,1})(B_i^{\,2}+B_i^{\,1})/4 + (s_i^{\,2}+s_i^{\,1})(\beta_i^{\,2}+\beta_i^{\,1})(B_i^{\,2}-B_i^{\,1})/4 + (s_i^{\,2}-s_i^{\,1})(\beta_i^{\,2}-\beta_i^{\,1})(B_i^{\,2}-B_i^{\,1})/4 + (s_i^{\,2}+s_{i1})(D_i^{\,2}-D_i^{\,1})/2\},$$

which may be perhaps more naturally written as

$$\beta = \Sigma_i\{\Delta s_i(\bar{\beta}_i\bar{B}_i + \bar{D}_i) + \Delta\beta_i\bar{s}_i\bar{B}_i + \Delta B_i\bar{s}_i\bar{\beta}_i + \Delta s_i\Delta\beta_i\Delta B_i/4 + \Delta D_i\bar{s}_i\},$$

where "$\Delta$" indicates a difference and "$\bar{\ }$" represents an average (half the sum) across the values of the variable in the two time periods. This expression can be naturally interpreted as the sum of the contributions of changes in each of the components to changes in the aggregate. The first term is the "pure" compositional effect: the change in the employment share of the ith industry holding the $\beta_i$, $B_i$, and $D_i$ constant at their cross-period average values. The second and third terms are the contributions of changes in industry elasticities and of the degree to which an industry is pro-cyclical. The fourth term is the interaction of changes in $s_i$, $\beta_i$ and $B_i$, and the final term is the contribution from the change in cross-correlations (the $D_i$).

Table 6 presents the results from calculating the terms in equation (12) for every industry. The first four columns show the change in each component variable, the next six are the six terms in (12), and the final column is the sum of those six terms, the contribution to aggregate change of the changes in each industry. The bottom row provides the sum for each column, a calculation of the sum across industries of a given component's contribution to the aggregate change. Of course, the sum of the first column, the changes in employment shares, necessarily equals zero. The sum of the final column, the industry contributions to aggregate change, is the calculated change in aggregate $\beta$, namely $\beta^2-\beta^1$. For the reader's convenience, the sum of each of the components in (12), part of the bottom row, is reproduced in Table 6a, which summarizes the results from Table 6.

**Table 6**

Decomposition of Changes in the Aggregate
Employment-Output Elasticity
From 1949-69 to 1970-1985

| SIC | si2-si1 | Bi2-Bi1 | bi2-bi1 | Di2-Di1 | (si2-si1) *Bi*bi | (si2-si1)D̄i | (Bi2-Bi1) *s̄i*bi | (bi2-bi1) *s̄i*Bi | (si2-si1)*(bi2-bi1) *(Bi2-Bi1)/4 | (Di2-Di1)s̄i | Industry Contribution |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10.0 | -.001 | -.125 | 0.103 | -.523 | .001 | 0.000 | .000 | 0.000 | 0.000 | -.001 | -.0013 |
| 11.0 | -.002 | -2.86 | 0.407 | -.291 | -.002 | 0.001 | -.008 | 0.002 | 0.001 | -.001 | -.0073 |
| 13.0 | 0.000 | -.915 | 0.638 | -.703 | 0.000 | -.000 | -.006 | 0.003 | -.000 | .005 | -.0077 |
| 14.0 | -.001 | 0.571 | -.190 | -.060 | -.000 | 0.000 | 0.000 | -.001 | 0.000 | -.000 | -.0006 |
| 15.0 | -.001 | 0.795 | 0.440 | -.318 | -.001 | -.000 | 0.042 | 0.039 | .000 | .025 | 0.0548 |
| 20.0 | -.012 | -.111 | -.116 | 0.068 | -.000 | -.003 | -.000 | -.001 | -.000 | 0.002 | -.0024 |
| 21.0 | -.001 | -.007 | -.235 | 0.079 | -.000 | -.000 | -.000 | .000 | -.000 | 0.000 | 0.0000 |
| 22.0 | -.008 | -.239 | 0.004 | 0.259 | -.004 | -.006 | -.002 | 0.000 | 0.000 | 0.005 | -.0070 |
| 23.0 | -.007 | 0.261 | 0.055 | 0.214 | -.005 | -.001 | 0.004 | 0.002 | -.000 | 0.005 | 0.0040 |
| 24.0 | -.005 | -.144 | 0.338 | -.220 | -.006 | -.003 | -.001 | 0.010 | 0.000 | -.003 | -.0035 |
| 25.0 | -.001 | 0.848 | 0.033 | -.081 | -.001 | -.000 | 0.004 | 0.001 | -.000 | -.001 | 0.0022 |
| 26.0 | -.002 | 0.412 | 0.047 | -.055 | -.001 | -.000 | 0.001 | 0.001 | -.000 | -.001 | 0.0003 |
| 27.0 | -.001 | 0.472 | 0.275 | -.033 | -.000 | -.000 | 0.002 | 0.003 | .000 | .001 | 0.0041 |
| 28.0 | -.001 | 0.052 | -.182 | -.256 | -.000 | -.000 | 0.000 | .005 | 0.000 | .004 | -.0092 |
| 29.0 | -.001 | -.109 | 0.354 | -.381 | 0.000 | -.000 | 0.000 | 0.001 | 0.000 | .001 | -.0009 |
| 30.0 | 0.002 | 0.141 | 0.132 | -.031 | 0.003 | 0.001 | 0.001 | 0.003 | 0.000 | .000 | 0.0073 |
| 31.0 | -.004 | -1.05 | 0.410 | 0.122 | -.002 | -.001 | -.003 | 0.003 | 0.000 | 0.001 | .0016 |
| 32.0 | -.003 | 0.432 | 0.082 | -.173 | -.003 | -.001 | 0.003 | 0.002 | -.000 | -.002 | -.0009 |
| 33.0 | -.009 | -.657 | -.028 | -.047 | -.014 | .001 | -.008 | -.002 | -.000 | .001 | .0257 |
| 34.0 | -.004 | 0.343 | -.211 | 0.078 | -.006 | .000 | 0.007 | .012 | 0.000 | 0.002 | -.0093 |
| 35.0 | 0.000 | -.291 | -.274 | -.028 | 0.000 | 0.000 | -.006 | -.022 | 0.000 | -.001 | .0285 |
| 36.0 | 0.001 | -.214 | -.120 | -.101 | 0.001 | 0.000 | -.005 | .008 | 0.000 | -.003 | -.0146 |
| 37.1 | -.003 | 0.248 | -.019 | 0.306 | .007 | -.002 | 0.002 | -.001 | 0.000 | 0.005 | .0033 |
| 37.2 | -.005 | 0.058 | -.456 | 0.117 | -.004 | -.002 | 0.001 | .009 | 0.000 | 0.002 | -.0126 |
| 38.0 | 0.001 | -.381 | -.242 | -.013 | 0.001 | 0.000 | -.002 | -.003 | 0.000 | -.000 | -.0043 |
| 39.0 | -.002 | -.014 | .366 | 0.518 | -.001 | -.001 | -.000 | -.004 | -.000 | 0.004 | -.0023 |
| 40.0 | -.014 | -.468 | -.136 | -.296 | -.012 | 0.000 | -.003 | -.004 | .000 | -.005 | -.0237 |
| 41.0 | -.003 | 0.195 | -.298 | 0.089 | -.000 | 0.000 | 0.000 | -.001 | 0.000 | 0.001 | -.0005 |
| 42.0 | 0.001 | 0.567 | 0.028 | -.131 | 0.001 | 0.000 | 0.005 | 0.001 | 0.000 | -.003 | 0.0042 |
| 44.0 | -.002 | -1.09 | 0.076 | -.164 | -.001 | -.000 | -.002 | 0.001 | 0.000 | -.001 | -.0034 |
| 45.0 | 0.002 | 0.553 | -.065 | 0.288 | 0.001 | 0.000 | 0.001 | -.000 | -.000 | 0.001 | 0.0029 |
| 46.0 | -.000 | -.751 | -.366 | 0.111 | 0.000 | 0.000 | 0.000 | -.000 | -.000 | 0.000 | -.0000 |
| 48.1 | -.000 | -.432 | -.263 | -.024 | -.000 | 0.000 | -.005 | -.001 | -.000 | -.000 | -.0065 |
| 48.3 | 0.001 | -.151 | -.128 | 0.086 | 0.000 | .000 | -.000 | -.000 | 0.000 | 0.000 | 0.0001 |
| 49.0 | -.001 | 0.097 | -.017 | 0.165 | .000 | 0.000 | 0.000 | -.000 | 0.000 | 0.002 | 0.0022 |
| 50.0 | 0.006 | -.038 | 0.067 | 0.112 | 0.001 | 0.001 | -.001 | 0.004 | -.000 | 0.009 | 0.0141 |
| 52.0 | 0.013 | 0.319 | 0.238 | -.068 | 0.003 | 0.002 | 0.020 | 0.035 | 0.000 | -.014 | 0.0466 |
| 64.0 | 0.002 | -.016 | 0.069 | 0.232 | -.000 | -.000 | 0.000 | 0.000 | -.000 | 0.002 | 0.0017 |
| 65.0 | 0.004 | 0.249 | 1.187 | -.278 | 0.001 | 0.001 | 0.003 | 0.005 | 0.000 | -.004 | 0.0047 |
| 70.0 | 0.004 | 0.331 | -.476 | 0.061 | 0.001 | 0.001 | 0.002 | -.005 | -.000 | 0.001 | .0008 |
| 72.0 | -.006 | 0.393 | 0.184 | 0.051 | -.001 | -.001 | 0.005 | 0.001 | -.000 | 0.001 | 0.0055 |
| 75.0 | 0.004 | 0.605 | 0.004 | 0.365 | 0.002 | -.001 | 0.002 | 0.000 | 0.000 | 0.004 | 0.0071 |
| 78.0 | -.000 | 0.309 | -.321 | 0.468 | -.000 | -.000 | 0.000 | -.001 | 0.000 | 0.002 | 0.0013 |
| 79.0 | 0.003 | 0.234 | 0.023 | 0.458 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.004 | 0.0049 |
| 80.0 | 0.035 | 0.016 | 0.715 | -.051 | 0.000 | 0.002 | 0.000 | 0.001 | 0.000 | -.003 | 0.0008 |
| 81.0 | 0.003 | 0.541 | -.058 | -.003 | 0.000 | 0.000 | 0.000 | -.000 | -.000 | -.000 | 0.0005 |
| 83.0 | 0.009 | 0.080 | 0.065 | -.037 | 0.001 | -.001 | 0.002 | 0.000 | 0.000 | -.001 | 0.0018 |
| 84.0 | 0.009 | 0.582 | -.564 | 0.127 | 0.004 | 0.001 | 0.005 | -.006 | -.001 | 0.002 | 0.0053 |
| | ===== | ===== | ===== | ===== | ===== | ===== | ===== | ===== | ===== | ===== | ===== |
| | 0.000 | -.360 | 0.845 | 0.008 | -.053 | -.013 | 0.061 | 0.031 | 0.001 | -.028 | -.0019 |

Notes. The decomposition is equation (17) in the text.
The bottom row is the sum of the corresponding column.
Industry contribution = sum of the preceding 6 columns.

**Table 6a**

**Summary of Results in Table 6**

| Component | Measurement |
|---|---|
| $\Sigma_i(s_i^2-s_i^1)\cdot(\beta_i^2+\beta_i^1)\cdot(B_i^2+B_i^1)/4$ | -.0534 |
| $\Sigma_i(s_i^2-s_i^1)\cdot(D_i^2+D_i^1)/2$ | -.0134 |
| $\Sigma_i(\beta_i^2-\beta_i^1)\cdot(s_i^2+s_i^1)\cdot(B_i^2+B_i^1)/4$ | .0312 |
| $\Sigma_i(B_i^2-B_i^1)\cdot(s_i^2+s_i^1)\cdot(\beta_i^2+\beta_i^1)/4$ | .0608 |
| $\Sigma_i(s_i^2-s_i^1)\cdot(\beta_i^2-\beta_i^1)\cdot(B_i^2-B_i^1)/4$ | .0006 |
| $\Sigma_i(D_i^2-D_i^1)\cdot(s_i^2+s_{i1})/2$ | -.0278 |
| Total change: $\beta^2 - \beta^1$ | -.0019 |

Notes: This decomposition of the change in the estimate of ß between the two estimation periods, 1949 to 1969 and 1970 to 1985, is taken from Table 10, bottom row. These figures are the sums across industries (i) for each of the components.

The calculated change in the aggregate ß, -.0019, is precisely equal to the difference between the ß's calculated in Tables 3 and 4, and to the difference between the ß's directly estimated with equation (2), already presented in Table 2. This result should hopefully not be surprising, but it does verify the accuracy of these calculations, and it suggests that the very small approximation error in (10) is completely eliminated in the comparison across estimation periods.

The interaction term, the second to last column in Table 6 and thesecond to last component in Table 6a, is extremely small for all industries and for the sum across industries. This result eases the task of attributing change in the aggregate to change in specific disaggregated components. The sum of the $D_i$ also changes very little, but when weighted by the $s_i$ its contribution appears a bit more substantial, accounting for about two-thirds of the total change in $s_i \cdot D_i$. The other one-third is accounted for by changes in the $s_i$ weighted by the average $D_i$. This decomposition demonstrates the virtue of this framework: an ability to account explicitly for all the sources of change in the aggregate.

Thus, the compositional effect in Table 6 and 6a has two parts. The first part, weighted by the product of (cross-period) average $\beta_i$ and average $B_i$, is equal to -.0534, and the second part, weighted by the average $D_i$, is equal to -.0134. Together they suggest that, ceteris paribus, compositional shifts should have lowered the aggregate output elasticity of employment by about seven percentage points.

However, as was also the case for the simulation in Section 3, finding this effect of the intersectoral shifts depends on recognizing all the different components that relate the relative size of industries to behavior at the aggregate level. Ignoring the second term, $s_iD_i$, would have resulted in an underestimate of the compositional effect on the change in aggregate ß. And omitting the $B_i$'s and simply calculating $\Sigma_i \; s_i ß_i$ would have yielded an opposite result.

This is illustrated by the weighted average $ß_i$'s in Table 7, which hold constant the industry elasticities reported in Table 1 and use the employment share weights from 1950, 1965 and 1980. According to this simplistic calculation, the weighted average elasticity seems to have actually increased, a remarkable result, because it suggests that those industries with more volatility (higher $ß_i$'s) have increased relative to those with less. This "partial composition effect" is probably the natural measure of the effect of the shifts for most economists, but it leads to exactly the opposite conclusion as that suggested by the evidence of intersectoral differences and shifts.

**Table 7**

**Fixed-Weighted Average**
**Output Elasticities of Industry Employment**

| Year of Weights | $L_{it}$ | $E_{it}$ |
|---|---|---|
| 1950 | .379 | .412 |
| 1965 | .426 | .452 |
| 1980 | .439 | .462 |

Notes: Industry elasticities and weights come from Table 1. Weights are the share in the same concept of aggregate employment. Aggregate elasticities are for the entire private economy.

That the "full composition effect" (including the $B_i$'s and $D_i$'s) was negative implies that other components have changed in ways that are offsetting. As Tables 6 and 6a show, the primary offsets were a small positive contribution from the $\beta_i$ term and a larger one from the $B_i$. Industry elasticities increased on average about .02; when appropriately weighted this led to a contribution of about .03. This illustrates the divergence of the microunits from the macro: industry employment was becoming more sensitive to the cycle, while aggregate employment behavior remained unchanged.

The degree of association between industry and aggregate cycles actually fell slightly on average; the weighted average change or contribution to the aggregate, however, was a positive .06: industries with relatively high employment fluctuations came to account for more of the aggregate cycle. Combined with the small negative contribution from the change in $D_i$ and the almost zero interaction term, the net result was essentially no change in aggregate $\beta$.

Other factors thus played a role in keeping aggregate employment behavior constant, but it is interesting that the "partial composition effect" was in the opposite direction from the simple story characterizing the behavior of goods and services sectors and the shifts between them. The explanation for this seems to be that the basis for the prediction was a too highly aggregated view of the economy. Many industries are exceptions to the stylized facts. For instance, Table 1 showed that machinery (SIC 35), electrical equipment (SIC 36) and transportation equipment except for motor vehicles (SIC 372-379) manufacturing are high elasticity industries that have grown significantly relative to the aggregate over this period, and motion pictures (SIC 78) is a low elasticity industry that has contracted. Considered at a more disaggregated level, the changing composition of the economy seems to have less implication for this aspect of macroeconomic behavior.

## Section 5: Conclusion

A general conclusion emerging from this research is that much of the policy analysis that draws inferences about aggregate relationships from estimates at the disaggregated level is incomplete and potentially seriously misleading. In the context of cyclical employment fluctuations, many researchers would either investigate the effect of some policy variable on the $\beta_i$ and draw direct inferences about the effect on $\beta$, or they would infer the effect on the $\beta_i$ from an estimate of the effect on $\beta$. But as I have shown, there are several factors that prevent such inferences.

There are weights in aggregating variables (the $s_i$), weights in aggregating relationships (the $B_i$), and correlations across equations (the $D_i$); these create a discrepancy between average $\beta_i$ and $\beta$. So a policy that causes a change in the unweighted average of the $\beta_i$ may have a completely different effect on $\beta$. Furthermore, that same policy may also have significant effects on the $B_i$, the $D_i$, or even in the long run on the $s_i$, each of which must in turn be weighted for its contribution to the whole to be assessed. These effects may offset the effect of the policy on the $\beta_i$ or they may strengthen that effect: a priori, one cannot judge.

For instance, suppose unions tend to stabilize employment over the cycle, that is industries with a higher degree of unionism tend to have lower $\beta_i$. A decrease in unionism might be expected therefore to have a positive effect on the aggregate $\beta$, but the weights in aggregating different industries may mitigate this effect, and the possible effects of unions on the other components of the aggregation may offset, reverse or strengthen the conclusion. One possibility is that unions might decrease the responsiveness of employment in one industry to output changes in another. If steel firms' hiring is based on expectations of future demand, for instance in automobiles, then a downturn in the auto industry may lead to a negative shock to employment in steel before steel output falls. In other words, $u_{it}$ may be correlated with $x_{jt}$, where i=steel and j=autos. If unions decrease this correlation, then the average effect of unions on $\beta_i$ may be an underestimate of their effect on $\beta$. This particular example depends on a timing consideration, "hiring in advance," but the general point is that unions may decrease the flexibility of firms to adjust employment to respond to external as well as internal changes. Not considering this will lead to a bias in inferring the aggregate effect of unions on the cyclical fluctuation of employment.

This paper has confirmed the common perceptions about differences in cyclical employment behavior between goods and services sectors and verified the existence of large shifts in the distribution of employment between the goods and services sectors. But the implication of these empirical regularities for change in aggregate behavior turned out to be incorrect.

The effect of shifts in industrial composition was offset by other changes. Relationships between the aggregate and the industry output cycles changed, leading to a somewhat larger aggregation weight ($B_i$) on industries with more volatile employment. To a lesser degree, individual industry behavior (the $\beta_i$) also changed: on average industry employment has become slightly more volatile over the business cycle.

Moreover, although the "full compositional effect" (appropriately weighted) is in the hypothesized direction, the perhaps more natural "partial compositional effect" is opposite: weighted-average industry fluctuations have increased, not decreased. Holding industry behavior constant, the more volatile industries have increased in relative size in the U.S. economy.

This paradoxical result suggests not only that the concept of the compositional effect is somewhat ambiguous, but also that the characterization of aggregate sectoral behavior that is the basis for the seemingly straightforward predictions about the compositional effect is overly simplified. Although the goods sector and the services sector are on average quite different, they are heterogeneous in terms of behavior and relative growth; many individual industries prove to be exceptions to the aggregate stylized facts. The apparent paradox of little effect of changes in industrial composition on cyclical employment fluctuations is the result of both complex offsetting factors and overly aggregated generalizations about the services sector.

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**Table A-1**

**Aggregate Cyclical Employment Fluctuations**
**Estimates with Adjustment for Serial Correlation**

| | 1949-1969 | 1970-1985 |
|---|---|---|
| $\alpha$ | -.013 (.005) | -.001 (.005) |
| $\beta$ | .698 (.096) | .712 (.113) |
| $R^2$ | .75 | .75 |
| mean $l_t$ | .013 | .017 |

Notes: The estimates result from applying the Yule-Walker estimation method to equation (8) in the text. Standard errors appear in parentheses. These estimates correspond to the OLS estimates of equation (8) in Table (4).