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THE EFFECTS OF CHANGING INDUSTRIAL COMPOSITION ON THE POSTWAR U.S. ECONOMY

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Edwin McLean Denson

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UMI Number: 9714573

UMI
300 North Zeeb Road
Ann Arbor, MI 48103

ABSTRACT

THE EFFECTS OF CHANGING INDUSTRIAL COMPOSITION ON THE POSTWAR U.S. ECONOMY

Edwin McLean Denson

This dissertation addresses the measurement of the effect of the changing industrial composition of the postwar U.S. economy on the behavior of a variety of macroeconomic statistics. The main theme throughout the research herein is to focus on the measurement aspect; however, there are some instances where measurement issues arise that require an appeal to economic assumptions. The first statistic considered is the rate of average labor productivity growth, which appears to have declined since the early 1970's, and since the slowdown was recognized has been the center of a large volume of research. The shifting of the industrial composition of the economy toward industries with historically lower than average rates of productivity growth seems a reasonable candidate for explaining at least part of this apparent slowdown. The calculations made here indicate that shifting industrial composition explains about one fifth of the observed decline in the rate of average labor productivity growth. The other statistics considered are a number of measures of the dynamic properties of aggregate labor input growth, aggregate output growth, and the relationship between aggregate labor input growth and aggregate output growth. For example, it has been noted that the volatility of employment and output has declined over the postwar era. The shifting of industrial composition of the economy toward industries with historically lower than average volatility in both labor input growth and output growth seems a reasonable candidate for explaining the decline in the volatility observed in the aggregate versions of these statistics. The results show that for labor input volatility shifting industrial composition explains roughly half of the observed changes, while for output volatility shifting industrial composition explains more than two thirds of the observed changes. Additionally, there is evidence that shifting composition explains roughly half of the observed decline in the sensitivity of labor input growth to contemporaneous output growth. However, for most of the other dynamic properties examined, shifting industrial composition explains very little of the observed changes.

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CHAPTER 1

CHANGING INDUSTRIAL COMPOSITION AND THE PRODUCTIVITY SLOWDOWN

Introduction

The purpose of this chapter is to determine the effects of the change in industrial composition on the trend behavior of aggregate productivity in the postwar U.S. economy. Fuchs (1968) carefully documented the shift in employment toward the service sector that occurred between 1947 and 1965 and pointed out that no such dramatic shift had occurred in output. He concluded that the major explanation of this shift in employment was that output per person grew much more slowly in the service sectors than in other sectors over this period. Baumol (1967) presented an economic model in which the rate of technological change is different among industries and the composition of demand is held constant. The prediction of the model is that employment shifts toward the slow productivity growth industries and that aggregate productivity growth asymptotically approaches the productivity growth of the slowest growing industry.

Nordhaus (1972) concluded that 77 percent of the measured labor productivity slowdown between 1948-55 and 1965-71 could be explained by the changing composition of demand, rather than by changing rates of measured labor productivity growth in individual industries. Further, Nordhaus concluded that the slowdown was due mainly to differences in productivity levels among industries, rather than to different rates of productivity growth among industries. Wolff (1985) found that the change in composition of employment explained between 17 percent and 22 percent of the observed slowdown in total factor productivity between 1947-67 and 1967-76.

Recently, Griliches (1992) noted that "...productivity as measured in the national accounts has grown significantly slower in services, especially in the early postwar period, 1948-60, and in the most recent decade, 1979-89. That slowness of growth, together with the rising share of services in nominal GNP and in employment, has been viewed as a major drag on the productivity growth of the entire

GNP and in employment, has been viewed as a major drag on the productivity growth of the entire economy and its competitive performance." Twenty-five years after the first detailed description of these trends in composition and their possible effects on aggregate productivity growth both in theory and in empirical models, it is widely assumed that changing industrial composition plays an important role in explaining the observed slowdown in aggregate productivity growth.

This chapter provides a set of facts concerning industrial composition, productivity growth by industry, and productivity levels by industry and calculates some decompositions to determine the plausibility of this changing composition hypothesis (hereafter referred to as the CCH). Productivity is defined as output per hour (average labor productivity). The results suggest that 21 percent of the productivity slowdown can be explained by shifts in composition toward industries with lower productivity growth or lower productivity levels.

The main difference between this chapter and those listed above is that there is no explicit model of industry behavior. There are only two primitive assumptions made. First, the industry output produced is purchased by consumers who maximize a utility function subject to their income. Second, labor is homogenous. These assumptions determine the indexing methods by which industry output growth and hours growth are aggregated in the calculation of aggregate average labor productivity growth (hereafter referred to as ALP growth). The aggregate ALP growth rate is interpreted as the growth rate in utility derived per hour of labor committed to production.[1]

The chapter proceeds as follows. First, the measurement issues involved in the calculation of aggregate ALP growth from the published National Income and Product Accounts industry data are discussed. Then evidence is presented to suggest that changing industrial composition may be a plausible explanation for the changes observed in aggregate ALP growth. Next, some decompositions are

[1] See Baumol and McLennan (1985) and Baumol, Blachman, and Wolff (1989) for surveys on the literature on the CCH and the productivity slowdown. They also contain surveys on other explanations of the productivity slowdown.

calculated to determine the extent to which changing industrial composition and changing industry ALP growth rates each explain the observed changes in trend aggregate ALP growth. Finally, the effect of changing composition is further broken down and one of the components is a relative level effect similar to that found in the literature on the CCH.

Computing Aggregate ALP Growth From Industry Data

This section discusses the computation of aggregate ALP growth from the industry output and labor input data available in the National Income and Product Accounts (hereafter referred to as NIPA). There are two measurement problems with the NIPA data. The first problem is that the industry real output data that are available in the NIPA are computed using fixed-price-weight indexes. They are fixed-price-weight indexes because they are computed using the quantities observed in each year valued at prices in some (fixed) base year. The real aggregate output data provided are simply the sum of these industry fixed-price-weight indexes. This method of aggregating output does not allow for the substitution effects between industry outputs that arise from changes in relative prices over time. This leads to the mismeasurement of real aggregate output growth. An alternative method of aggregation is used here which accounts for these substitution effects. The second problem is that the industry hours data from NIPA excludes the hours of self-employed workers. The hours data provided in NIPA are adjusted to correct for this using two different sets of employment data provided in NIPA.

The NIPA data used in this chapter are annual from 1948 to 1990. The output data used are Gross Domestic Product by Industry in current and constant dollars. The hours input data are Hours Worked by Full-Time and Part-Time Employees by Industry. The employment input data used to adjust hours are Persons Engaged in Production by Industry and Full-Time Equivalent Employees by Industry. For a precise explanation of data sources, how revisions are incorporated into the data set used here, and how industry shares and growth rates are constructed, see appendix 1.

Constructing the Growth Rate of Real Aggregate Output

The issues involved in properly computing the growth rate of real aggregate output from the industry data that is available are discussed here. As stated above, the levels of real aggregate output in NIPA are simply the sum of the real industry outputs. Real industry outputs themselves are fixed-price-weight indexes of the commodities that make up each industry. If the growth of real aggregate output is computed as the ratio of the sum of fixed-price-weight industry indexes at time t divided by the same sum at time $t-1$, the resulting index of growth is implicitly a fixed-price-weight index where the relative values of a unit of output in each industry are held constant. The problem with this is that the period covered here is over forty years and the relative price structure in the economy has presumably changed over this period.

To make the discussion of index issues more concrete, make the following definitions: P_t^i is the price level in industry i at time t, P_B^i is the price level in industry i in the base year and Q_t^i is the number of units produced in industry i at time t. Then the index of aggregate output reported in NIPA for any year t is

$$\text{FPWQ}_t = \sum_i P_B^i Q_t^i \tag{1.1}$$

and the growth in aggregate output from year $t-1$ to year is t

$$\left(\frac{\text{FPWQ}_t}{\text{FPWQ}_{t-1}}\right) = \frac{\sum_i P_B^i Q_t^i}{\sum_i P_B^i Q_{t-1}^i} = \sum_i SB_{t-1}^i \left(\frac{Q_t^i}{Q_{t-1}^i}\right), \tag{1.2}$$

where

$$SB_{t-1}^i = \left(\frac{P_B^i Q_{t-1}^i}{\sum_i P_B^i Q_{t-1}^i}\right)$$

and FPWQ means fixed-price-weight quantity index. When real aggregate growth is computed from the official industry data in this manner, a fixed-price-weight index is implicitly being used where the relative values of industry output are fixed at base year prices.

Two alternatives to this index come from the index number literature. Both alternatives appeal to the notion of consumers maximizing a utility function and each measures the increase in utility between two periods given real output and prices in the two periods. These are the Fisher Ideal quantity index and the Tornqvist quantity index which are given, respectively, by

$$\text{(1.3)} \qquad \left(\frac{FIQ_t}{FIQ_{t-1}}\right) = \left[\frac{\sum_i P_t^i Q_t^i}{\sum_i P_t^i Q_{t-1}^i} \frac{\sum_i P_{t-1}^i Q_t^i}{\sum_i P_{t-1}^i Q_{t-1}^i}\right]^{\frac{1}{2}} = \left[\frac{\sum_i S_{t-1}^i \left(Q_t^i / Q_{t-1}^i\right)}{\sum_i S_t^i \left(Q_{t-1}^i / Q_t^i\right)}\right]^{\frac{1}{2}}$$

and

$$\text{(1.4)} \qquad \left(\frac{TQ_t}{TQ_{t-1}}\right) = \prod_i \left(\frac{Q_t^i}{Q_{t-1}^i}\right)^{\frac{1}{2}[S_t^i + S_{t-1}^i]},$$

where $$S_t^i = \frac{P_t^i Q_t^i}{\sum_i P_t^i Q_t^i},$$

FIQ means Fisher Ideal quantity index, and TQ means Tornqvist quantity index.

Diewert (1976) showed that the Fisher Ideal quantity index is a particular version of the more general Quadratic Mean of Order r Quantity Index (where r=2), which in turn is 'exact' for both Leontief and linear utility functions and is a 'superlative' index[2]. Diewert also showed that the Tornqvist quantity

[2] Diewart (1976) offers the following definitions for 'exact' and 'superlative': If a quantity index Q and a functional form for a utility function U satisfy $(x^r)/U(x^o) = Q(p^r, p^o; x^r, x^o)$ then we say that Q

index is 'exact' for a homogeneous translog utility function (which includes Cobb-Douglas) and is a 'superlative' index.

These alternative indexes do not fix the problem that exists within the individual industry indexes. Real output in each industry is still calculated from a fixed-price-weight index of the commodities within that industry. Given these indexes of real industry output, however, the aggregation of the data across industries is done correctly. The alternative indexes allow for changes in relative price between "units" of different industry outputs and the substitution between industry goods that this may cause over time.

In this chapter the behavior of the growth *rate* of labor productivity, is the object of interest. This means that expressions for the growth *rate* of aggregate output and labor input are required. Also, the decompositions calculated later in the text require that output and labor input growth rates in industries and industry shares be explicitly separated so that their effects can be individually controlled. With these considerations in mind, rewrite the three indexes from above, respectively, using the notation Δx_t to denote the log first difference (growth *rate*) of any quantity X_t, as

(1.5)
$$\Delta fpwq_t = \ln\left[\sum_i SB^i_{t-1}\left(\frac{Q^i_t}{Q^i_{t-1}}\right)\right] \cong \sum_i SB^i_{t-1}\Delta q^i_t,$$

---

is exact for U. A quantity index is 'superlative' if it is 'exact' for a utility function which can provide a second-order approximation to an arbitrary twice-differentiable linear homogeneous function.

(1.6) $$\Delta fiq_t = \ln\left[\frac{\sum_i S_{t-1}^i \left(Q_t^i / Q_{t-1}^i\right)}{\sum_i S_t^i \left(Q_{t-1}^i / Q_t^i\right)}\right]^{\frac{1}{2}} = \frac{1}{2}\left[\ln\sum_i S_{t-1}^i\left(\frac{Q_t^i}{Q_{t-1}^i}\right) - \ln\sum_i S_t^i\left(\frac{Q_{t-1}^i}{Q_t^i}\right)\right]$$

$$\cong \frac{1}{2}\left[\sum_i S_{t-1}^i \ln\left(\frac{Q_t^i}{Q_{t-1}^i}\right) - \sum_i S_t^i \ln\left(\frac{Q_{t-1}^i}{Q_t^i}\right)\right] = \sum_i AS_t^i \Delta q_t^i,$$

and

(1.7) $$\Delta tq_t = \ln\left[\prod_i \left(\frac{Q_t^i}{Q_{t-1}^i}\right)^{\frac{1}{2}[s_t^i + s_{t-1}^i]}\right] = \sum_i AS_t^i \Delta q_t^i,$$

where $$AS_t^i = \frac{1}{2}\left(S_{t-1}^i + S_t^i\right).$$

For the fixed-price-weight and Fisher Ideal indexes, a log approximation had to be made to get the expression of aggregate growth in terms of the individual industry growth rates, Δq_t^i. No such approximation had to be made for the Tornqvist index and, in fact, the Tornqvist index is equal to the Fisher Ideal index when the log approximation is made. Since the log approximation is used throughout the chapter, the Fisher Ideal quantity index is dropped from the discussion.

Another complication that arises in the decompositions to come is that not all subsamples that are compared are of equal lengths. Because of this, averages of shares and growth rates are used in the above expressions when computing productivity growth over a particular period. When this is done, the indexes for growth over any period of T years become

$$\overline{\Delta fpwq_t} \cong \sum_i \overline{SB^i_{t-1}\Delta q^i_t} \tag{1.8}$$

and

$$\overline{\Delta tq_t} \cong \sum_i \overline{AS^i_t \Delta q^i_t}, \tag{1.9}$$

where $\overline{\Delta q^i_t} = \sum_t \frac{\Delta q^i_t}{T}$, $\overline{SB^i_t} = \sum_t \frac{SB^i_t}{T}$, and $\overline{AS^i_t} = \sum_t \frac{AS^i_t}{T}$.

The approximation error induced by the use of the log approximation and the use of sample averages in computing the sample average of aggregate ALP growth can be seen in table 1, which is discussed at the end of this section.

In the BEA's ongoing efforts to improve its estimates of Gross Product Originating by Industry (GPO) in Constant Dollars, it has introduced an improved experimental index of industry output for the manufacturing industries. This is a benchmark-weighted years index (hereafter referred to as a BMWY index). It is similar to the Fisher Ideal index except that instead of using the prices in two consecutive years, it uses prices in two consecutive benchmark-years which are five years apart. This allows the relative price structure to change every five years. The cumulation of the BMWY index values for the years between times t and $t+k$ is equal to the Fisher Ideal index calculated directly from year t to year $t+k$. The results of the chapter are reported with the BMWY index used for manufacturing industries over the years for which it is available (1977-87).

The BEA has also recently begun to publish the NIPA on a chain-weighted basis, where prices are used from consecutive years, allowing for annual changes in the relative price structure of the economy. Unfortunately, the BEA has not yet finished preparing chain-weighted estimates of GPO by industry. Once these are completed, the index number issues that complicated the calculations here will not be as much of a factor. However, it is still instructive to understand why the index number issues matter and see how much they can affect the quantitative results contained here.

Constructing the Growth Rate of Aggregate Hours

The adjustment of the NIPA hours data that is made here and the aggregation of industry hours growth are discussed below. The hours data provided in NIPA are hours of full-time and part-time employees, which excludes the hours of self-employed workers. The employment variable Persons Engaged in Production includes Full-Time equivalent employees and the Self-Employed. Thus, the hours data provided are not as comprehensive as the employment data in that the hours of the self-employed are omitted in hours while the self-employed are counted in employment. This omission is significant for industries which have a high proportion of self-employed persons out of total employment. To account for this, all hours data are multiplied by the ratio of Persons Engaged in Production, which includes the self-employed, to the number of Full-Time Equivalent employees. This adjustment assumes that the average hours of the self-employed in an industry are the same as the average hours of full-time workers.

When adding up industry hours to obtain aggregate figures, there are no indexing number issues as there were with output if we assume that hours and employees measured using the methods described above are real quantities (i.e., we ignore changes in the quality of labor). The only point to be made here is that calculations of aggregate hours growth are calculated in a manner consistent with the method of calculating output growth for a particular index. Log approximations and the use of sample averages are employed with the labor input variables as they are with the output variables.

Specifically, letting H_t^i denote industry hours at time t and H_t aggregate hours at time t, when the fixed-price-weight index method is used for aggregate output growth, aggregate hours growth over a period of T years is calculated as

(1.10) $$\sum_i \overline{SH^i_{t-1}\,\Delta h^i_t}$$

and when the Tornqvist index is used for output growth, aggregate hours growth over a period of T years is calculated as

(1.11) $$\sum_i \overline{ASH^i_t \Delta h^i_t},$$

where

$$SH^i_t = \frac{H^i_t}{\sum_i H^i_t},\quad \overline{SH^i_t} = \sum_t \frac{SH^i_t}{T},\quad ASH^i_t = \frac{1}{2}\left[SH^i_{t-1} + SH^i_t\right],$$

$$\overline{ASH^i_t} = \sum_t \frac{ASH^i_t}{T}, \text{ and } \overline{\Delta h^i_t} = \sum_t \frac{\Delta h^i_t}{T}.$$

Constructing Aggregate ALP Growth

Given the above discussions of aggregate output and labor input growth, the calculation of aggregate ALP growth using the two indexing methods is straightforward. The indexes over an interval of length T become

(1.12) $$\Delta fpwp = \sum_i \left[\overline{SB^i_{t-1}\,\Delta q^i_t} - \overline{SH^i_{t-1}\,\Delta h^i_t}\right]$$

and

(1.13) $$\Delta tp = \sum_i \left[\overline{AS^i_t \Delta q^i_t} - \overline{ASH^i_t \Delta h^i_t}\right]$$

with all quantities as previously defined. FPWP means fixed-price-weight productivity index and TP means Tornqvist productivity index.

It should be noted here that the Tornqvist quantity index is the proper way to aggregate the industry output data and that it is more accurate to use the BMWY index of manufacturing output growth for the years that it is available. Whenever results are reported for the Tornqvist productivity index, it will be implicit that the BMWY index is used for manufacturing output growth. Occasionally, results will also be reported for the fixed-price-weight index of productivity growth. When this index is used, it is implicit that the fixed-price-weight index is used for manufacturing output growth. (Both the fixed-price-weight index and BMWY index of manufacturing are provided in NIPA for the years 1977-87). The purpose of showing these fixed-price-weight results is to emphasize the importance of using proper indexes in making the calculations.

Table 1 shows the calculation of growth in output per hour for the period 1948-90, 1948-69, 1969-90, and the difference between 1948-69 and 1969-90. The size of the approximation errors that result from using the log approximation and sample averages are presented. Panel A shows the results obtained using the Tornqvist index of aggregate productivity growth. Panel B shows the results obtained using the fixed-price-weight index of aggregate productivity growth. Panel C dramatizes the importance of the two measurement issues. It shows the results obtained using the fixed-price-weight index of aggregate productivity growth and using hours when they are *not* adjusted for the self-employed.

The results of the first panel indicate that an aggregate ALP slowdown of 1.43 percent occurs. This number remains unchanged when the log approximation is made and changes to 1.39 when sample averages of industry shares and growth rates are used. The second panel indicates that a slowdown of 1.51 percent occurs. This calculation changes to 1.52 when the log approximation is made and to 1.46 when sample averages are used. Comparing the two panels brings to light a couple of points. First, the use of the log approximation has negligible effects on the calculations and the use of sample averages has a small effect on the calculations. Second, by simply using the proper method of aggregating the industry data, the size of the productivity slowdown is reduced from 1.46 to 1.39, or by 4.8 percent[3]. The last panel shows the importance of adjusting hours for the self-employed. The measured slowdown here is only 0.88 percent when hours are not properly adjusted. The decompositions to come, as mentioned previously, require the use of the log approximation and sample averages.

Table 2 reveals the industry origin of the slowdown by showing the contribution of each industry in the calculation of aggregate ALP growth for each period, and the change in contribution between the periods. Eleven of the fifteen industries have declines in contribution to aggregate ALP growth. Among these, the largest decline in contribution comes from Farming, followed by Finance, Insurance, and Real Estate, Services, Construction, and Manufacturing Nondurables. The increases come from Nonelectrical Machinery, Communications, General Government, and Government Enterprise.

The Facts

Below, some basic facts regarding the industrial composition of the U.S. economy, industry ALP growth rates, and industry ALP levels, are presented. These facts are then discussed in light of the CCH. The economy is broken down into fifteen industry groups which include the following: Farming; Mining; Construction; Manufacturing Durables Excluding Nonelectrical Machinery (hereafter referred to as Manufacturing Durables); Manufacturing Nonelectrical Machinery, Manufacturing Nondurables; Transportation; Communications; Electricity, Gas, and Sanitary Services (hereafter referred to as E.G.A.S.S.); Wholesale Trade; Retail Trade; Finance, Insurance, and Real Estate (hereafter referred to as F.I.R.E.); General Government; and Government Enterprise. This breakdown was chosen because it is

[3] Most of the differences are caused by changes in the measurement of the growth of aggregate output caused by different indexing methods. The growth of aggregate hours largely unaffected by choice of index.

the lowest level of aggregation for which industry hours are available, except for Manufacturing Nonelectrical Machinery[4].

Tables 3 and 4 provide the evidence for the CCH. Table 3 displays the average shares of individual industries out of total real output, total nominal output, and total hours for the two periods and the change between periods. Table 4 shows the average growth rate of real output per hour for each industry over the entire 1948-90 period. An industry appears to 'fit' the CCH if it has either of the following two characteristics. It is an industry with higher than average ALP growth over the entire 1948-90 period that experiences a decline in shares, or it is an industry with lower than average ALP growth over the entire 1948-90 period that experiences an increase in shares. Industries of either type are expected to have a negative effect on aggregate ALP growth.

The industries which have declines in both real and nominal output shares, and declines in hours shares while having higher than average ALP growth rates are Farming, Manufacturing Durables, and Manufacturing Nonelectrical Machinery. The industries which have increases in both real and nominal output shares, and increases in hours shares while having lower than average ALP growth rates are F.I.R.E., Services, and Government Enterprise. Manufacturing Nondurables has a decline in both nominal output and hours shares, but has an increase in real output share. General Government has increases in both nominal output and hours shares, but has a decrease in real output share. Since we are using the Tornqvist index for calculating productivity growth here it is appropriate to look at nominal output shares. Manufacturing Nondurables has higher than average productivity growth and General Government has lower than average productivity growth, so each works in favor of the CCH, thus eight industries appear to fit the CCH.

[4] Manufacturing Nonelectrical Machinery is separated from Manufacturing Durables, even though hours data is not available for Nonelectrical Machinery, because computers are in Nonelectrical Machinery and there are well-documented problems with real output estimates in this industry. See, for example, Baily and Gordon (1988) and Denison (1989), among others. Hours in Nonelectrical Machinery are found by assuming that the share of hours in Nonelectrical Machinery out of total Manufacturing Durables hours is equal to Nonelectrical Machinery's share of total manufacturing Durables employment in any given year.

From these tables, it is also evident that there are some industries which work directly against the CCH. Transportation experiences declines in all shares yet has lower than average productivity growth. Communications, E.G.A.S.S., and Wholesale Trade each experience increases in all shares yet have higher than average productivity growth rates. These changes are expected to increase aggregate productivity growth. The three remaining industries (Mining, Construction, and Retail Trade) have changes in nominal output shares and hours shares in opposite directions, so it is difficult to predict what effect the shift in shares that these industries experience has on aggregate productivity growth.

Many macroeconomic models suggest that the major source of economic fluctuations are what are termed as macroeconomic disturbances or disturbances which effect the entire economy at once. These models suggest that another explanation of the aggregate ALP growth rate slowdown could be that some large disturbance occurred in the late 1960's or early 1970's that decreased ALP growth rates in all industries. Table 5 shows the changes that have occurred in the average growth rates of output per hour in individual industries between the periods 1948-69 and 1969-90. Eleven of the fifteen industries exhibit a decline in the growth rate of output per hour. These results strongly suggest that secular changes in industry ALP growth rates may account for much (but not all) of the aggregate ALP growth slowdown.

Of course, the explanation of the slowdown does not have to be only one of the above. It seems perfectly reasonable that the slowdown was due to the combination of a shift in composition along with a decrease in ALP growth rates across almost every major industry in the economy. The purpose of the next section is to determine the extent to which each of the effects explains the slowdown.

Decomposition into Growth and Share Effects

Here, some decompositions are calculated in order to quantify the importance of changes in industrial composition and industry ALP growth rates in explaining the changes in the growth rate of aggregate ALP. The decompositions involve using industry data to construct aggregate quantities. The goal here is to calculate the extent to which each effect can separately explain the observed changes in aggregate behavior. This is accomplished through two calculations. Recall the two indexes for ALP growth over a period

(1.14) $$\Delta fpwp = \sum_i \left[\overline{SB^i_{t-1} \Delta q^i_t} - \overline{SH^i_{t-1} \Delta h^i_t} \right]$$

and

(1.15) $$\Delta tp = \sum_i \left[\overline{AS^i_t \Delta q^i_t} - \overline{ASH^i_t \Delta h^i_t} \right].$$

The first calculation is made assuming that average industry ALP growth rates are constant at their 1948-90 averages through the entire 1948-90 period and allows average industry shares between the 1948-69 and 1969-90 periods to change as observed. Then the only changes that are observed in the implied aggregate between the 1948-69 and 1969-90 periods are due to changes in industrial composition. The second calculation is made assuming that average industry shares are constant at their 1948-90 averages over the entire 1948-90 period and allows average ALP growth rates between the 1948-69 and 1948-90 period to change as observed. Then the only changes that are observed in the implied aggregate between 1948-69 and 1948-90 are due to changes in industry ALP growth rates. These results can then be compared to the changes between 1948-69 and 1969-90 that are observed when both industrial composition and industry ALP growth rates are allowed to change. This will decompose the slowdown in aggregate ALP growth into a growth effect, referring to the effect of lower ALP growth rates among industries, and a share effect, referring to the effect of changing industrial composition.

In particular, make the following definitions. Let $\overline{SB^i_1}$, $\overline{SB^i_2}$, $\overline{SB^i}$, $\overline{AS^i_1}$, $\overline{AS^i_2}$, $\overline{AS^i}$, $\overline{SH^i_1}$, $\overline{SH^i_2}$, $\overline{SH^i}$, $\overline{ASH^i_1}$, $\overline{ASH^i_2}$, and $\overline{ASH^i}$ denote average shares over the different subsamples. The subscript 1 means the average over the first period (1948-69), subscript 2 means the average over second period (1969-90), and no subscript means the average over the entire period (1948-90). Define $\overline{\Delta q_1^i}$, $\overline{\Delta q_2^i}$, $\overline{\Delta q^i}$, $\overline{\Delta h_1^i}$, $\overline{\Delta h_2^i}$, $\overline{\Delta h^i}$ similarly. Then the share effect for the fixed-price-weight and Tornqvist productivity indexes is calculated, respectively, as

(1.16)
$$\sum_i \left[\left(\overline{SB_2^i} - \overline{SB_1^i} \right) \overline{\Delta q^i} - \left(\overline{SH_2^i} - \overline{SH_1^i} \right) \overline{\Delta h^i} \right]$$

(1.17)
$$\sum_i \left[\left(\overline{AS_2^i} - \overline{AS_1^i} \right) \overline{\Delta q^i} - \left(\overline{ASH_2^i} - \overline{ASH_1^i} \right) \overline{\Delta h^i} \right]$$

and the growth effect for both productivity indexes is calculated, respectively, as

(1.18)
$$\sum_i \left[\overline{SB^i} \left(\overline{\Delta q_2^i} - \overline{\Delta q_1^i} \right) - \overline{SH^i} \left(\overline{\Delta h_2^i} - \overline{\Delta h_1^i} \right) \right]$$

(1.19)
$$\sum_i \left[\overline{AS^i} \left(\overline{\Delta q_2^i} - \overline{\Delta q_1^i} \right) - \overline{ASH^i} \left(\overline{\Delta h_2^i} - \overline{\Delta h_1^i} \right) \right]$$

Table 6 shows the results of these calculations. Using the Tornqvist index, the results are that changing composition explains 0.29 of the 1.39 slowdown (21 percent) and changing industry ALP growth rates explains 1.09 (78 percent) of the slowdown. For the fixed-price-weight index, changing composition explains 0.12 of the 1.46 slowdown (8 percent) and changing industry ALP growth rates explains 1.34 (92 percent) of the slowdown. Use of the fixed-price-weight index leads to an undercalculation of the share effect. From now on only the results for the Tornqvist index are reported.

Table 7 decomposes the changes in contribution of each industry into those due to the growth effect and those due to the share effect. For four industries, the share effect was positive, meaning that the change in composition that occurred for these industries had a positive effect on aggregate ALP growth. These include Communications, E.G.A.S.S., F.I.R.E., and General Government. These results are expected for Communication and E.G.A.S.S., since they are higher than average ALP growth industries with increases in shares. F.I.R.E. and General Government are a surprise since they are lower than average productivity growth industries with increases in shares. These results will be explained below when the share effect is further decomposed. Transportation and Wholesale Trade were expected to have positive share effects, but they turned out to be slightly negative. The remaining industries either had share effects in the expected direction or had share effects for which we had no expectations because nominal output shares and hours shares moved in opposite directions.

Another way of measuring the importance of the share effect is to look at the magnitudes of the growth effects compared to the share effects. When changes in contribution are of the expected sign, the growth effect if usually larger in magnitude than the share effect. The share effect is greater than or equal to the magnitude of the growth effect for Farming, Manufacturing Durables, Manufacturing Nondurables, Transportation, and Communications. The sum of the absolute values of the share effect is 0.56 compared to 1.50 for the growth effects. This means that the magnitude of the share effect is 38 percent of the magnitude of the growth effect. From above we know that the net total of share effects is 0.29 and the net total of growth effects is 1.09. This means that the net share effect is 27 percent of the net growth effect. The smaller percentage of the net effect explained by the share effects reflects the fact that the industry share effects tend to cancel each other more than the industry growth effects.

Now it is interesting to consider the two industries that are at the center of the common view of the CCH. Services and Manufacturing Durables have some of the largest changes in composition of all industries. The shifts in nominal output shares and hours shares are toward Services and away from

Manufacturing Durables. Services has a lower than average ALP growth rate while Manufacturing Durables has a higher than average ALP growth rate. Table 7 reveals that the magnitude of the share effect for Manufacturing Durables is the second largest of all the industries. The magnitude of the share effect for Services is relatively small.

The results of this section are that changing industrial composition can explain 21 percent of the slowdown observed in the aggregate ALP growth rate. This percentage is undercalculated if the proper indexing methods are not used in computing the aggregate ALP growth rate. The magnitude of the share effect (measured as the sum of absolute values) relative to the growth effect is somewhat larger than the net share effect relative to the net growth effect. This is because industry share effects tend to cancel each other more than the industry growth effects. The share effect is unexpectedly positive for F.I.R.E., and General Government and unexpectedly negative for Transportation and Wholesale Trade.

Further Decomposing the Share Effect

The share effect can be decomposed further to understand where it comes from. The share effect is decomposed here into four effects, one of which is a relative nominal ALP level effect. This will help assess the importance of the level effect described in the literature and will explain the counterintuitive results reached in the above section for certain industries. The decomposition is carried out for the Tornqvist productivity index only.

The decomposition into these effects is easier to understand if it is recalled that the effect of changing shares on the Tornqvist productivity indexes is measured as

$$\sum_i \left[\left(\overline{AS_2^i} - \overline{AS_1^i} \right) \overline{\Delta q^i} - \left(\overline{ASH_2^i} - \overline{ASH_1^i} \right) \overline{\Delta h^i} \right] \tag{1.20}$$

with all quantities as defined previously. This effect can then be written as the sum of the following three effects:

(1.21) $$\left(\overline{ASH_2^i} - \overline{ASH_1^i}\right)\overline{\Delta agq} - \left(\overline{ASH_2^i} - \overline{ASH_1^i}\right)\overline{\Delta agh}$$

(1.22) $$\left(\overline{ASH_2^i} - \overline{ASH_1^i}\right)\left(\overline{\Delta q^i} - \overline{\Delta agq}\right) - \left(\overline{ASH_2^i} - \overline{ASH_1^i}\right)\left(\overline{\Delta h^i} - \overline{\Delta agh}\right)$$

(1.23) $$\left(\overline{AS_2^i} - \overline{AS_1^i}\right)\overline{\Delta q^i} - \left(\overline{ASH_2^i} - \overline{ASH_1^i}\right)\overline{\Delta q^i}$$

where $\overline{\Delta agq}$ is the growth rate of aggregate output over the total 1948-90 period and $\overline{\Delta agh}$ is the growth rate of aggregate hours over the total 1948-90 period. The first effect is termed the average growth rate effect, the second is the relative growth rate effect, and the third is the total level effect.

The first effect calculates what the share effect from an industry would be if the industry had productivity growth equal to that observed in the aggregate, had a nominal productivity level equal to that of the aggregate, and experienced the share shift that was observed in the industry. To see this compare the given expression for the average growth rate effect (1.21) with the expression for the share effect (1.17). The first difference is that the industry output and hours growth rates are replaced with those of the aggregate. This sets productivity growth equal to that of the aggregate. The second difference is that the nominal output shares in each period are set equal to (and hence are replaced with) the hours shares in each period. This restricts the nominal productivity level of the industry to be equal to the aggregate average[5]. The sum of this component across industries is zero by construction. If every industry had

[5] It is straightforward to show that when the nominal output share of an industry equals the hours share, the level of nominal output per hour equals that of the aggregate:

average productivity growth and average productivity levels, then changes in shares would have no effect on the aggregate.

The second effect calculates the additional effect from the deviation from average productivity growth observed in the industry. It still restricts the productivity level in the industry to be equal to the aggregate average, but allows the productivity growth rate to deviate from the aggregate productivity growth rate as observed.

The third effects is a residual which calculates what the share effect would be if there was zero productivity growth in the industry, the average relative productivity level changed as observed, and shares changed as observed. Productivity growth is equal to zero because the hours growth rate is replaced with the output growth rate.

This third effect can be decomposed into the sum of the following two effects:

(1.24)
$$\overline{ASH_1^i \Delta q^i}\left[\left(\Gamma_{ASH^i} - 1\right)\left(\frac{\overline{AS_1^{\,i}}}{\overline{ASH_1^i}} - 1\right)\right]$$

and

(1.25)
$$\overline{ASH_1^i \Delta q^i}\left[\left(\Gamma_{AS^i} - \Gamma_{ASH^i}\right)\left(\frac{\overline{AS_1^i}}{\overline{ASH_1^i}}\right)\right],$$

where
$$\Gamma_{ASH^i} = \frac{\overline{ASH_2^i}}{\overline{ASH_1^i}} \text{ and } \Gamma_{AS^i} = \frac{\overline{AS_2^i}}{\overline{AS_1^i}}.$$

$S_t^i / \sum_i S_t^i = H_t^i / \sum_i H_t^i \Rightarrow S_t^i / H_t^i = \sum_i S_t^i / \sum_i H_t^i$

The first effect is termed the relative level effect and the second is the change in level effect. The first component measures the effect of the shift in share that is observed in an industry that has the relative productivity level in the first period that is observed. The $\left(\overline{AS_1^i} / \overline{ASH_1^i} - 1\right)$ term measures the relative productivity level in the first period. If the level is lower than the aggregate average, then $\left(\overline{AS_1^i} / \overline{ASH_1^i}\right)$ is less than one and the term $\left(\overline{AS_1^i} / \overline{ASH_1^i} - 1\right)$ is negative. The $\left(\Gamma_{ASH^i} - 1\right)$ term measures whether the industry has an increasing or decreasing share between the two periods. If the share is decreasing, then $\left(\Gamma_{ASH^i}\right)$ is less than one and the term $\left(\Gamma_{ASH^i} - 1\right)$ is negative. An example of what this is measuring would be instructive. Suppose an industry has a lower than average productivity level and has a decreasing share. This should help aggregate productivity growth. The measured effect here would reflect this because both terms would be negative and their product would be positive.

The second effect measures the effect of the change in level that is observed in the industry. This is the effect of the change in relative productivity in the industry on aggregate ALP growth regardless of change in shares. The $\left(\Gamma_{AS^i} - \Gamma_{ASH^i}\right)$ term measures whether an industry's productivity level increased or decreased.[6]

Table 8 summarizes the results of the decomposition of the share effect for all industries. The four effects are the average growth rate effect, the relative growth rate effect, the relative level effect, and the change in relative level effect. The sum across industries of the relative growth effect is -0.25, the sum of the relative level effect is 0.12, and the sum of the change in level effect is -0.16. The magnitude of the relative growth effect as measured by the sum across industries of the absolute values is 0.27, the

[6] To see this consider the following. If $\Gamma_{AS^i} > \Gamma_{ASH^i}$, then $\overline{AS_2^i} / \overline{AS_1^i} > \overline{ASH_2^i} / \overline{ASH_1^i}$, which implies $\overline{AS_2^i} / \overline{AS_2^i} > \overline{ASH_1^i} / \overline{ASH_1^i}$, or nominal productivity level is higher over second period than over the first period.

magnitude of the relative level effect is 0.34, and the magnitude of the change in level effect is 0.38. The magnitude of the relative level effect is larger than the magnitude of the relative growth rate effect. These level effects, however, tend to cancel each other and, as a result, the growth effects have a much larger net effect.

An intuitive explanation of the effects for an industry would be instructive for understanding the effects (i.e., understanding how to interpret the results in Table 8). The results for Farming indicate that the average growth effect is -0.11. This is the effect that the shift in shares observed in Farming would have on an average ALP growth rate, average productivity level industry. Since shares shifted away from Farming, this figure is negative. The relative growth effect is -0.12. This is the extra effect that the shift in shares observed in Farming has because Farming is not an average ALP growth rate industry. This figure is negative because shares shifted away from Farming and Farming is a higher than average ALP growth rate industry. The relative level effect is 0.04. This is the effect that the shift in shares observed in Farming has because of Farming's relative productivity level. This figure is positive because there is a shift away from a below average productivity level industry. Finally, the change in relative level effect is 0.01. This is the effect from the change observed in the relative productivity level in Farming. This figure is positive since the relative productivity level in Farming has increased.

As mentioned above, the results for the overall share effect in F.I.R.E., General Government, Transportation, and Wholesale Trade are unexpected. Table 8 helps explain these results. The positive share effect for F.I.R.E. is due to the high relative productivity level in the industry. Also, the effect from F.I.R.E. being a low ALP growth rate industry, while negative as expected, is small in magnitude relative to the other effects. The positive share effect for General Government is due to its increase in relative productivity level. The negative share effect for Transportation is due to its high relative level, its decline in relative level, and the smallness of its relative growth effect. Wholesale Trade has a negative share effect because of the decline in relative level.

The results indicate that the change in industrial composition to or away from industries with high or low relative productivity levels has considerable effects on an industry's contribution to aggregate ALP growth at the industry level. In fact, the magnitude of this effect is larger than the magnitude of the effect of composition shifting to or away from industries with higher or lower than average ALP growth. However, these effects tend to cancel each other when industries are aggregated in the net effect of the relative industry levels is hence smaller than the net effect of relative industry ALP growth rates.

Conclusion

The conclusion is that changing industrial composition can explain 21 percent of the observed decline in the average aggregate ALP growth rate between the periods 1948-69 and 1969-90. Using the proper indexing method for aggregate productivity growth and adjusting the hours data published in NIPA to include the self-employed are quantitatively important in measuring the extent to which changing composition explains the productivity slowdown. The relative productivity level effects discussed in the literature on the CCH have a larger magnitude than the relative ALP growth rate effects, but tend to cancel each other when aggregated across industries. Hence, on net, the relative growth rate effects dominate the relative level effects in the determination of the overall effect of changing composition.

CHAPTER 2

CHANGING INDUSTRIAL COMPOSITION AND THE DYNAMICS OF LABOR INPUT GROWTH AND OUTPUT GROWTH

Introduction

The purpose of this chapter is to measure the extent to which the changing industrial composition of the postwar U.S. economy can explain any of the changes observed in the dynamic properties of aggregate labor input growth, aggregate output growth, and the response of aggregate labor input growth to aggregate output growth.

The motivation for investigating these changes and the possible contribution to them from shifting industrial composition comes from Zarnowitz and Moore (1986). In this article, the authors note that the average percent decline in aggregate employment experienced from business cycle peak to business cycle trough has decreased between the periods 1948-60 and 1970-82. They also note that over the 1948-82 period, the industrial composition of aggregate employment shifted toward industries that in general experience smaller percent declines in employment relative to other industries during recessions. This suggests that the changing composition of employment may explain some of the observed decrease in aggregate employment declines during recessions.

In order to demonstrate the importance of these compositional effects, Zarnowitz and Moore estimate what the average percent decline in aggregate employment during recessions would have been in the 1948-60 and 1970-82 periods if industrial composition had been different. The demonstration is carried out by recognizing that the percent change in aggregate employment is equal to the weighted sum of percent changes in industry employment, with the weight for each industry being its share of aggregate employment. The same relation holds approximately if sample averages are taken. In particular, they restrict average percent declines in employment in individual industries during recessions to their observed values in the 1948-60 and 1970-82 periods. They then insert the industrial composition from different years to generate estimates of what the decline in average aggregate employment would have been if industrial composition had been different.

As a result of their calculations, Zarnowitz and Moore conclude that most of the decrease in the average percentage decline in aggregate employment during recessions seen between 1948-60 and 1970-82 is due to shifts in industrial composition toward industries that are generally less responsive to the business cycle. It is evident from their calculations, however, that this is not the entire explanation. A logical alternative is that the responsiveness of employment in individual industries to the business cycle has declined over the 1948-82 period.

This study applies decompositions in the spirit of the Zarnowitz and Moore calculations to a wide array of statistics based on second moments. The purpose is not only to provide evidence that industrial composition matters, but also to quantify the extent to which it matters. The goal is to be able to assign percentages of the observed change in aggregate behavior to changing industrial composition and to changing behavior of industry second moments.

The chapter considers, in turn, the behavior of aggregate labor input growth, the correspondence between aggregate labor input growth and aggregate output growth, and finally the behavior of aggregate output growth. For each, the facts regarding changes in behavior are displayed and simple evidence suggesting a role for compositional effects is presented. Then a decomposition of aggregate behavior into industry behavior and industry shares is developed, and the results of the decomposition are shown and discussed.

Labor Input Dynamics

This section measures the extent to which changing industrial composition can explain any of the observed changes in the dynamic properties of aggregate employment growth and aggregate hours growth. Explanations of the remaining changes, though not the focus, are also briefly investigated. These dynamic properties are studied in isolation from any other variables that may have effects on labor input growth. Possible additional effects that come through the link between labor input and aggregate output are considered later in the text.

Throughout the section, three sets of comparisons are made. The first is between behavior during the periods 1948-69 and 1970-89. These correspond roughly to the pre- and post- productivity slowdown eras. The second is between behavior during 1948-60 and 1970-82 (periods of business cycles), and the third is between behavior during 1961-69 and 1983-89 (periods of sustained growth). The purpose of the second and third comparisons is to see whether observed changes in dynamic behavior over the longer periods are attributable to changes in behavior during business cycles, during periods of sustained growth, or both.

The Facts

Before proceeding with any measurements of compositional effects, it is necessary to determine how the second moments of aggregate labor input have changed, and understand why shifts in industrial composition may explain these changes. The statistics for the growth rate of labor input that are examined are the standard deviation, autocorrelations, the spectrum, partial autocorrelations, and regression coefficients from an autoregression. The statistics are calculated using the generalized method of moments and standard errors are estimated nonparametrically using a quadratic spectral kernel with automatic bandwidth choice as described in Andrews (1991). The data used are unpublished monthly employment and hours worked by industry from the BLS summed to quarterly levels.

Standard Deviation

Table 9 shows the standard deviation of aggregate employment growth and aggregate hours growth for the three pairs of periods. For each pair, t-statistics and associated p-values for a two-sided alternative are given for the null hypothesis that there is no difference in the standard deviation between that particular pair of periods. In all cases the point estimates indicate a decline in the standard deviation of labor input growth from the earlier period to the more recent period, although the changes vary in degree of significance. The strongest statistical evidence supports a decline in the standard deviation of both employment growth and hours growth between 1948-60 and 1970-82, periods of business cycle activity. The next strongest case for a significant decline is between 1948-69 and 1970-82, periods including both business cycles and a period of sustained growth. Finally, a reduction in the standard deviation of both employment growth and hours growth between 1961-69 and 1983-89 has the weakest statistical support.

Table 10 presents evidence suggesting that changing industrial composition explains at least part of the observed decline in the standard deviation of aggregate employment growth and aggregate hours growth. The standard deviation of employment growth and of hours growth is calculated over the entire 1948-89 period for each industry and shown next to the change in average share for each industry between the 1948-69 and 1970-89 periods. For both employment growth and hours growth, four of the five industries with the lowest standard deviation over the 1948-89 period have an increase in share, while the five industries with the highest standard deviation over the 1948-89 period have a decrease in share. Composition shifts away from more volatile industries and toward less volatile industries, suggestive of less volatility in the aggregate.

Autocorrelations

Table 11 shows the first 12 autocorrelations of aggregate employment growth for the entire 1948-89 period and for the three pairs of periods. Point estimates that are significant at either the 5 percent or 10 percent level are indicated as described in the table. Table 12 displays the same statistics for aggregate hours growth.

Employment growth exhibits significant positive first and second order autocorrelation over the 1948-89 period as well as over all of the shorter periods. Employment growth also shows significant negative fifth through eighth order autocorrelation over the 1948-89 period, but not over all of the shorter periods. The fourth through seventh order autocorrelations are negative and significant in the 1948-69 period, but are not significant in the 1970-89 period. Meanwhile, the eighth through twelve autocorrelations are not significant in the 1948-69 period, but are negative and significant in the 1970-89 period. Between the 1948-69 and 1970-89 periods, a sequence of significant negative autocorrelations shifts from lower order to higher order. Comparing the business cycle periods of 1948-60 and 1970-82, a similar phenomena occurs, with a sequence of negative autocorrelations shifting from lower to higher order. However, comparing the expansion periods of 1961-69 and 1983-89, something slightly different occurs. The 1961-69 period shows no significant autocorrelation beyond the first and second, while the 1983-89 period shows significant negative fifth through tenth autocorrelation.

The autocorrelation structure changes between 1948-69 and 1970-89 through a shift of negative autocorrelation from lower to higher order. This is due to the same phenomena occurring between periods of business cycle activity in each period, and the development of higher order negative autocorrelation in the latter period of expansion. The results for aggregate hours growth are similar. Table 13 shows the changes in each of the autocorrelations for both employment growth and hours growth for each of the three pairs of periods. Changes that are significant at the 5 percent and 10 percent levels are indicated as described in the table.

The shift of significant negative autocorrelations in employment growth from lower order to higher order between 1948-69 and 1970-89 is evident here, as the third through fifth autocorrelations increase significantly and the ninth through twelve autocorrelations decline significantly. The same result holds for the periods of business cycle activity, except that the declines in higher order autocorrelations, though sizable, are not statistically significant. The expected result for the comparison between periods of expansion appears, as the sixth through tenth autocorrelations decline significantly.

The story for employment growth seems to be that lower order autocorrelations increase and higher order autocorrelations decline over the postwar period. The lower order autocorrelations increase because of a significant increase in lower order autocorrelation during business cycles that more than counteracts an insignificant decline in lower order autocorrelations during periods of sustained growth. The higher order autocorrelations decline because of a significant decline in higher order autocorrelations during periods of sustained growth coupled with a less than significant decline in higher order autocorrelations during business cycles. For aggregate hours growth, point estimates generally change in the same direction and by similar magnitudes, but fewer of the changes are statistically significant. The story suggested by the results for hours growth is the same as that suggested above for employment growth.

Table 14 presents evidence suggesting that changing industrial composition explains at least part of the observed changes in the autocorrelations of aggregate employment growth. The table shows the autocorrelations of employment growth by industry for the entire 1948-89 period along side the change in average share for each industry between the 1948-69 and 1970-89 periods. As a reminder, the autocorrelations that change significantly in the aggregate between these periods are indicated as described in the table.

Focusing on the autocorrelations that change significantly in the aggregate, the four industries with the largest third autocorrelation, three of the four industries with the largest fourth autocorrelation, and the four industries with the largest fifth autocorrelations have an increase in average share. This suggests that an increase in these autocorrelations in the aggregate between the 1948-69 and 1970-89 periods may be due to compositional effects.

For the ninth through twelfth autocorrelations, the same type of argument is not as apparent. Only two of out of the four industries with the most negative ninth, tenth, eleventh, and twelfe autocorrelations have an increase in share, suggesting a relatively smaller role for changing composition in explaining these changes in the aggregate.

Table 15 presents evidence suggesting that changing industrial composition explains at least part of the observed changes in the autocorrelations of aggregate hours growth. Three of the four industries with highest fourth autocorrelation and two of the four with the highest fifth autocorrelations have an increase in share, suggesting that an increase in these autocorrelations in the aggregate between the 1948-69 and 1970-89 periods may be due to compositional effects. In addition, three of the four lowest tenth autocorrelation industries have an increase in share, also suggesting a role for compositional influence.

Spectrum

The spectrum provides an alternative expression of the autocovariances (it is a function of the autocovariances) and gives a nice visual representation of the cyclical properties of the data. Estimates of the spectrum are calculated from the sample periodogram, which in turn is calculated from the sample autocovariances. Figure 1 shows the estimated spectrum for employment growth over the 1948-69 and 1970-89 periods. The figure suggests that the variance of employment growth falls, as the entire spectrum shifts downward. The peak of the spectrum also shifts slightly to the left, suggesting that more of the cyclical behavior of employment growth can be explained by cycles of lower frequency. Figure 2 shows the estimated spectrum for employment growth over the 1948-60 and 1970-82 periods, the periods of business cycles. The figure suggests the same general conclusions, that the variance of employment growth falls and that more of the cyclical behavior of employment growth can be explained by cycles of lower frequency. Figures 3 and 4 are the same as figures 1 and 2, except that the calculations are for hours growth, and suggesting the same general conclusions.

Partial Autocorrelations and Regression Coefficients

Table 16 shows the first 12 partial autocorrelations of aggregate employment growth for the entire 1948-89 period and for the three pairs of periods. Point estimates that are significant at either the 5 percent or 10 percent level are indicated as described in the table. Table 17 displays the same statistics for aggregate hours growth.

The first partial correlation of employment growth is positive and significant over the entire 1948-89 period as well as over all of the shorter periods (which we already knew since the first partial autocorrelation equals the first autocorrelation by definition). The second partial autocorrelation is negative and significant over the 1948-89 period and over every shorter period except for the 1970-82 and 1983-89 periods. Some of the other partial correlations are significant over the 1948-89 period, with the same partial correlations being significant over a subset of the shorter periods. However, there do not appear to be any characteristic shifts in the partial autocorrelations as there were in the autocorrelations. The results for aggregate hours growth, contained in table 17, are much the same.

Table 18 shows the changes in partial autocorrelations of both employment growth and hours growth between all three sets of periods. Changes that are significant at the 5 percent and 10 percent levels are indicated as described in the table. Very few of the changes in partial autocorrelations are significant. For employment growth, only a decline in the eighth partial autocorrelation between 1948-69 and 1970-89 is significant. For hours growth, a decline in the sixth partial autocorrelation between 1948-69 and 1970-89, and a decline in the sixth partial autocorrelation between 1961-69 and 1983-89 are significant.

Table 19 shows partial autocorrelations of employment growth by industry for the entire 1948-89 period along side the change in average share for each industry between the 1948-69 and 1970-89 periods. Again, focusing only on those partial autocorrelations which changed significantly in the aggregate, three of the five industries with the lowest eight partial correlations have an increase in share. Table 20 shows the same statistics for hours growth. Two of the five industries with the lowest sixth order partial correlation have an increase in share. For the few partial correlations that change, composition may play a role in explaining the changes.

Table 21 shows the regression coefficients for an AR(8) model of aggregate employment growth for the entire 1948-89 period and for the three pairs of periods. Point estimates that are significant at either the 5 percent or 10 percent level are indicated as described in the table. Table 22 displays the same statistics for aggregate hours growth.

For employment growth the coefficient on the first lag is positive and significant over all periods, and the coefficient on the second lag is negative and significant over the 1948-89 period and over the longer 1948-69 and 1970-89 periods. A significant negative coefficient on the fifth lag and a significant positive coefficient on the sixth lag over the 1948-89 period appears to stem from the behavior over the 1948-60 period. For hours growth the coefficient on the first lag is positive and significant over all periods, while the coefficient on the second lag is always negative but never significant. The coefficient on the fifth lag is negative and significant over some of the periods and the coefficient on the sixth lag is positive and significant over the 1948-69 period.

Table 23 shows the changes in the regression coefficients for an AR(8) regression for both employment growth and hours growth between all three sets of periods. Changes that are significant at the 5 percent and 10 percent levels are indicated as described in the table. As with the partial autocorrelations, very few of the regression coefficients change significantly. For employment growth, only the coefficient on the eighth lag between 1948-69 and 1970-89 changes significantly. For hours growth, the coefficient on the fifth lag increases significantly and the coefficient on the sixth lag decreases significantly between the 1948-69 and 1970-89 periods. The coefficient on the fifth lag increases significantly between both the 1948-60 and 1970-82 periods and the 1961-69 and 1982-89 periods. The coefficients on the fourth and sixth lags decrease significantly between the 1961-69 and 1983-89 periods.

Table 24 shows regression coefficients AR(8) models of employment growth by industry for the entire 1948-89 period along with the change in average share for each industry between the 1948-69 and 1970-89 periods. Focusing on the one coefficient that changed significantly in the aggregate, three of the five industries with the lowest coefficient on the eighth lag have an increase in share, suggesting a role for changing composition in explaining the decline seen in the coefficient on the eighth lag in the aggregate.

Table 25 shows the same statistics for hours growth. Only two of the five industries with the highest coefficient on the fifth lag and only two of the five industries with the lowest coefficient on the sixth lag have an increase in share. This suggests that composition may not help much in explaining the aggregate increase in the coefficient on the fifth lag and the aggregate decline in the coefficient on the sixth lag.

Summary

Most of the significant changes in the second moments of aggregate employment and aggregate hours growth occur in the standard deviation and several of the autocorrelations. For employment growth there are only two significant changes among the partial autocorrelations and regression coefficients. For hours growth there are only two significant changes in partial autocorrelations, but there are six significant changes in regression coefficients. For the standard deviation, some of the autocorrelations, and a few of the partial correlations and regression coefficients, there appears to be a role for changing industrial composition in explaining changes in aggregate statistics.

Expressing Aggregate Dynamic Properties in Terms of Industry Dynamic Properties and Industry Shares.

Expressions for aggregate second moments in terms of industry second moments and industry shares are developed below. Changes in aggregate second moments can then be viewed as a combination of changes in industry second moments and changes in industry shares. The relative importance of each effect can be measured by taking what is conceptually equivalent to a partial derivative.

Let L_t denote aggregate labor input at time t and let L_t^i denote labor input in a particular industry at time t. Then aggregate labor input at time t is simply the sum of industry labor input over the I industries

(2.1) $$L_t = \sum_{i=1}^{I} L_t^i .$$

The gross percent change of aggregate labor input is a weighted average of the growth in each industry, with the weights given by industry shares

(2.2) $$\frac{L_t}{L_{t-1}} = \sum_{i=1}^{I}\left(\frac{L_{t-1}^i}{L_{t-1}}\right)\left(\frac{L_t^i}{L_{t-1}^i}\right) = \sum_{i=1}^{I}\left(S_{t-1}^i\right)\left(\frac{L_t^i}{L_{t-1}^i}\right), \quad \text{where} \quad S_{t-1}^i = \frac{L_{t-1}^i}{L_{t-1}}.$$

Equation (2.2) is essentially the expression utilized by Zarnowitz and Moore in their calculations. They set the industry gross percent changes equal to observed averages over business cycles and inserted shares from different years to generate alternative aggregate gross percent changes.

Taking the natural logarithm of both sides gives the approximation

(2.3) $$\Delta l_t \cong \sum_{i=1}^{I} S_{t-1}^i \Delta l_t^i$$

where $l_t = \ln(L_t)$, $l_t^i = \ln(L_t^i)$, and $\Delta = (1 - L)$ the first difference operator. The approximation is due to the fact that the natural logarithm of a sum of elements is not equal to the sum of the natural logarithms of the elements. The growth rate over a period of time can be approximated by substituting sample averages over that time period into (2.3) to obtain

$$\overline{\Delta l_t} \cong \sum_{i=1}^{I} \overline{S_{t-1}^i \Delta l_t^i}. \tag{2.4}$$

Using approximations of a similar type, the variance (and hence the standard deviation) of the aggregate over a period of time can be approximated by

$$\text{var}(\Delta l_t) \cong \sum_{i=1}^{I} \left(\overline{S_{t-1}^i}\right)^2 \text{var}(\Delta l_t^i) + 2\sum_{i=1}^{I} \sum_{j=i+1}^{J} \left(\overline{S_{t-1}^i}\right)\left(\overline{S_{t-1}^j}\right) \text{cov}(\Delta l_t^i, \Delta l_t^j). \tag{2.5}$$

Similarly, autocovariances over a period of time can be approximated by

$$\text{cov}(\Delta l_t, \Delta l_{t-1}) \cong \sum_{i=1}^{I} \sum_{j=1}^{I} \left(\overline{S_{t-1}^i}\right)\left(\overline{S_{t-2}^j}\right) \text{cov}(\Delta l_t^i, \Delta l_{t-1}^j) \tag{2.6}$$

and

$$\text{cov}(\Delta l_t, \Delta l_{t-k}) \cong \sum_{i=1}^{I} \sum_{j=1}^{I} \left(\overline{S_{t-1}^i}\right)\left(\overline{S_{t-1-k}^j}\right) \text{cov}(\Delta l_t^i, \Delta l_{t-k}^j). \tag{2.7}$$

Now, an array of other statistics based on second moments can be expressed in terms of industry second moments and average industry shares. Autocorrelations can be expressed as

(2.8) $$\rho_k(\Delta I_t) = \frac{\operatorname{cov}(\Delta I_t, \Delta I_{t-k})}{\operatorname{var}(\Delta I_t)} \cong \frac{\sum_{i=1}^{I}\sum_{j=1}^{I}\left(\overline{S_{t-1}^{i}}\right)\left(\overline{S_{t-1-k}^{j}}\right)\operatorname{cov}\left(\Delta I_t^i, \Delta I_{t-k}^j\right)}{\sum_{i=1}^{I}\left(\overline{S_{t-1}^{i}}\right)^2 \operatorname{var}\left(\Delta I_t^i\right) + 2\sum_{i=1}^{I}\sum_{j=i+1}^{J}\operatorname{cov}\left(\Delta I_t^i, \Delta I_t^j\right)}.$$

The sample periodogram can be expressed as

(2.9) $$S(\Delta I_t, \omega) = \frac{1}{2\pi}\left[\operatorname{var}(\Delta I_t) + 2\sum_{k=1}^{\infty}\operatorname{cov}(\Delta I_t, \Delta I_{t-k})\cos(\omega k)\right] \cong$$

$$\frac{1}{2\pi}\left[\left(\sum_{i=1}^{I}\left(\overline{S_{t-1}^{i}}\right)^2 \operatorname{var}\left(\Delta I_t^i\right) + 2\sum_{i=1}^{I}\sum_{j=i+1}^{J}\left(\overline{S_{t-1}^{i}}\right)\left(\overline{S_{t-1}^{j}}\right)\operatorname{cov}\left(\Delta I_t^i, \Delta I_t^j\right)\right) + \right.$$

$$\left. 2\sum_{k=1}^{T-1}\left(\sum_{i=1}^{I}\sum_{j=1}^{I}\left(\overline{S_{t-1}^{i}}\right)\left(\overline{S_{t-1-k}^{j}}\right)\operatorname{cov}\left(\Delta I_t^i, \Delta I_{t-k}^j\right)\right)\cos(\omega k)\right].$$

The parameters of an autoregression

(2.10) $$\Delta I_t = \phi_1 \Delta I_{t-1} + \phi_2 \Delta I_{t-2} + \cdots + \phi_p \Delta I_{t-p}$$

can be expressed in terms of variances and covariances

(2.11)

$$\begin{bmatrix}\phi_1\\ \phi_2\\ \vdots\\ \phi_p\end{bmatrix} = \begin{bmatrix}\operatorname{var}(\Delta I_t) & \operatorname{cov}(\Delta I_t, \Delta I_{t-1}) & \cdots & \operatorname{cov}(\Delta I_t, \Delta I_{t-p+1})\\ \operatorname{cov}(\Delta I_t, \Delta I_{t-1}) & \operatorname{var}(\Delta I_t) & & \operatorname{cov}(\Delta I_t, \Delta I_{t-p+2})\\ \vdots & & \ddots & \vdots\\ \operatorname{cov}(\Delta I_t, \Delta I_{t-p+1}) & \operatorname{cov}(\Delta I_t, \Delta I_{t-p+2}) & \cdots & \operatorname{var}(\Delta I_t)\end{bmatrix}^{-1}\begin{bmatrix}\operatorname{cov}(\Delta I_t, \Delta I_{t-1})\\ \operatorname{cov}(\Delta I_t, \Delta I_{t-2})\\ \vdots\\ \operatorname{cov}(\Delta I_t, \Delta I_{t-p})\end{bmatrix},$$

where the variances and covariances can be written in terms of industry variances and covariances and industry shares as shown above. Partial autocorrelations are defined as the last coefficient from such a regression. For example, the fourth partial autocorrelation is the coefficient on the fourth lag in (2.10) when $p = 4$, the fifth partial autocorrelation is the coefficient on the fifth lag in (2.10) when $p = 5$, etc.

Expressions for a myriad of aggregate second moments in terms of industry second moments and industry shares have been established. Now, these expressions can be used to derive estimates of the impact of changes in industry second moments and industry shares on observed changes in aggregate second moments. For example, suppose it is desired to decompose the change in the standard deviation of labor input growth between 1948-69 and 1970-89 into compositional and other effects. First, using the sample industry second moments calculated over the entire 1948-89 period, alternately insert the industry share averages from 1948-69 and 1970-89 into (2.5) to generate two estimates of aggregate labor input growth standard deviation. The difference between these two is the amount of the change attributable to change in composition. Then, using industry share averages calculated over the entire 1948-89 period, alternately insert the industry second moments from 1948-69 and 1970-89 into (2.5) to generate two more estimates of aggregate labor input growth standard deviation. The difference between these two is the amount of the change attributable to change in industry second moments. These two differences will approximately sum to the difference observed in aggregate labor input growth between 1948-69 and 1970-89. Percentages can then be assigned to each influence. It should be noted that there is nothing that restricts the percentages to sum to 100 percent.

Results of Decomposition

Highlights of the results of the decompositions of all the dynamic properties of aggregate employment growth and aggregate hours growth are contained below. Tables for all results are provided for completeness, although some of the results are either uninteresting or uninterpretable. The discussion focuses, for the most part, on the decomposition of statistically significant changes in aggregate second moments.

Standard Deviation

In (2.5) it was shown how to express the variance of aggregate labor input growth in terms of the variances of industry labor input growth, the covariances between labor input growth in different industries, and the average share of each industry. Taking the square root of both sides of (2.5) gives the expression for the standard deviation of aggregate labor input growth.

Table 26 shows the results of the decomposition for the change in the standard deviation of aggregate employment growth and aggregate hours growth between all three pairs of periods. Between the longer pair 1948-69 and 1970-89, changing industrial composition explains 49 percent of the observed decline in the standard deviation of aggregate employment growth, while changing industry variances explain 19 percent of the decline, and changing industry covariances explain 28 percent of the decline. Between 1948-69 and 1970-89, changing industrial composition explains 44 percent of the observed decline in the standard deviation of aggregate hours growth, while changing industry variances explain 21 percent of the decline, and changing industry covariances explain 34 percent of the decline. For the other comparisons for both employment and hours growth, composition explains between 35 percent and 44 percent of the decline, industry variances explain between 16 percent and 29 percent of the decline, and industry covariances explain between 30 percent and 43 percent of the decline. In all cases, changing covariances between industry growth rates explains more of the observed decline than changing variances of industry growth rates.

Autocorrelations

In (2.8) it was shown how to express the autocorrelations of aggregate labor input growth in terms of the variances of industry labor input growth, the covariances between labor input growth in different industries, and the average share of each industry. Table 27 shows the results of the decomposition for the autocorrelations of aggregate employment growth and aggregate hours growth between 1948-69 and 1970-89. As a reminder, the autocorrelations that change significantly are indicated as described in the table. Industrial composition explains a sizable, but smaller amount of the observed changes compared to standard deviation. For statistically significant changes in employment growth autocorrelations, shifting composition explains between 3 percent and 14 percent of the observed change, while changing industry variances explain between 16 percent and 26 percent and changing industry covariances explain between 63 percent and 76 percent of the observed changes. Similar results hold for aggregate hours growth. Table 28 shows quantitatively similar results for the comparison between the 1948-60 and 1970-82 periods, while table 29 suggests that compositional effects work in the direction opposite of the observed change for the comparison between the 1961-69 and 1983-89 periods.

Spectrum

Equation (2.9) shows how to express the sample periodogram in terms of the variances of industry labor input growth, the covariances between labor input growth in different industries, and the average share of each industry. In figure 5, the autocovariances of employment growth are calculated over the entire 1948-89 period, and then average shares from 1948-69 and 1970-89 are alternately inserted to produce two estimates of the spectrum, with the difference representing the change due to compositional effects. Figure 6 shows the results of the same exercise, but with autocovariances and shares changing roles. Composition is held at its 1948-89 average and autocovariances estimated over 1948-69 and 1970-89 are alternately inserted to generate two estimates of the spectrum, with the difference representing the change due to changing autocovariances. In figure 7, these are combined to give a visual accounting of the sources of change. The figure shows the change in the spectrum, along with the changes induced separately by changing composition and by changing autocovariances. Figure 8 displays the same decomposition, but for the change in spectrum between the periods of business cycles 1948-60 and 1970-82. Figures 9 through 12 show the same calculations as figures 5 through 8, but for hours growth, with the results being very similar. The overall conclusion for labor input growth is that compositional effects tend to shift the spectrum down without affecting the location of the peak much, although the shift is more pronounced around cycles of lower frequency. Changing autocovariances tend to shift the spectrum down and affect its shape by moving the location of the peak toward lower frequencies.

Partial Autocorrelations and Regression Coefficients

In (2.11) it was shown how to express regression coefficients from an autoregressions, and hence, partial autocorrelations in terms of industry second moments and industry shares. Table 30 shows the results of the decomposition for the change in partial autocorrelations between 1948-69 and 1970-89 into compositional effects and changing second moments for both aggregate employment and aggregate hours growth. For the only two statistically significant changes, shifting composition explains between 6 percent and 11 percent of the observed change while changing industry variances and covariances explain between 80 percent and 97 percent of the observed change. There are no significant changes in table 31, which displays the decomposition of changes between 1948-60 and 1970-82. There is one statistically significant change in table 32, which displays the decomposition of changes between 1961-69 and 1983-89, showing that composition works in the direction opposite of the observed change in the aggregate.

Table 33 display the results of the decomposition for the changes in AR(8) coefficients between 1948-69 and 1970-89 into compositional effects and changing second moments for both aggregate employment and aggregate hours growth. For statistically significant changes, shifting composition explains between 2 percent and 11 percent, while changing industry variances and covariances explain between 80 percent and 105 percent of the observed change. In table 34 (changes between 1948-60 and 1970-82) composition works in the wrong direction for the only statistically significant change. Table 35 (changes between 1961-69 and 1983-89) also indicates that composition generally operates in the wrong direction, including the three cases where changes are statistically significant.

Summary

The conclusion from these results is that changing industrial composition does play a role in explaining the changes observed in the second moments of aggregate labor input growth over the postwar era. While explaining more of the change in the standard deviation of aggregate labor input growth than changing industry second moments, the latter dominates significant changes in all other second moments. Of particular note is the role of covariances between labor input growth in industries, which generally explains more of the change in aggregate second moments than the variances of labor input growth within individual industries. Also, for changes between the periods of prolonged business expansion, changing composition quite often works in the direction opposite of that observed in the aggregate.

Dynamic Relationship Between Labor Input Growth and Output Growth

Zarnowitz and Moore focus on the behavior of aggregate employment in response to (or coincident with) the large declines observed in output during recessions. The above analysis considered the behavior of employment and hours growth in isolation. Presumably, most of the fluctuations in employment and hours growth coincide with fluctuations in output growth. However, this may not entirely be the case and an analysis more in the spirit of Zarnowitz and Moore can be achieved by examining the relationship between employment and hours growth and output growth. To this end, the analysis below focuses on the second moments between aggregate labor input growth and aggregate output growth. The three sets of period comparisons made above for labor input growth are retained here.

The Facts

The second moments studied here are the correlation of aggregate labor input growth with aggregate output growth and lags of aggregate output growth, partial correlations of labor input growth with respect to output growth and lags of output growth, and regression coefficients from a regression of labor input growth on output growth and lags of output growth. The partial correlation of labor input growth with respect to a particular lag of output growth is defined as the regression coefficient on that particular lag resulting from a regression of labor input growth onto output growth and all lags of output growth up to and including the lag of interest. This measures the correlation between labor input growth and the lag of output growth once the effects of other lower order lags of output growth are accounted for or "partialed" out. As above, the statistics are calculated using the generalized method of moments and standard errors are estimated nonparametrically using a quadratic spectral kernel with automatic bandwidth choice as described in Andrews (1991). The labor input data are the same as used above, and the output data are real gross domestic product in 1987 dollars.

Contemporaneous and Dynamic Correlations

Table 36 shows the correlation coefficients of aggregate employment growth with aggregate output growth and 12 lags of output growth for the entire 1948-89 period as well as the three pairs of periods. Table 37 displays the same statistics for aggregate hours growth. For the 1948-89 period, both employment growth and hours growth are significantly positively correlated with output growth and the first three lags of output growth. For the shorter periods, at least three of these four correlations are significant except in the 1961-69 period.

Table 38 displays the changes in the correlations between labor input growth and output growth and lags of output growth. For employment growth, correlations with the fourth and fifth lags of output growth increase significantly between 1948-69 and 1970-89. The significant increase in the correlation with the fourth lag of output growth is also evident between 1948-60 and 1970-82. Also, the correlation with the eighth through eleventh lags of output growth falls significantly between 1961-69 and 1983-89. Of note is the fact that the contemporaneous correlation of both employment growth and hours growth with output growth does not decline significant, even between the business cycle periods of 1948-60 and 1970-82, seemingly at odds with the Zarnowitz and Moore findings. However, the Zarnowitz and Moore findings will come to light later when partial correlations are examined.

For hours growth, the correlation with the fourth lag of output growth also increases significantly between 1948-69 and 1970-89. Correlations with the third and fourth lags increase significantly between 1948-60 and 1970-82, while correlations with the eighth and tenth lags decrease significantly between 1961-69 and 1982-89.

The pattern of change here is very similar to what was observed for the autocorrelations of labor input growth. Lower order correlations with output growth increase while higher order correlations decline in general. However, the changes are not statistically significant as often as they are for autocorrelations of labor input growth.

Table 39 provides the correlations of employment growth in individual industries with aggregate output growth and lags of aggregate output growth over the 1948-89 period, along with changes in average shares of labor input between 1948-69 and 1970-89. Three of the industries with the highest correlations with the fourth lag of output growth and the two with the highest correlations with the fifth lag of output growth increase in share. Table 40 provides the same information for hours growth. Three of the four industries with highest correlation with the fourth lag of output have an increase in share.

Partial Correlations and Regression Coefficients

Table 41 shows the partial correlations of aggregate employment growth with output growth and lags of output growth. Table 42 displays the same for hours growth. None of the partial correlations beyond the contemporaneous and first lag are significant over any of the time periods. The partial correlation with contemporaneous output growth is positive and significant in all cases except for employment growth over the 1983-89 period. The partial correlation with the first lag of output growth is positive and significant in all cases except for both employment growth and hours growth over the 1983-89 period.

Table 43 shows the changes in partial correlations of labor input growth with output growth. The only statistically significant change is a reduction in the contemporaneous partial correlation between hours growth and output growth between the 1948-60 and 1970-82 periods. This is of particular interest because this is the closest of the statistics considered to what Zarnowitz and Moore drive at in their article. Although the change in the contemporaneous correlation between employment growth and output growth between the 1948-60 and 1970-82 periods is not significant, it will be examined in the decompositions to follow for this reason.

Tables 44 and 45 show partial correlations of industry employment growth and hours growth, respectively, with aggregate output growth and lags of aggregate output growth over the entire 1948-89 period along with changes in labor input shares between 1948-69 and 1970-89. Though none of the changes in the aggregate were significant, the results for the contemporaneous and first lag of output are suggestive of compositional influence. For employment growth four of the five industries with the lowest partial correlation with output growth and the four industries with the lowest partial correlation with the first lag of output growth have an increase in share. Similar results appear for hours growth.

Tables 46 and 47 show the results of a regression of employment growth and hours growth, respectively, on output growth and eight lags of output growth. Similar to the results for partial correlations, only the coefficient on output growth and the first lag of output growth are ever significant. Table 48 shows the changes in the regression coefficients between the various periods, with none being significant.

Tables 49 and 50 show results from regressing industry employment growth and hours growth, respectively, on aggregate output growth and lags of aggregate output growth over the entire 1948-89 period along with changes in labor input shares between 1948-69 and 1970-89. As with partial correlations, despite the fact that none of the changes in the aggregate are significant, there is still evidence for compositional effects in the coefficients on output growth and the first lag of output growth. For employment growth four of the five industries with the smallest coefficient on output growth and three of the five industries with the smallest coefficient on the first lag of output growth had an increase in share. The same is true for hours growth.

Summary

Significant changes in the second moments between labor input growth and output growth are not as prevalent as in the case of the second moments of labor input growth. There are no significant changes in the contemporaneous correlation between labor input growth and output growth. However, a pattern similar to the shift one seen in the autocorrelations of labor input is seen in the correlation between labor input growth and lags of output growth, with negative correlations shifting from lower order to higher order. Not many of the partial correlations between labor input growth and output growth and lags of output growth, or regressions coefficients of labor input growth on output growth and lags of output growth are significant. However, the partial correlation between hours growth and output growth between the periods of business cycles does decline significantly.

Decomposing Changes in Dynamics

Expressions similar to those derived above for aggregate labor input growth can be obtained for expressing these aggregate statistics in terms of industry second moments and industry shares. Let Q_t denote aggregate output at time t and let $q_t = \ln(Q_t)$. For the covariance between aggregate labor input growth and the k^{th} lag of aggregate output growth

$$\text{(2.12)} \qquad \text{cov}(\Delta l_t, \Delta q_{t-k}) \cong \sum_{i=1}^{I} \overline{S_{t-1}^{i}}\, \text{cov}(\Delta l_t^{i}, \Delta q_{t-k})$$

and for the correlation between aggregate labor input growth and the k^{th} lag of aggregate output growth

$$\text{(2.13)} \qquad \rho(\Delta l_t, \Delta q_{t-k}) = \frac{\text{cov}(\Delta l_t, \Delta q_{t-k})}{\sqrt{\text{var}(\Delta l_t)}\sqrt{\text{var}(\Delta q_{t-k})}} \cong$$

$$\frac{\sum_{i=1}^{I} \overline{S_{t-1}^{i}}\, \text{cov}(\Delta l_t^{i}, \Delta q_{t-k})}{\sqrt{\left(\sum_{i=1}^{I} \left(\overline{S_{t-1}^{i}}\right)^2 \text{var}(\Delta l_t^{i}) + 2\sum_{i=1}^{I} \sum_{j=i+1}^{J} \left(\overline{S_{t-1}^{i}}\right)\left(\overline{S_{t-1}^{j}}\right) \text{cov}(\Delta l_t^{i}, \Delta l_t^{j})\right) \text{var}(\Delta q_{t-k})}},$$

Now, expressions for the partial correlations and coefficients from a regression of labor input growth on output growth and lags of output growth can be derived in a similar manner as before.

The parameters of an autoregression

$$\text{(2.14)} \qquad \Delta l_t = \phi_0 \Delta q_t + \phi_1 \Delta q_{t-1} + \phi_2 \Delta q_{t-2} + \cdots + \phi_p \Delta q_{t-p}$$

can be expressed in terms of variances and covariances

(2.15)

$$\begin{bmatrix}\phi_1\\ \phi_2\\ \vdots\\ \phi_p\end{bmatrix}=\begin{bmatrix}\mathrm{var}(\Delta q_t) & \mathrm{cov}(\Delta q_t,\Delta q_{t-1}) & \cdots & \mathrm{cov}(\Delta q_t,\Delta q_{t-p})\\ \mathrm{cov}(\Delta q_t,\Delta q_{t-1}) & \mathrm{var}(\Delta q_t) & & \mathrm{cov}(\Delta q_t,\Delta q_{t-p+1})\\ \vdots & & \ddots & \vdots\\ \mathrm{cov}(\Delta q_t,\Delta q_{t-p}) & \mathrm{cov}(\Delta q_t,\Delta q_{t-p+1}) & \cdots & \mathrm{var}(\Delta q_t)\end{bmatrix}^{-1}\begin{bmatrix}\mathrm{cov}(\Delta l_t,\Delta q_t)\\ \mathrm{cov}(\Delta l_t,\Delta q_{t-1})\\ \vdots\\ \mathrm{cov}(\Delta l_t,\Delta q_{t-p})\end{bmatrix}.$$

Results of Decomposition

Highlights of the results of the decompositions of all the dynamic relationships between aggregate labor input growth and output growth are contained below. Tables for all results are provided for completeness, although some of the results are either uninteresting or uninterpretable. The discussion focuses, for the most part, on the decomposition of statistically significant changes in aggregate second moments.

Contemporaneous and Dynamic Correlations

In (2.13) it was shown how to express correlations of aggregate labor input growth with aggregate output growth in terms covariances between industry labor input growth and aggregate output growth, variances of industry labor input growth, covariances of labor input growth between industries, and the variance of aggregate output growth. Table 51 shows the results of the decomposition for the change in correlations between aggregate employment growth and aggregate output growth and lags of aggregate output growth between the periods 1948-69 and 1970-89. For the two correlations that change significantly, compositional effects explain 6 percent and 5 percent of the observed change. Changing covariances of employment growth with aggregate output growth in individual industries explain the majority of the observed change, 85 percent and 97 percent in the two cases. The remaining influences explain between -2 percent and 2 percent of the observed changes. Table 52 and 53 show the results for changes between the periods 1948-60 and 1970-82, and between the periods 1961-69 and 1983-89 with much the same results. Tables 54, 55, and 56 display the results for hours growth, which are quantitatively similar. The message is that for the correlations that change significantly, composition has almost no effect while changing covariances of industry labor input with aggregate output explains the vast majority of the changes.

Partial Correlations and Regression Coefficients

Tables 57, 58, and 59 show the results for the changes in partial correlations between the three pairs of periods. These are shown mainly for completeness. However, in table 58, the change in the contemporaneous partial correlation between employment growth and output growth between 1948-60 and 1970-82, and the change in the contemporaneous partial correlation between hours growth and output growth between 1948-60 and 1970-82 (which is the only significant change in all three tables) are of special interest. These are closest to what Zarnowitz and Moore examine. Changing composition plays a large role in determining the changes in these partial correlations for both employment (58 percent) and hours (47 percent) growth. Tables 60, 61, and 62 show the decomposition results for the changes in regression coefficients. None of the changes were significant in the aggregate and the tables are presented for completeness.

Summary

The only change in aggregate second moments between labor input growth and output growth that can be explained for a large part by changing industrial composition is the decline in the contemporaneous partial correlation between hours growth and output growth between periods of business cycle activity. For the remaining statistically significant changes, changing composition plays a negligible role.

Dynamics of Aggregate Output Growth

The remaining question is whether any observed changes in the dynamics of aggregate output growth can be explained by the changing industrial composition of output itself. There are complications in determining this because of the fact that there are no official data on GPO by industry on a quarterly basis, only annual data exist. A distribution scheme for distributing the reported annual flows of GPO by industry over quarters using related series is discussed in detail in the final chapter. In the analysis below, the results of that exercise are taken as given, and calculations similar to those above for labor input are executed for output. The index number issues that arose in the first chapter apply here as well, requiring some modifications to the calculations.

The Facts

The statistics for the growth rate of output that are examined are the standard deviation, autocorrelations, the spectrum, partial autocorrelations, and regression coefficients from an autoregression. The statistics are calculated using the generalized method of moments and standard errors are estimated nonparametrically using a quadratic spectral kernel with automatic bandwidth choice as described in Andrews (1991). The output data used are the quarterly growth rates of aggregate real gross domestic product calculated from the results of the next chapter. Essentially, the quarterly growth rates of industry gross domestic product estimated in the next chapter are aggregated using the appropriate indexing method to obtain the growth rate of quarterly aggregate real gross domestic product. This growth rate series is used in the analysis below. For a detailed description of the aggregation of the industry data, see appendix 2.

Standard Deviation

Table 63 shows the standard deviation of aggregate output for the three pairs of periods. For each pair, t-statistics and associated p-values for a two-sided alternative are given for the null hypothesis that there is no difference in the standard deviation between that particular pair of periods. In all three cases the point estimates indicate a decline in the standard deviation of output growth from the earlier period to the more recent period, although the changes vary in degree of significance. The strongest statistical evidence supports a decline in the standard deviation of output growth between 1948-60 and 1970-82, periods of business cycle activity, although the p-value is just over 0.100. For the other two comparisons, the decline is not significant, even at the 20% level.

Table 64 presents evidence suggesting that changing industrial composition may work to lower the standard deviation of aggregate output growth. The standard deviation of output growth is calculated over the entire 1948-89 period for each industry and shown next to the change in average share for each industry between the 1948-69 and 1970-89 periods. Four of the five industries and five of the seven industries with the lowest standard deviation over the 1948-89 period have an increase in share, while the four industries with the highest standard deviation over the 1948-89 period have a decrease in share. Composition shifts away from more volatile industries and toward less volatile industries, suggestive of less volatility in the aggregate.

Autocorrelations

Table 65 shows the first 12 autocorrelations of aggregate output growth for the entire 1948-89 period and for each of the three pairs of periods. Point estimates that are significant at either the 5 percent or 10 percent level are indicated as described in the table. Output growth exhibits significant positive first order autocorrelation over the 1948-89 period as well as in all of the shorter periods, except for 1961-69. Output growth also exhibits significant positive second order autocorrelation, and significant negative fifth and eighth order autocorrelation over the 1948-89 period. Only a subset of the shorter periods share these features.

Table 66 shows changes in the autocorrelations of aggregate output between all three of the pairs of periods. The third and fourth autocorrelations rise significantly and the eighth autocorrelation declines significantly between the 1948-69 and 1970-89 periods. Between 1948-60 and 1970-82 the third and fourth autocorrelations rise and the eighth and ninth decline significantly, while between 1961-69 and 1982-89 the seventh, eighth, and tenth fall significantly. The increase in the third and fourth autocorrelations between 1948-69 and 1970-89 stems from a significant increase in both between the periods of business cycle activity coupled with a statistically insignificant yet sizable increase in both between the periods of sustained growth. The decline in the eighth order autocorrelation comes from a significant decline in the statistic between both the periods of business cycle activity and the periods of sustained growth. A pattern similar to that seen for labor input growth appears, as lower order autocorrelations (beyond the first two) increase and higher order autocorrelations decline over the postwar period. However, the output growth autocorrelation changes are not statistically significant as often as the labor input growth autocorrelation changes.

Table 67 shows the autocorrelations of output growth by industry for the entire 1948-89 period along with the change in average share for each industry between the 1948-69 and 1970-89 periods. As a reminder, the autocorrelations that changed significantly in the aggregate between these periods are indicated as described in the table. Focusing on these autocorrelations, five of the seven industries with the largest third autocorrelation have an increase in average share, suggesting that the aggregate may display an increase in these autocorrelations between the 1948-69 and 1970-89 periods due to compositional effects. For higher order autocorrelations, the role of compositional effects is less clear. Only three of the seven industries with highest fourth autocorrelation, and three of the seven industries with the lowest eighth order autocorrelation have an increase in share.

Spectrum

Figure 13 shows the estimated spectrum for output growth over the 1948-69 and 1970-89 periods. Figure 14 displays the estimated spectrum for output growth over business cycle periods of 1948-69 and 1970-82. Both figures show that although it appears that the variance of output growth falls (the area under the spectrum declines), there is an increase in cyclical activity in cycles of higher frequency, something not observed in the labor input data. However the same shift in the location of the peak to a slightly lower frequency that occurs with labor input growth also occurs with output growth.

Partial Autocorrelations and Regression Coefficients

Table 68 shows the first 12 partial autocorrelations of aggregate output growth for the entire 1948-89 period and for each of the three pairs of periods. Point estimates that are significant at either the 5 percent or 10 percent level are indicated as described in the table. Output growth exhibits significant positive first order partial autocorrelation over the 1948-89 period as well as in four of the six shorter periods. Also, the fourth, fifth, eighth, and twelfth partial autocorrelations are negative and significant over the entire 1948-89 period, with each autocorrelation only being negative and significant over a subset of the shorter periods.

Table 69 shows changes in the partial autocorrelations of aggregate output between all three of the period pairs. The third partial autocorrelation increases significantly between the 1948-69 and 1970-89 periods, and between the 1948-60 and 1970-82 periods. Between the 1961-69 and 1983-89 periods the third partial autocorrelation also increases, but the rise is not significant.

Table 70 presents the partial autocorrelations of output growth by industry for the entire 1948-89 period along with the change in average share for each industry between the 1948-69 and 1970-89 periods. Four of the seven industries with the highest third partial autocorrelation have an increase in share, suggesting that changing composition may explain part of the increase in this partial autocorrelation seen in the aggregate.

Table 71 shows the regression coefficients for an AR(8) regression of aggregate output growth for the entire 1948-89 period and for each of the three pairs of periods. Point estimates that are significant at either the 5 percent or 10 percent level are indicated as described in the table. The coefficient on the first lag is positive and significant over the entire 1948-89 period and in four of the six shorter periods. The coefficients on the fifth and eighth lags are negative and significant over the entire 1948-89 period. The coefficient on the fifth lag is not significant over any of the shorter periods while the coefficient on the eighth lag is negative and significant over two of the shorter periods.

Table 72 shows the changes in the regression coefficients for an AR(8) regression output growth. Changes that are significant at the 5 percent and 10 percent levels are indicated as described in the table. The coefficient on the third lag changes significantly, rising between 1948-69 and 1970-89, and also increasing between 1948-60 and 1970-82. The coefficient on the third lag also rises between 1961-69 and 1983-89, but the increase is not significant. Table 73 shows the coefficients from an AR(8) regression for output growth over the 1948-89 period for each industry along with the change in share between 1948-69 and 1970-89. Four of the seven industries with the highest coefficient on the third lag of output had an increase in share.

Summary

There are similarities between the results from output growth and those from labor input growth. Both show a decline in point estimates of the standard deviation between earlier and more recent periods, although the results for labor input growth are on more convincing statistical ground. The autocorrelations of both experience a shift in a sequence of negative autocorrelations from lower to higher order, again with the results for labor input growth statistically significant more often.

Expressing Aggregate Dynamic Properties in Terms of Industry Dynamic Properties and Industry Shares.

The expressions from above for labor input growth are essentially the same used for output growth, except the shares are nominal. Let Q_t^i denote output in a particular industry at time t and let $q_t^i = \ln(Q_t^i)$. The variance (and hence the standard deviation) of the aggregate over a period of time can be approximated by

(2.16) $$\operatorname{var}(\Delta q_t) \cong \sum_{i=1}^{I} \left(\overline{S_{t-1}^i}\right)^2 \operatorname{var}(\Delta q_t^i) + 2\sum_{i=1}^{I} \sum_{j=i+1}^{J} \left(\overline{S_{t-1}^i}\right)\left(\overline{S_{t-1}^j}\right) \operatorname{cov}(\Delta q_t^i, \Delta q_t^j).$$

Similarly, autocovariances over a period of time can be approximated by

(2.17) $$\operatorname{cov}(\Delta q_t, \Delta q_{t-1}) \cong \sum_{i=1}^{I} \sum_{j=1}^{I} \left(\overline{S_{t-1}^i}\right)\left(\overline{S_{t-2}^j}\right) \operatorname{cov}(\Delta q_t^i, \Delta q_{t-1}^j)$$

and

(2.18) $$\operatorname{cov}(\Delta q_t, \Delta q_{t-k}) \cong \sum_{i=1}^{I} \sum_{j=1}^{I} \left(\overline{S_{t-1}^i}\right)\left(\overline{S_{t-1-k}^j}\right) \operatorname{cov}(\Delta q_t^i, \Delta q_{t-k}^j).$$

Now, an array of other statistics based on second moments can be expressed in terms of industry second moments and average industry shares. Autocorrelations can be expressed as

(2.19) $$\rho_k(\Delta q_t) = \frac{\operatorname{cov}(\Delta q_t, \Delta q_{t-k})}{\operatorname{var}(\Delta q_t)} \cong \frac{\sum_{i=1}^{I} \sum_{j=1}^{I} \left(\overline{S_{t-1}^i}\right)\left(\overline{S_{t-1-k}^j}\right) \operatorname{cov}(\Delta q_t^i, \Delta q_{t-k}^j)}{\sum_{i=1}^{I} \left(\overline{S_{t-1}^i}\right)^2 \operatorname{var}(\Delta q_t^i) + 2\sum_{i=1}^{I} \sum_{j=i+1}^{J} \operatorname{cov}(\Delta q_t^i, \Delta q_t^j)}.$$

The sample periodogram can be expressed as

(2.20)
$$S(\Delta q_t,\omega)=\frac{1}{2\pi}\left[\operatorname{var}(\Delta q_t)+2\sum_{k=1}^{\infty}\operatorname{cov}(\Delta q_t,\Delta q_{t-k})\cos(\omega k)\right]\cong$$

$$\frac{1}{2\pi}\left[\left(\sum_{i=1}^{I}\left(\overline{S_{t-1}^{i}}\right)^2\operatorname{var}(\Delta q_t^i)+2\sum_{i=1}^{I}\sum_{j=i+1}^{J}\left(\overline{S_{t-1}^{i}}\right)\left(\overline{S_{t-1}^{j}}\right)\operatorname{cov}(\Delta q_t^i,\Delta q_t^j)\right)+\right.$$

$$\left.2\sum_{k=1}^{T-1}\left(\sum_{i=1}^{I}\sum_{j=1}^{I}\left(\overline{S_{t-1}^{i}}\right)\left(\overline{S_{t-1-k}^{j}}\right)\operatorname{cov}(\Delta q_t^i,\Delta q_{t-k}^j)\right)\cos(\omega k)\right].$$

The parameters of an autoregression

(2.21)
$$\Delta q_t=\phi_1\Delta q_{t-1}+\phi_2\Delta q_{t-2}+\cdots+\phi_p\Delta q_{t-p}$$

can be expressed in terms of variances and covariances

(2.22)

$$\begin{bmatrix}\phi_1\\ \phi_2\\ \vdots\\ \phi_p\end{bmatrix}=\begin{bmatrix}\operatorname{var}(\Delta q_t) & \operatorname{cov}(\Delta q_t,\Delta q_{t-1}) & \cdots & \operatorname{cov}(\Delta q_t,\Delta q_{t-p+1})\\ \operatorname{cov}(\Delta q_t,\Delta q_{t-1}) & \operatorname{var}(\Delta q_t) & & \operatorname{cov}(\Delta q_t,\Delta q_{t-p+2})\\ \vdots & & \ddots & \vdots\\ \operatorname{cov}(\Delta q_t,\Delta q_{t-p+1}) & \operatorname{cov}(\Delta q_t,\Delta q_{t-p+2}) & \cdots & \operatorname{var}(\Delta q_t)\end{bmatrix}^{-1}\begin{bmatrix}\operatorname{cov}(\Delta q_t,\Delta q_{t-1})\\ \operatorname{cov}(\Delta q_t,\Delta q_{t-2})\\ \vdots\\ \operatorname{cov}(\Delta q_t,\Delta q_{t-p})\end{bmatrix}.$$

Results of Decomposition

Standard Deviation

Table 74 shows the results of the decomposition of the change in the standard deviation of aggregate output growth. Changing composition of output explains 107 percent of the decline in the standard deviation of output observed between 1948-69 and 1970-89, while changing industry variances explain 21 percent, and changing covariances between industries account for -19 percent. These results should be viewed with caution since the decline in the standard deviation of output between these two periods is not statistically significant, even at the 20% level. The same caution applies to the decline between 1961-69 and 1983-89, where changing composition explains 76 percent of the decline, while changing industry variances explain 41 percent, and changing covariances between industries account for -4 percent. The results for the decline between the periods of business cycle activity 1948-60 and 1970-82, which is the most statistically significant, show that changing composition explains 70 percent of the decline, while changing industry variances explain 21 percent, and changing covariances between industries account for 8 percent.

Autocorrelations

Table 75 shows the decomposition of the change in autocorrelations between the 1948-69 and 1970-89 periods. For statistically significant changes, composition explains between 1 percent and 6 percent of the observed change in the autocorrelation, while changing industry variances explain 15 percent to 35 percent and changing industry covariances explain 59 percent to 73 percent of the change. Table 76 shows the results for changes between the 1948-60 and 1970-82 periods, where composition explains between 1 percent and 3 percent of the observed changes. Table 77 shows the results for changes between the 1961-69 and 1983-89 periods, where composition explains between 0 percent and 21 percent of the observed changes.

Spectrum

Figure 15 shows the estimated effect of shifting industrial composition on the spectrum of output growth, while figure 16 shows the estimated effect of changing autocovariances. The results are similar to those for labor input growth as composition works to shift the spectrum down without affecting the location of the peaks, while changing autocovariances affect both the general height and the peak locations. However, the one difference is that composition causes an equal downward shift across all frequencies here, unlike the results with labor input growth where some frequencies were affected more than others. Figures 17 and 18 show the decomposition between the 1948-69 and 1970-89 periods and between the 1948-60 and 1970-82 periods, respectively.

Partial Autocorrelations and Regression Coefficients

Table 78 shows the decomposition for the change in partial autocorrelations and table 79 shows the decomposition for the change in an AR(8) model of aggregate output growth between all three sets of periods. For the only four statistically significant changes, shifting composition explains between -1 percent and -5 percent of the observed change.

Summary

The results for aggregate output growth are very similar to the results for aggregate labor input growth. Beyond standard deviation, changing industrial composition does not explain much of the observed changes in aggregate second moments. Changing covariances between growth rates in individual industries explains the majority of the changes in aggregate second moments other than the standard deviation.

Conclusion

Tables 80, 81, and 82 provide a useful summary of the results from this chapter. Table 80 shows the second moments of labor input growth that change significantly along with the periods between which the second moment changes, the direction in which it changes, and the amount of the change attributable to changing industrial composition. Table 81 displays the same summary for the second moments between labor input growth and output growth, while table 82 shows the summary for the second moments of output growth.

When considering aggregate labor input growth or aggregate output growth in isolation, shifting industrial composition can explain a large proportion of the observed decline in standard deviation. This explanatory power drops off considerably when considering autocorrelations, partial correlations, and regression coefficients from an autoregression. The effect of changing composition on the relationship between aggregate labor input growth and aggregate output growth is difficult to assess because of a general lack of statistical significance in changes in the relationship over the postwar era. However, a significant decline in the partial correlation between aggregate hours growth and aggregate output growth between periods of business cycle activity, and a sizable although not statistically significant decline in the partial correlation between aggregate employment growth and aggregate output growth between the same periods provides an opportunity to assess the impact of compositional shifts. Changing composition again is able to explain a large proportion of the observed changes. Beyond this contemporaneous partial correlation, changing composition cannot explain much of any other statistically significant changes in the relationship between aggregate labor input growth and aggregate output growth.

CHAPTER 3

OPTIMAL DISTRIBUTION OF ANNUAL GPO FLOWS OVER QUARTERS USING RELATED SERIES

Introduction

The purpose of this chapter is to estimate quarterly real gross product originating (GPO) by industry. The data exist at an annual frequency, but for the purposes of the calculations of the previous chapter, quarterly data are required. The objective is to take the observed annual flow of real GPO in each industry in each year and distribute the flow across the quarters within the year in some optimal manner. The quarterly real GPO data are treated as unobservable, but related to other series that are observable on a quarterly (or higher) frequency through a stationary stochastic process, which jointly determines both the unobserved quarterly GPO flows and the observable series. The information contained in the related series and the observed annual GPO flow is used to estimate the distribution of the GPO flow across quarters. A key feature of the approach is that the observed series are not assumed to be weakly exogenous with respect to the unobserved data, an assumption that is made in most widely-used interpolation or distribution schemes. An additional feature is that the model for the data is specified in terms of natural logarithms of the data, while the observed annual real GPO flows are in levels, introducing a non-linearity.

A natural choice for modeling in a situation where there are unobservable variables is a state space model. A state space model that handles the distribution problem, while allowing for the specification of a joint process for the unobserved and observed series and the non-linearity introduced by specifying the joint process in natural logarithms is presented below. Two modifications of the standard state-space model are required. One handles the distribution of the annual flow across quarters and restricts the sum of the unobservable quarterly flows in a given year to sum to the annual flow observed in the year. The other handles the non-linearity problem by employing the extended Kalman filter. Once the parameters of the model are estimated, the Kalman filter and fixed-interval smoother, with the appropriate modifications, can be used to get estimates of the unobserved real GPO quarterly flows. The chapter proceeds with a brief review of the state space model, the Kalman filter, the fixed interval smoother, and the extended Kalman filter and smoother. Then an example is given using a particular specification of the assumed underlying model generating the data. Finally, the implementation and results of the exercise are presented.

General Discussion

The following description of the state space model, the Kalman filter, the fixed-interval smoother, and the extended Kalman filter follows Harvey (1989). The general state space form consists of an $N \times 1$ vector of observable time series y_t that are related to an $m \times 1$ vector of unobservable variables α_t through an observation equation

(3.1) $$y_t = Z_t \alpha_t + d_t + \varepsilon_t, \quad E(\varepsilon_t) = 0, \quad Var(\varepsilon_t) = H_t$$

where Z_t is an $N \times m$ matrix, d_t is an $N \times 1$ vector, and ε_t is $N \times 1$ vector of serially uncorrelated disturbances. In general the elements of α_t are unobservable (though some or all elements could be observable) and are assumed to be generated by a first-order Markov transition equation

(3.2) $$\alpha_t = T_t \alpha_{t-1} + c_t + R_t \eta_t, \quad E(\eta_t) = 0, \quad Var(\eta_t) = Q_t$$

where T_t is an $m \times m$ matrix, c_t is an $m \times 1$ vector, R_t is an $m \times g$ matrix and η_t is a $g \times 1$ vector of serially uncorrelated disturbances. Let $\hat{\alpha}_{t-1|t-1}$ denote the optimal estimator of α_{t-1} based on the observations through y_{t-1} and denote the $m \times m$ covariance matrix of the estimation error

(3.3) $$P_{t-1|t-1} = E\left[\left(\alpha_{t-1} - \hat{\alpha}_{t-1|t-1}\right)\left(\alpha_{t-1} - \hat{\alpha}_{t-1|t-1}\right)'\right]$$

Given $\hat{\alpha}_{t-1|t-1}$ and $P_{t-1|t-1}$ the optimal estimator of α_t is given by

(3.4) $$\hat{\alpha}_{t|t-1} = T_t\hat{\alpha}_{t-1|t-1} + c_t$$

and the covariance matrix of the estimation error is

(3.5) $$P_{t|t-1} = T_t P_{t-1|t-1} T_t' + R_t Q_t R_t'$$

These two equations are called the prediction equations. Once the new observation y_t becomes available, the estimates can be updating using the updating equations

(3.6) $$\hat{\alpha}_{t|t} = \hat{\alpha}_{t|t-1} + P_{t|t-1} Z_t' F_t^{-1}\left(y_t - Z_t\alpha_{t|t-1} - d_t\right)$$

(3.7) $$P_{t|t} = P_{t|t-1} - P_{t|t-1} Z_t' F_t^{-1} Z_t P_{t|t-1}$$

where

(3.8) $$F_t = Z_t P_{t|t-1} Z_t' + H_t$$

Equations (3.4) through (3.8) define the Kalman filter. Given $\hat{\alpha}_{0|0}$ and $P_{0|0}$ the filter can be used recursively to obtain estimates $\hat{\alpha}_{t|t}$ and $P_{t|t}$ through the end of the sample. Once at the end of the sample, estimates of $\hat{\alpha}_{t|T}$ and $P_{t|T}$ based on all of the information contained in the sample can be obtained by employing a fixed-interval smoother. Starting with $\hat{\alpha}_{T|T}$ and $P_{T|T}$ from the Kalman filtering of the final observation in the sample, work backwards through the recursion

(3.9) $$\hat{\alpha}_{t|T} = \hat{\alpha}_{t|t} + P_t^{*}\left(\hat{\alpha}_{t+1|T} - T_{t+1}\hat{\alpha}_{t|t}\right)$$

(3.10) $$P_{t|T} = P_{t|t} + P_t^*\left(P_{t+1|T} - P_{t+1|t}\right)P_t^{*\prime}$$

where

(3.11) $$P_t^* = P_{t|t}T_{t+1}'P_{t+1|t}^{-1}.$$

Once the model is specified in state space form and the parameters contained in the matrices Z_t, H_t, T_t, and Q_t are estimated, a pass through the Kalman filter and then the fixed-interval smoother gives estimates of the unobservables based on all of the information in the sample.

In general, the observation and state transition equations may be non-linear functions of their arguments. The functionally non-linear state space model can be written

(3.12) $$y_t = z_t(\alpha_t) + \varepsilon_t$$

(3.13) $$\alpha_t = t_t(\alpha_{t-1}) + R_t\eta_t$$

Now, to obtain a linear approximation to the model so that the Kalman filter can be applied, expand the functions $z_t(\cdot)$ and $t_t(\cdot)$ in Taylor series around conditional means $\hat{\alpha}_{t|t-1}$ and $\hat{\alpha}_{t-1|t-1}$ to obtain

(3.14) $$z_t(\alpha_t) \cong z_t(\hat{\alpha}_{t|t-1}) + \hat{Z}_t(\alpha_{t|t} - \hat{\alpha}_{t|t-1})$$

(3.15) $$t_t(\alpha_{t-1}) \cong t_t(\hat{\alpha}_{t-1|t-1}) + \hat{T}_t(\alpha_{t-1} - \hat{\alpha}_{t-1|t-1})$$

where

(3.16) $$\hat{Z}_t = \frac{\partial z_t(\alpha_t)}{\partial \alpha_t'}\bigg|_{\alpha_t = \hat{\alpha}_{t|t-1}}$$

(3.17) $$\hat{T}_t = \frac{\partial t_t(\alpha_{t-1})}{\partial \alpha_{t-1}'}\bigg|_{\alpha_t = \hat{\alpha}_{t-1|t-1}}$$

Substituting into the updating equations of the Kalman filter and assuming knowledge of $\hat{\alpha}_{t|t-1}$ and $\hat{\alpha}_{t-1|t-1}$ leads to an approximation of the original model by

(3.18) $$y_t \cong \hat{Z}_t \alpha_t + \hat{d}_t + \varepsilon_t$$

(3.19) $$\alpha_t \cong \hat{T}_t \alpha_{t-1} + \hat{c}_t + R_t \eta_t$$

where

(3.20) $$\hat{d}_t = z_t\left(\hat{\alpha}_{t|t-1}\right) - \hat{Z}_t \hat{\alpha}_{t|t-1}$$

(3.21) $$\hat{c}_t = t_t\left(\hat{\alpha}_{t-1|t-1}\right) - \hat{T}_t \hat{\alpha}_{t-1|t-1}$$

The quantities $\hat{\alpha}_{t|t}$ and $\hat{\alpha}_{t|t-1}$ are calculated by applying the Kalman filter to the approximate system with a few modifications. The prediction equations become

(3.22) $$\hat{\alpha}_{t|t-1} = t_t\left(\hat{\alpha}_{t-1|t-1}\right)$$

and

(3.23) $$P_{t|t-1} = \hat{T}_t P_{t-1|t-1} \hat{T}_t' + R_t Q_t R_t'$$

while the updating equations become

(3.24) $$\hat{\alpha}_{t|t} = \hat{\alpha}_{t|t-1} + P_{t|t-1} \hat{Z}_t' \hat{F}_t^{-1}\left[y_t - z_t\left(\hat{\alpha}_{t|t-1}\right)\right]$$

and

(3.25) $$P_{t|t} = P_{t|t-1} - P_{t|t-1} \hat{Z}_t' \hat{F}_t^{-1} \hat{Z}_t P_{t|t-1}$$

where

(3.26) $$\hat{F}_t = \hat{Z}_t P_{t|t-1} \hat{Z}_t' + H_t$$

The recursion defined by (3.22) through (3.26) is the extended Kalman filter. The fixed-interval smoother also requires modification. The smoothing recursion becomes

(3.27) $$\hat{\alpha}_{t|T} = \hat{\alpha}_{t|t} + P_t^*\left(\hat{\alpha}_{t+1|T} - t_{t+1}\left(\hat{\alpha}_{t|t}\right)\right)$$

(3.28) $$P_{t|T} = P_{t|t} + P_t^*\left(P_{t+1|T} - P_{t+1|t}\right)P_t^{*\prime}$$

where

(3.29) $$P_t^* = P_{t|t} T_{t+1}' P_{t+1|t}^{-1}.$$

The above set-up encompasses a number of possible specifications for the joint process generating the related series and the unobserved quarterly GPO flows. In the example given in the next section, the joint process is specified as a VAR(1), although the example is easily extended to a VAR(p) for any p and can also be reduced to a multivariate random walk with drift.

An Example

Consider an example where the unobservable real GPO series and a single observable related series are assumed to follow a VAR(1) process,

(3.30) $$\begin{bmatrix} \Delta y_t - \mu_y \\ \Delta x_t - \mu_x \end{bmatrix} = \begin{bmatrix} \Phi_{1,1} & \Phi_{1,2} \\ \Phi_{2,1} & \Phi_{2,2} \end{bmatrix} \begin{bmatrix} \Delta y_{t-1} - \mu_y \\ \Delta x_{t-1} - \mu_x \end{bmatrix} + \begin{bmatrix} \varepsilon_t^y \\ \varepsilon_t^x \end{bmatrix}, \quad E\begin{bmatrix} \varepsilon_t^y \\ \varepsilon_t^x \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}, \quad E\begin{bmatrix} \varepsilon_t^y \\ \varepsilon_t^x \end{bmatrix}\begin{bmatrix} \varepsilon_t^y & \varepsilon_t^x \end{bmatrix} = Q$$

where Y_t denotes the unobserved quarterly flow, y_t denotes the natural logarithm of Y_t, Δ denotes the first difference operator $(1 - L)$, and μ_y denotes the average of Δy_t over the sample. Similarly, X_t denotes the observed quarterly related series, x_t denotes the natural logarithm of X_t, and μ_x denotes the average of Δx_t over the sample. Now, let $Y_\tau^* = \sum_{i=0}^{3} Y_{4\tau-i}, \quad \tau = 1,\ldots,T$ denote the observed annual flow for the real GPO series, which is the sum of the unobserved quarterly flows, and is only observed after every four periods. There are T years going from $\tau = 1,\ldots,T$ and $4T$ quarters running from $t = 1,..,4T$. Finally, define the cumulator variable, which keeps track of the running total of the flows during each year $Y^f_{4(\tau-1)+i} = \sum_{s=1}^{i} Y_{4(\tau-1)+s}$, $\tau = 1,...,T$, $i = 1,...,4$. With these definitions in hand, the model can be expressed in state-space form. The observation equation is

$$\text{(3.31)} \quad \begin{bmatrix} Y^*_\tau \\ \Delta x_t - \mu_x \end{bmatrix} = \begin{bmatrix} \exp(\cdot) & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} y_t \\ y_{t-1} \\ \mu^y_t \\ Y^f_{t-1} \\ \Delta x_t - \mu_x \end{bmatrix} = \begin{bmatrix} \exp(y_t) + Y^f_{t-1} \\ \Delta x_t - \mu_x \end{bmatrix}, \quad \begin{matrix} t = 4\tau \\ \tau = 1,...,T \end{matrix}$$

(3.32)

$$[\Delta x_t - \mu_x] = [0 \ \ 0 \ \ 0 \ \ 0 \ \ 1] \begin{bmatrix} y_t \\ y_{t-1} \\ \mu^y_t \\ Y^f_{t-1} \\ \Delta x_t - \mu_x \end{bmatrix} = [\Delta x_t - \mu_x], \quad t = 1,2,3,5,6,7,9,10,11,...,(4T-1)$$

and the state transition equation is

$$\text{(3.33)} \quad \begin{bmatrix} y_t \\ y_{t-1} \\ \mu^y_t \\ Y^f_{t-1} \\ \Delta x_t - \mu_x \end{bmatrix} = \begin{bmatrix} 1+\Phi_{1,1} & -\Phi_{1,1} & 1-\Phi_{1,1} & 0 & \Phi_{1,2} \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ \exp(\cdot) & 0 & 0 & \Psi_t & 0 \\ \Phi_{2,1} & -\Phi_{2,1} & -\Phi_{2,1} & 0 & \Phi_{2,2} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ y_{t-2} \\ \mu^y_{t-1} \\ Y^f_{t-2} \\ \Delta x_{t-1} - \mu_x \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \varepsilon^y_t \\ \varepsilon^x_t \end{bmatrix}$$

$$= \begin{bmatrix} (1+\Phi_{1,1})y_{t-1} - \Phi_{1,1}y_{t-2} + (1-\Phi_{1,1})\mu^y_{t-1} + \Phi_{1,2}(\Delta x_{t-1} - \mu_x) \\ y_{t-1} \\ \mu^y_{t-1} \\ \exp(y_{t-1}) + \Psi_t Y^f_{t-2} \\ \Phi_{2,1}y_{t-1} - \Phi_{2,1}y_{t-2} - \Phi_{2,1}\mu^y_{t-1} + \Phi_{2,2}(\Delta x_{t-1} - \mu_x) \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \varepsilon^y_t \\ \varepsilon^x_t \end{bmatrix},$$

$$\Psi_t = \begin{cases} 0, & t = 4(\tau - 1) + 2, \quad \tau = 1, \ldots T \\ 1, & \textit{otherwise} \end{cases}$$

Note that both the observation and state transition equations are functionally non-linear. The need to exponentiate the natural logarithm is the cause of the non-linearity. The matrices

(3.34) $$\hat{Z}_t = \frac{\partial z_t(\alpha_t)}{\partial \alpha'_t}\bigg|_{\alpha_t = \hat{\alpha}_{t|t-1}} \text{ and } \hat{T}_t = \frac{\partial t_t(\alpha_{t-1})}{\partial \alpha'_{t-1}}\bigg|_{\alpha_t = \hat{\alpha}_{t-1|t-1}}$$

are required for the extended filter. In this example, these matrices are

(3.35) $$\hat{Z}_t = \begin{bmatrix} \exp(\hat{y}_{t|t-1}) & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}, \quad t = 4,8,12,16,\ldots$$

(3.36) $$\hat{Z}_t = \begin{bmatrix} 0 & 0 & 0 & 0 & 1 \end{bmatrix}, \quad t = 1,2,3,5,6,7,9,\ldots$$

(3.37) $$\hat{T}_t = \begin{bmatrix} 1+\Phi_{1,1} & -\Phi_{1,1} & 1-\Phi_{1,1} & 0 & \Phi_{1,2} \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ \exp(\hat{y}_{t-1|t-1}) & 0 & 0 & \Psi_t & 0 \\ \Phi_{2,1} & -\Phi_{2,1} & -\Phi_{2,1} & 0 & \Phi_{2,2} \end{bmatrix}$$

Now the extended filter and fixed-interval smoother can be run. Note that because the filter and smoother are operating on a linear approximation to the model, the sum of the quarterly flows will not add up precisely to the observed annual total.

Implementation and Results

To implement the approach described above, it is necessary to determine the related series to use for each industry, to adopt a model selection strategy, and to choose an estimation technique. This section discusses these issues in order, and then presents the results for the fifteen industry breakdown from chapter 1 and the end of chapter 2.

In searching for related series, it is useful to remember that real GPO by industry, in theory, is the real value added in each industry. This is equal to the real value of output in the industry minus the real value of intermediate inputs. Related series that would be useful are those that are either correlated with value added or correlated with any of its components.

One series that is available for most of the industries on a quarterly basis and is expected to be highly correlated with real value added is National Income without Capital Consumption Adjustment by Industry from the NIPA. This series should theoretically equal the nominal value added in an industry. Its disadvantage is that it is in nominal terms and not in real terms. This can be partly remedied through deflating the series by an appropriate deflator. For mining and manufacturing industries, another source for related series are the indexes of industrial production, which are measures of real output. GDP by major type of product from NIPA provides series for real quarterly output for the construction, durable goods, and nondurable goods industries. Finally, GDP by sector from NIPA provides a measure of real output for the general government sector.

Model selection and model estimation are carried out in the following manner. The strategy, for computational reasons, is to try to limit the order of the VAR describing the joint quarterly process to as small an order as is reasonable. To this end, the model is first specified as a multivariate random walk with drift, then as a VAR(1), then as a VAR(2), etc. Likelihood ratio statistics are calculated at each stage to see if the exclusion of the most recent addition of lags is rejected or not. At each stage, the parameters of the model are estimated via maximum likelihood. A version of the EM algorithm as described in Watson and Engle (1983) is employed to get close to the maximum and then numerical methods are used to reach the final estimates. Table 83 shows for each industry, the related series, the deflator (if any) for National Income without Capital Consumption Adjustment, and the model used in distributing the annual flows over the quarters. Tables 84 through 98 show the quarterly GPO estimates for each industry.

TABLE 1

AGGREGATE PRODUCTIVITY GROWTH USING DIFFERENT INDEXING METHODS AND DIFFERENT DEGREES OF APPROXIMATION.
(OUTPUT PER HOUR AT ANNUAL RATES)

A			
Index of real manufacturing output growth:	BMWY		
Index of aggregate real output growth:	Tornqvist		
Hours adjusted for the self-employed:	Yes		
Log Approximation:	No	Yes	Yes
Sample Averages:	No	No	Yes
Sample			
1948-1990:	1.92	1.92	1.93
1948-1969:	2.64	2.64	2.64
1969-1990:	1.21	1.21	1.25
Change:	-1.43	-1.43	-1.39

B			
Index of real manufacturing output growth:	Fixed-Price-Weight		
Index of aggregate real output growth:	Fixed-Price-Weight		
Hours adjusted for the self-employed:	Yes		
Log Approximation:	No	Yes	Yes
Sample Averages:	No	No	Yes
Sample			
1948-1990:	1.80	1.78	1.78
1948-1969:	2.55	2.54	2.56
1969-1990:	1.04	1.02	1.10
Change:	-1.51	-1.52	-1.46

C			
Index of real manufacturing output growth:	Fixed-Price-Weight		
Index of aggregate real output growth:	Fixed-Price-Weight		
Hours adjusted for the self-employed:	No		
Log Approximation:	No	Yes	Yes
Sample Averages:	No	No	Yes
Sample			
1948-1990:	1.48	1.46	1.49
1948-1969:	1.95	1.93	1.94
1969-1990:	1.00	0.99	1.06
Change:	-0.95	-0.94	-0.88

TABLE 2
CONTRIBUTION AND CHANGE IN CONTRIBUTION TO AGGREGATE PRODUCTIVITY BY INDUSTRY

	Contribution to aggregate productivity					
	Fixed-Price-Weight Index			Tornqvist Index		
Industry	1948-69	1969-90	Change	1948-69	1969-90	Change
Farming	0.45	0.09	-0.37	0.44	0.10	-0.34
Mining	0.18	-0.00	-0.19	0.09	-0.01	-0.10
Construction	0.23	-0.12	-0.35	0.09	-0.12	-0.20
Manufacturing						
Durables Excluding Nonelectrical Machinery	0.25	0.20	-0.06	0.37	0.26	-0.11
Nonelectrical Machinery	0.04	0.04	0.00	0.06	0.11	0.06
Nondurables	0.24	0.22	-0.02	0.38	0.24	-0.15
Transportation	0.10	0.05	-0.04	0.10	0.06	-0.04
Communications	0.05	0.11	0.06	0.11	0.13	0.02
Electricity, Gas, and Sanitary Services	0.12	0.06	-0.06	0.15	0.06	-0.10
Wholesale Trade	0.17	0.18	0.01	0.24	0.21	-0.02
Retail Trade	0.15	0.05	-0.10	0.18	0.06	-0.12
Finance, Insurance, and Real Estate	0.47	0.36	-0.11	0.56	0.33	-0.22
Services	0.08	-0.15	-0.23	0.02	-0.19	-0.21
General Government	0.03	0.02	-0.01	-0.13	0.01	0.14
Government Enterprise	-0.00	-0.00	0.00	-0.01	-0.00	0.01
Total	2.56	1.10	-1.46	2.64	1.25	-1.39

TABLE 3
INDUSTRIAL COMPOSITION

Industry	Average Real Output Share			Average Nominal Output Share			Average Hours Share		
	1948-69	1969-90	Change	1948-69	1969-90	Change	1948-69	1969-90	Change
Farming	4.0	2.1	-1.9	4.7	2.7	-2.0	9.3	3.9	-5.4
Mining	5.7	3.1	-2.6	2.6	2.7	0.1	1.1	1.0	-0.2
Construction	8.9	5.3	-3.7	4.8	4.7	-0.1	5.3	5.8	0.5
Manufacturing									
Durables	10.9	9.7	-1.2	13.8	10.3	-3.5	12.0	10.1	-1.9
Nonelectrical Machinery	2.3	2.2	-0.1	2.7	2.5	-0.3	2.3	2.3	-0.0
Nondurables	8.2	8.4	0.2	12.1	9.1	-3.0	10.8	8.6	-2.2
Transportation	4.7	3.6	-1.1	4.8	3.7	-1.2	4.2	3.3	-0.8
Communications	1.1	2.4	1.3	2.0	2.6	0.7	1.2	1.3	0.1
E.G.A.S.S.	1.9	3.0	1.1	2.3	2.8	0.5	0.9	0.9	0.0
Wholesale Trade	5.4	6.3	0.9	6.7	6.9	0.2	5.0	5.7	0.6
Retail Trade	9.2	9.4	0.2	10.1	9.6	-0.5	14.5	14.8	0.3
F.I.R.E.	11.6	16.5	4.9	13.2	15.7	2.5	3.8	5.5	1.7
Services	11.2	15.2	4.1	9.7	14.4	4.7	14.5	20.5	6.1
General Government	13.3	11.4	-2.0	9.4	11.0	1.6	13.8	14.8	1.0
Government Enterprise	1.4	1.5	0.1	1.2	1.4	0.2	1.4	1.6	0.2
Total	100.0	100.0	0.0	100.0	100.0	0.0	100.0	100.0	0.0

TABLE 4
AVERAGE GROWTH RATE OF REAL
OUTPUT PER HOUR AT ANNUAL RATES: 1948-1990

Industry	Growth Rate
Farming	4.00
Mining	1.95
Construction	-0.02
Manufacturing	
Durables	2.51 [2.23]
Nonelectrical Machinery	3.16 [1.82]
Nondurables	2.83 [2.81]
Transportation	1.72
Communications	4.79
E.G.A.S.S.	3.53
Wholesale Trade	2.93
Retail Trade	1.87
F.I.R.E.	1.17
Services	0.77
General Government	0.34
Government Enterprise	-0.12
Total	1.93 [1.78]

TABLE 5
CHANGES IN PRODUCTIVITY GROWTH BY INDUSTRY

	Average growth rate of real output per hour at annual rates		
Industry	1948-69	1969-90	Change
Farming	4.77	3.22	-1.55
Mining	4.67	-0.78	-5.45
Construction	1.98	-2.03	-4.01
Manufacturing			
Durables	2.49	2.53 [1.97]	0.04 [-0.52]
Nonelectrical Machinery	1.76	4.55 [1.88]	2.79 [0.12]
Nondurables	3.06	2.59 [2.56]	-0.48 [-0.50]
Transportation	2.03	1.40	-0.63
Communications	5.05	4.52	-0.53
E.G.A.S.S.	6.01	1.06	-4.96
Wholesale trade	3.10	2.76	-0.34
Retail trade	2.23	1.50	-0.73
F.I.R.E.	2.12	0.22	-1.90
Services	1.38	0.17	-1.21
General Government	0.28	0.40	0.12
Government Enterprise	0.28	0.40	0.12
Tornqvist Index	2.64	1.25	-1.39
Fixed-Price-Weight Index	2.56	1.10	-1.46

TABLE 6
PRODUCTIVITY GROWTH DECOMPOSITION

A. Tornqvist index of aggregate productivity growth.
BMWY index of manufacturing output growth.

Subsample	Productivity Growth	Industry growth rates fixed at total sample averages	Industry shares fixed at total sample averages
1948-1969	2.64	2.08	2.48
1969-1990	1.25	1.79	1.39
Change	-1.39	-0.29	-1.09

B. Fixed-price-weight index of aggregate productivity growth.
Fixed-price-weight index of manufacturing output growth.

Subsample	Productivity Growth	Industry growth rates fixed at total sample averages	Industry shares fixed at total sample averages
1948-1969	2.56	1.84	2.45
1969-1990	1.10	1.72	1.11
Change	-1.46	-0.12	-1.34

TABLE 7
CHANGE IN CONTRIBUTION
TO AGGREGATE PRODUCTIVITY
BY EFFECT, BY INDUSTRY

Industry	Share Effect	Growth Effect
Farming	-0.18	-0.16
Mining	0.00	-0.10
Construction	-0.01	-0.20
Manufacturing		
Durables	-0.09	-0.01
Nonelectrical Machinery	-0.01	0.07
Nondurables	-0.09	-0.06
Transportation	-0.02	-0.02
Communications	0.04	-0.02
E.G.A.S.S.	0.02	-0.12
Wholesale trade	-0.00	-0.02
Retail trade	-0.02	-0.10
F.I.R.E.	0.05	-0.28
Services	-0.01	-0.20
General Government	0.02	0.13
Government Enterprise	-0.00	0.01
Total	-0.29	-1.09
Sum of absolute values	0.56	1.50

TABLE 8
DECOMPOSITION OF SHARE EFFECT

	(1) =	(2) +	(3) +	(4) +	(5)
Industry	Total Share Effect	Average Growth Rate Effect	Relative Growth Rate Effect	Relative Level Effect	Change in Relative Level Effect
Farming	-0.18	-0.11	-0.12	0.04	0.01
Mining	0.00	-0.00	-0.00	-0.00	0.01
Construction	-0.01	0.01	-0.01	-0.00	-0.01
Manufacturing					
Durables	-0.09	-0.03	-0.01	-0.01	-0.04
Nonelectrical Machinery	-0.01	0.00	0.00	0.00	-0.01
Nondurables	-0.09	-0.04	-0.02	-0.01	-0.02
Transportation	-0.02	-0.02	0.00	-0.00	-0.00
Communications	0.04	0.00	0.00	0.01	0.03
E.G.A.S.S.	0.02	0.00	0.00	0.00	0.02
Wholesale trade	-0.00	0.01	0.01	0.01	-0.03
Retail trade	-0.02	0.00	-0.00	-0.00	-0.02
F.I.R.E.	0.05	0.03	-0.01	0.17	-0.14
Services	-0.01	0.11	-0.07	-0.07	0.02
General Government	0.02	0.02	-0.02	-0.01	0.02
Government Enterprise	-0.00	0.00	-0.00	-0.00	0.00
Total	-0.29	0.00	-0.25	0.12	-0.16
Sum of absolute values	0.56	0.41	0.27	0.34	0.38

TABLE 9

STANDARD DEVIATION OF LABOR INPUT GROWTH

Period	Standard Deviation (As a percent) Employment	Hours
1948-69	0.859	1.064
1970-89	0.613	0.781
Change	-0.246	-0.283
T-Statistic	-1.744	-1.633
(P-Value)	(0.085)	(0.106)
Period		
1948-60	1.058	1.323
1970-82	0.708	0.892
Change	-0.350	-0.431
T-Statistic	-2.768	-2.601
(P-Value)	(0.008)	(0.012)
Period		
1961-69	0.478	0.581
1983-89	0.287	0.382
Change	-0.191	-0.199
T-Statistic	-1.415	-1.630
(P-Value)	(0.168)	(0.114)

TABLE 10

STANDARD DEVIATION OF LABOR INPUT GROWTH AND CHANGE IN AVERAGE SHARE BY INDUSTRY

	Employment		Hours	
Industry	Standard Deviation (As a percent) 1948-89	Change in Average Share 1948-69 to 1970-89	Standard Deviation (As a percent) 1948-89	Change in Average Share 1948-69 to 1970-89
Mining	3.682	-0.5	4.416	-0.4
Construction	1.879	-0.5	2.666	-0.2
Durables	2.182	-4.5	2.572	-3.7
Nondurables	0.893	-4.6	1.251	-3.9
Transportation	1.020	-2.0	1.289	-1.9
Wholesale Trade	0.599	-0.0	0.696	0.2
Retail Trade	0.628	1.8	0.701	-0.2
F.I.R.E.	0.379	1.1	0.531	1.3
Services	0.423	6.6	0.566	5.6
Government	0.510	2.7	1.028	3.2

TABLE 11

AUTOCORRELATIONS OF AGGREGATE EMPLOYMENT GROWTH

Auto-Correlation	1948-89	1948-69	1970-89	1948-60	1970-82	1961-69	1983-89
1st	0.689*	0.667*	0.735*	0.654*	0.709*	0.697*	0.614*
2nd	0.330*	0.278*	0.441*	0.246*	0.416*	0.355*	0.324*
3rd	0.107	0.026	0.286*	-0.052	0.300*	0.110	0.055
4th	-0.130	-0.234*	0.107	-0.350*	0.150	-0.027	-0.047
5th	-0.289*	-0.381*	-0.057	-0.501*	0.021	-0.041	-0.158*
6th	-0.211*	-0.245*	-0.094	-0.306*	0.028	-0.003	-0.282*
7th	-0.162*	-0.150†	-0.145	-0.134	-0.011	0.060	-0.327*
8th	-0.162*	-0.085	-0.286*	-0.072	-0.174	0.106	-0.286*
9th	-0.059	0.072	-0.305*	0.029	-0.214	0.132	-0.262*
10th	0.028	0.171†	-0.251*	0.081	-0.201†	0.082	-0.211†
11th	-0.044	0.066	-0.274*	-0.080	-0.247*	0.043	-0.129
12th	-0.104	-0.003	-0.323*	-0.152	-0.308*	0.015	0.084

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 12

AUTOCORRELATIONS OF AGGREGATE HOURS GROWTH

Auto-Correlation	1948-89	1948-69	1970-89	1948-60	1970-82	1961-69	1983-89
1st	0.606*	0.602*	0.610*	0.612*	0.582*	0.485*	0.610*
2nd	0.257*	0.235*	0.298*	0.238*	0.272†	0.170†	0.268*
3rd	0.036	-0.024	0.160	-0.073	0.196	-0.016	0.117*
4th	-0.150*	-0.247*	0.075	-0.340*	0.127	-0.043	-0.033
5th	-0.286*	-0.410*	-0.003	-0.493*	0.088	-0.230*	-0.064
6th	-0.226*	-0.261*	-0.114	-0.299†	-0.010	-0.072	-0.159*
7th	-0.169*	-0.140	-0.202	-0.115	-0.109	0.038	-0.145*
8th	-0.170*	-0.089	-0.299*	-0.044	-0.218	-0.024	-0.220*
9th	-0.061	0.030	-0.216†	0.041	-0.148	-0.045	-0.284†
10th	0.045	0.150	-0.157†	0.077	-0.118	0.072	-0.280
11th	-0.045	0.023	-0.191*	-0.096	-0.174†	0.074	-0.251†
12th	-0.121	-0.043	-0.298*	-0.179	-0.307*	-0.020	0.072

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 13

CHANGE IN AUTOCORRELATIONS OF LABOR INPUT GROWTH

	Employment			Hours		
Auto-Correlation	1948-69 vs. 1970-89	1948-60 vs. 1970-82	1961-69 vs. 1983-89	1948-69 vs. 1970-89	1948-60 vs. 1970-82	1961-69 vs. 1983-89
1st	0.067	0.055	-0.083	0.008	-0.031	0.125
2nd	0.163	0.170	-0.031	0.063	0.034	0.098
3rd	0.261†	0.352†	-0.055	0.185	0.242	0.133
4th	0.341†	0.500†	-0.020	0.322†	0.468†	0.010
5th	0.324†	0.522†	-0.116	0.407†	0.581†	0.166
6th	0.151	0.334*	-0.280†	0.147	0.289	-0.087
7th	0.005	0.123	-0.388†	-0.061	0.006	-0.182*
8th	-0.201	-0.102	-0.392†	-0.210	-0.174	-0.196
9th	-0.377†	-0.243	-0.395†	-0.246	-0.189	-0.239
10th	-0.422†	-0.282	-0.294†	-0.307†	-0.195	-0.352*
11th	-0.340†	-0.167	-0.172	-0.215	-0.078	-0.325*
12th	-0.319*	-0.155	0.068	-0.255	-0.128	0.092

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 14

AUTOCORRELATIONS OF EMPLOYMENT GROWTH 1948-89 AND CHANGES IN AVERAGE SHARE 1948-69 VS. 1970-89 BY INDUSTRY

	Autocorrelations												Change in Share
Industry	1st	2nd	3rd†	4th†	5th†	6th	7th	8th	9th†	10th†	11th†	12th*	
Mining	0.042	-0.019	0.019	-0.023	-0.005	0.021	0.035	-0.017	-0.017	0.109	0.036	-0.055	-0.5
Construction	0.479	0.227	0.126	0.083	-0.088	-0.103	-0.154	-0.225	-0.112	-0.050	-0.154	-0.231	-0.5
Durables	0.607	0.266	0.019	-0.219	-0.320	-0.231	-0.192	-0.111	-0.012	0.049	0.001	-0.087	-4.5
Nondurables	0.569	0.162	-0.078	-0.213	-0.295	-0.210	-0.137	-0.097	-0.008	0.103	0.077	-0.030	-4.6
Transportation	0.334	0.257	0.090	-0.108	-0.142	-0.121	-0.083	-0.113	-0.089	-0.011	0.039	-0.073	-2.0
Wholesale Trade	0.639	0.337	0.173	-0.060	-0.182	-0.250	-0.196	-0.203	-0.208	-0.113	-0.083	-0.053	-0.0
Retail Trade	0.462	0.283	0.202	0.024	0.003	-0.100	-0.003	-0.194	-0.137	0.003	-0.066	-0.056	1.8
F.I.R.E.	0.778	0.609	0.458	0.336	0.274	0.174	0.050	-0.074	-0.153	-0.252	-0.346	-0.374	1.1
Services	0.586	0.329	0.217	0.123	0.043	0.112	0.079	-0.033	-0.030	-0.094	-0.081	0.003	6.6
Government	0.462	0.282	0.258	0.217	0.027	0.022	0.126	0.077	-0.040	0.023	0.012	-0.159	2.7

* Change in Aggregate Significant at the 5% Level
† Change in Aggregate Significant at the 10% Level.

TABLE 15

AUTOCORRELATIONS OF HOURS GROWTH 1948-89 AND CHANGES IN AVERAGE SHARE 1948-69 VS. 1970-89 BY INDUSTRY

	Autocorrelations												Change in Share
Industry	1st	2nd	3rd	4th†	5th†	6th	7th	8th	9th	10th†	11th	12th	
Mining	0.073	-0.014	-0.093	-0.079	-0.013	0.060	0.056	-0.136	-0.006	0.104	-0.008	0.001	-0.4
Construction	0.104	0.143	0.031	0.057	-0.080	-0.121	-0.047	-0.234	-0.026	0.033	-0.129	-0.119	-0.2
Durables	0.565	0.218	0.015	-0.218	-0.328	-0.226	-0.157	-0.130	-0.015	0.076	-0.010	-0.090	-3.7
Nondurables	0.519	0.096	-0.121	-0.257	-0.281	-0.215	-0.134	-0.067	0.017	0.135	0.088	-0.045	-3.9
Transportation	0.366	0.167	0.039	-0.190	-0.165	-0.130	-0.065	-0.092	-0.078	0.016	0.003	-0.095	-1.9
Wholesale Trade	0.550	0.278	0.116	-0.079	-0.185	-0.259	-0.205	-0.196	-0.189	-0.097	-0.065	-0.042	0.2
Retail Trade	0.343	0.158	0.029	-0.070	0.030	-0.095	-0.061	-0.236	-0.189	-0.033	-0.018	-0.014	-0.2
F.I.R.E.	0.266	0.343	0.163	0.213	0.066	0.030	-0.003	-0.136	-0.050	-0.180	-0.123	-0.229	1.3
Services	0.237	0.144	0.097	-0.001	-0.066	0.143	-0.004	-0.176	-0.075	-0.165	-0.073	0.007	5.6
Government	-0.230	0.118	-0.005	0.037	0.170	-0.099	0.006	-0.126	0.057	-0.021	0.095	-0.212	3.2

* Change in Aggregate Significant at the 5% Level

† Change in Aggregate Significant at the 10% Level.

TABLE 16

PARTIAL AUTOCORRELATIONS OF AGGREGATE EMPLOYMENT GROWTH

Partial Auto-Correlation	1948-89	1948-69	1970-89	1948-60	1970-82	1961-69	1983-89
1st	0.689*	0.667*	0.735*	0.654*	0.709*	0.697*	0.614*
2nd	-0.275*	-0.032*	-0.214†	-0.316*	-0.173	-0.255†	-0.084
3rd	0.013	-0.029	0.113	-0.111	0.160	-0.048	-0.176
4th	-0.286*	-0.317*	-0.229*	-0.355*	-0.201	-0.028	-0.023
5th	-0.056	-0.064	-0.051	-0.121	0.005	0.072	-0.134
6th	0.190*	0.220*	0.071	0.273†	0.103	0.021	-0.207
7th	-0.185*	-0.203†	-0.157	-0.175	-0.136	0.062	-0.062
8th	-0.037	0.037	-0.222†	-0.172	-0.222	0.026	-0.024
9th	0.074	0.081	0.091	-0.040	0.068	0.051	-0.150
10th	-0.024	0.010	-0.047	-0.020	-0.080	-0.086	-0.058
11th	-0.165*	-0.167	-0.132	-0.252†	-0.057	0.056	0.005
12th	-0.075	-0.005	-0.167	-0.055	-0.181	-0.008	0.174

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 17

PARTIAL AUTOCORRELATIONS OF AGGREGATE HOURS GROWTH

Partial Auto-Correlation	1948-89	1948-69	1970-89	1948-60	1970-82	1961-69	1983-89
1st	0.606*	0.602*	0.610*	0.612*	0.582*	0.485*	0.610*
2nd	-0.174*	-0.199†	-0.117	-0.219	-0.100	-0.085	-0.166
3rd	-0.067	-0.122	0.046	-0.196	0.081	-0.084	0.045
4th	-0.166*	-0.216*	-0.031	-0.265†	0.018	0.018	-0.149
5th	-0.152*	-0.216*	-0.051	-0.213	0.002	-0.267†	0.062
6th	0.086	0.200†	-0.130	0.237	-0.101	0.210†	-0.210
7th	-0.084	-0.103	-0.098	-0.062	-0.092	0.028	0.109
8th	-0.118	-0.104	-0.175	-0.205	-0.161	-0.175	-0.299
9th	0.088	0.059	0.115	-0.052	0.104	0.086	0.017
10th	0.005	0.040	-0.067	-0.051	-0.076	0.053	-0.210
11th	-0.216*	-0.212*	-0.117	-0.245†	-0.092	-0.005	0.076
12th	-0.083	-0.002	-0.229†	-0.080	-0.223	-0.028	0.231†

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 18

CHANGE IN PARTIAL AUTOCORRELATIONS OF LABOR INPUT GROWTH

	Employment			Hours		
Partial Auto-Correlation	1948-69 vs. 1970-89	1948-60 vs. 1970-82	1961-69 vs. 1983-89	1948-69 vs. 1970-89	1948-60 vs. 1970-82	1961-69 vs. 1983-89
1st	0.067	0.055	-0.083	0.008	-0.031	0.125
2nd	0.088	0.142	0.171	0.082	0.119	-0.081
3rd	0.142	0.271	-0.128	0.168	0.277	0.129
4th	0.087	0.154	0.051	0.186	0.283	-0.167
5th	0.013	0.126	-0.206	0.165	0.215	0.329
6th	-0.149	-0.170	-0.227	-0.330*	-0.339	-0.420†
7th	0.046	0.039	-0.124	0.005	-0.029	0.082
8th	-0.260†	-0.049	-0.049	-0.071	0.044	-0.124
9th	0.010	0.109	-0.201	-0.056	0.156	-0.069
10th	-0.057	-0.060	0.028	-0.108	-0.025	-0.264
11th	0.035	0.195	-0.051	0.095	0.153	0.081
12th	-0.162	-0.125	0.182	-0.227	-0.143	0.358

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 19

PARTIAL AUTOCORRELATIONS OF EMPLOYMENT GROWTH 1948-89 AND CHANGES IN AVERAGE SHARE 1948-69 VS. 1970-89 BY INDUSTRY

	Partial Autocorrelations												Change in Share
Industry	1st	2nd	3rd	4th	5th	6th	7th	8th†	9th	10th	11th	12th	
Mining	0.042	-0.020	0.021	-0.025	-0.002	0.020	0.034	-0.019	-0.015	0.109	0.029	-0.055	-0.5
Construction	0.479	-0.003	0.025	0.018	-0.179	0.001	-0.106	-0.134	0.113	-0.020	-0.167	-0.134	-0.5
Durables	0.607	-0.161	-0.114	-0.233	-0.077	0.083	-0.129	-0.006	-0.012	0.015	-0.132	-0.156	-4.5
Nondurables	0.569	-0.241	-0.087	-0.127	-0.153	0.047	-0.101	-0.070	0.042	0.047	-0.094	-0.116	-4.6
Transportation	0.334	0.163	-0.042	-0.190	-0.085	0.009	0.021	-0.095	-0.069	0.050	0.073	-0.157	-2.0
Wholesale Trade	0.639	-0.121	0.016	-0.257	-0.024	-0.123	0.117	-0.192	-0.121	0.001	-0.039	-0.025	-0.0
Retail Trade	0.462	0.088	0.054	-0.133	0.011	-0.118	0.133	-0.280	0.086	0.076	-0.027	-0.102	1.8
F.I.R.E.	0.778	0.007	-0.044	-0.022	0.073	-0.122	-0.150	-0.117	-0.004	-0.173	-0.147	0.038	1.1
Services	0.586	-0.021	0.049	-0.029	-0.037	0.157	-0.066	-0.119	0.048	-0.127	0.076	0.072	6.6
Government	0.462	0.087	0.126	0.056	-0.162	0.017	0.136	-0.012	-0.098	0.043	-0.045	-0.177	2.7

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 20

PARTIAL AUTOCORRELATIONS OF HOURS GROWTH 1948-89 AND CHANGES IN AVERAGE SHARE 1948-69 VS. 1970-89 BY INDUSTRY

	Partial Autocorrelations												Change in
Industry	1st	2nd	3rd	4th	5th	6th*	7th	8th	9th	10th	11th	12th	Share
Mining	0.073	-0.020	-0.091	-0.067	-0.006	0.053	0.036	-0.152	0.023	0.123	-0.042	-0.021	-0.4
Construction	0.104	0.134	0.004	0.034	-0.096	-0.123	-0.005	-0.206	0.034	0.104	-0.167	-0.111	-0.2
Durables	0.565	-0.147	-0.064	-0.254	-0.110	0.071	-0.072	-0.099	0.032	0.030	-0.164	-0.127	-3.7
Nondurables	0.519	-0.238	-0.085	-0.175	-0.094	-0.065	-0.071	-0.065	-0.003	0.081	-0.121	-0.123	-3.9
Transportation	0.366	0.039	-0.039	-0.230	-0.031	-0.019	0.021	-0.119	-0.059	0.057	-0.007	-0.166	-1.9
Wholesale Trade	0.550	-0.036	-0.033	-0.175	-0.090	-0.122	0.034	-0.100	-0.079	0.011	-0.056	-0.046	0.2
Retail Trade	0.343	0.046	-0.043	-0.085	0.094	-0.132	-0.006	-0.233	-0.026	0.068	0.006	-0.084	-0.2
F.I.R.E.	0.266	0.293	0.024	0.092	-0.049	-0.075	-0.022	-0.164	0.019	-0.100	-0.046	-0.099	1.3
Services	0.237	0.093	0.047	-0.048	-0.077	0.187	-0.058	-0.212	-0.015	-0.104	0.058	0.011	5.6
Government	-0.230	0.069	0.038	0.038	0.193	-0.031	-0.063	-0.150	-0.015	-0.008	0.138	-0.154	3.2

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 21

REGRESSION COEFFICIENTS FROM AN AR(8) MODEL OF EMPLOYMENT GROWTH

Lag	1948-89	1948-69	1970-89	1948-60	1970-82	1961-69	1983-89
1st	0.908*	0.897*	0.910*	0.794*	0.876*	0.859*	0.616*
2nd	-0.336*	-0.356*	-0.328*	-0.192	-0.310	-0.218	0.026
3rd	0.156	0.146	0.219	0.012	0.247	-0.005	-0.219
4th	-0.138	-0.145	-0.135	-0.194	-0.154	-0.082	0.101
5th	-0.272*	-0.311*	-0.116	-0.347†	-0.073	0.067	-0.002
6th	0.340*	0.405*	0.134	0.364†	0.145	-0.027	-0.167
7th	-0.151	-0.237†	0.053	-0.033	0.065	0.040	-0.048
8th	-0.037	0.037	-0.222†	-0.172	-0.222	0.026	-0.024

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 22

REGRESSION COEFFICIENTS FROM AN AR(8) MODEL OF HOURS GROWTH

Lag	1948-89	1948-69	1970-89	1948-60	1970-82	1961-69	1983-89
1st	0.673*	0.677*	0.650*	0.647*	0.623*	0.580*	0.803*
2nd	-0.135	-0.121	-0.156	-0.029	-0.148	-0.054	-0.389
3rd	-0.006	-0.041	0.070	-0.102	0.085	-0.153	0.301
4th	-0.053	-0.051	-0.010	-0.127	0.010	0.203	-0.345
5th	-0.218*	-0.353*	0.035	-0.364*	0.067	-0.390*	0.315
6th	0.124	0.253*	-0.089	0.260	-0.065	0.179	-0.382
7th	-0.003	-0.022	0.019	0.073	0.011	0.128	0.340
8th	-0.188	-0.104	-0.175	-0.205	-0.161	-0.175	-0.299

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 23

CHANGE IN AR(8) REGRESSION COEFFICIENTS OF LABOR INPUT GROWTH

	Employment			Hours		
Lag	1948-69 vs. 1970-89	1948-60 vs. 1970-82	1961-69 vs. 1983-89	1948-69 vs. 1970-89	1948-60 vs. 1970-82	1961-69 vs. 1983-89
1st	0.013	0.082	-0.244	-0.027	-0.025	0.223
2nd	0.029	-0.118	0.244	-0.035	-0.119	-0.335
3rd	0.073	0.236	-0.214	0.111	0.188	0.454
4th	0.010	0.040	0.183	0.040	0.137	-0.549†
5th	0.195	0.274	-0.069	0.388*	0.431†	0.705*
6th	-0.271	-0.219	-0.140	-0.343†	-0.325	-0.561†
7th	0.289	0.098	-0.087	0.051	-0.062	0.211
8th	-0.260†	-0.049	-0.049	-0.071	0.044	-0.124

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 24

AR(8) MODEL OF EMPLOYMENT GROWTH 1948-89 AND CHANGE IN AVERAGE SHARE 1948-69 VS 1970-89 BY INDUSTRY

	Lag								Change in
Industry	1st	2nd	3rd	4th	5th	6th	7th	8th†	Share
Mining	0.044	-0.021	0.022	-0.026	-0.002	0.018	0.035	-0.019	-0.5
Construction	0.469	-0.024	0.000	0.119	-0.177	0.048	-0.041	-0.134	-0.5
Durables	0.658	-0.097	0.012	-0.171	-0.140	0.166	-0.125	-0.006	-4.5
Nondurables	0.660	-0.211	-0.045	-0.019	-0.206	0.099	-0.054	-0.070	-4.6
Transportation	0.265	0.213	0.024	-0.185	-0.088	0.024	0.046	-0.095	-2.0
Wholesale Trade	0.750	-0.238	0.267	-0.340	0.135	-0.245	0.257	-0.192	-0.0
Retail Trade	0.479	0.000	0.153	-0.186	0.092	-0.161	0.257	-0.280	1.8
F.I.R.E.	0.747	0.059	-0.024	-0.088	0.168	0.002	-0.060	-0.117	1.1
Services	0.608	-0.033	0.039	0.005	-0.128	0.190	0.007	-0.119	6.6
Government	0.415	0.069	0.088	0.108	-0.175	-0.039	0.141	-0.012	2.7

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 25

AR(8) MODEL OF HOURS GROWTH 1948-89 AND CHANGE IN AVERAGE SHARE 1948-69 VS 1970-89 BY INDUSTRY

	Lag								Change in
Industry	1st	2nd	3rd	4th	5th*	6th†	7th	8th	Share
Mining	0.070	-0.003	-0.081	-0.072	-0.021	0.049	0.046	-0.152	-0.4
Construction	0.080	0.109	-0.002	0.072	-0.081	-0.095	0.012	-0.206	-0.2
Durables	0.600	-0.108	0.049	-0.188	-0.153	0.102	-0.012	-0.099	-3.7
Nondurables	0.576	-0.226	-0.010	-0.140	-0.072	-0.038	-0.034	-0.065	-3.9
Transportation	0.340	0.059	0.046	-0.245	-0.020	-0.019	0.061	-0.119	-1.9
Wholesale Trade	0.544	-0.043	0.075	-0.142	-0.014	-0.143	0.088	-0.100	0.2
Retail Trade	0.344	0.022	0.007	-0.132	0.133	-0.118	0.075	-0.233	-0.2
F.I.R.E.	0.175	0.257	0.020	0.141	-0.026	-0.027	0.007	-0.164	1.3
Services	0.222	0.132	0.026	-0.055	-0.100	0.219	-0.009	-0.212	5.6
Government	-0.231	0.072	0.067	0.097	0.196	-0.034	-0.097	-0.150	3.2

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 26

DECOMPOSITION OF CHANGE IN STANDARD DEVIATION OF LABOR INPUT GROWTH

	Employment			Hours		
Comparison	Changing Industry Shares	Changing Industry Variances	Changing Industry Covariances	Changing Industry Shares	Changing Industry Variances	Changing Industry Covariances
1948-69 vs. 1970-89	49%	19%	28%	44%	21%	34%
1948-60 vs. 1970-82	44%	21%	33%	35%	22%	42%
1961-69 vs. 1983-89	35%	16%	43%	37%	29%	30%

TABLE 27

DECOMPOSITION OF CHANGE IN AUTOCORRELATIONS OF LABOR INPUT GROWTH 1948-69 VS. 1970-89

Employment				Hours			
AC	Changing Industry Shares	Changing Industry Variances	Changing Industry Covariances	AC	Changing Industry Shares	Changing Industry Variances	Changing Industry Covariances
1st	20%	44%	33%	1st	-246%	59%	233%
2nd	15%	28%	55%	2nd	15%	65%	22%
3rd†	14%	25%	63%	3rd	9%	27%	62%
4th†	12%	23%	64%	4th†	11%	21%	63%
5th†	12%	16%	69%	5th†	8%	20%	69%
6th	15%	10%	73%	6th	11%	7%	75%
7th	274%	-229%	36%	7th	-5%	26%	79%
8th	6%	38%	55%	8th	7%	34%	59%
9th†	6%	26%	64%	9th	7%	36%	53%
10th†	7%	20%	68%	10th†	9%	28%	60%
11th†	9%	20%	66%	11th	9%	24%	65%
12th*	3%	18%	76%	12th	4%	20%	73%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 28

DECOMPOSITION OF CHANGE IN AUTOCORRELATIONS
OF LABOR INPUT GROWTH 1948-60 VS. 1970-82

	Employment				Hours		
AC	Changing Industry Shares	Changing Industry Variances	Changing Industry Covariances	AC	Changing Industry Shares	Changing Industry Variances	Changing Industry Covariances
1st	20%	42%	30%	1st	55%	50%	7%
2nd	12%	24%	60%	2nd	34%	88%	-10%
3rd†	9%	26%	66%	3rd	6%	28%	65%
4th†	7%	23%	70%	4th†	9%	23%	67%
5th†	5%	18%	75%	5th†	4%	21%	71%
6th*	4%	16%	79%	6th	3%	14%	79%
7th	2%	3%	94%	7th	-102%	-139%	426%
8th	16%	67%	9%	8th	6%	39%	45%
9th	10%	33%	43%	9th	3%	39%	37%
10th	13%	23%	50%	10th	14%	32%	38%
11th	20%	24%	38%	11th	20%	34%	14%
12th	6%	16%	63%	12th	13%	18%	57%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 29

DECOMPOSITION OF CHANGE IN AUTOCORRELATIONS
OF LABOR INPUT GROWTH 1961-69 VS. 1983-89

Employment				Hours			
AC	Changing Industry Shares	Changing Industry Variances	Changing Industry Covariances	AC	Changing Industry Shares	Changing Industry Variances	Changing Industry Covariances
1st	-11%	-68%	134%	1st	-57%	129%	21%
2nd	-71%	-206%	215%	2nd	-35%	113%	46%
3rd	-79%	-76%	150%	3rd	6%	59%	50%
4th	-229%	-234%	285%	4th	377%	580%	-503%
5th	-36%	12%	79%	5th	0%	-0%	104%
6th†	-18%	13%	82%	6th	-61%	38%	69%
7th†	-11%	14%	76%	7th*	-13%	34%	60%
8th†	-12%	16%	77%	8th	-7%	23%	58%
9th†	-12%	13%	80%	9th	9%	31%	50%
10th†	-12%	13%	83%	10th*	-5%	23%	69%
11th	-9%	11%	72%	11th*	-6%	10%	82%
12th	41%	-15%	62%	12th	30%	-3%	60%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 30

DECOMPOSITION OF CHANGE IN PARTIAL AUTOCORRELATIONS
OF LABOR INPUT GROWTH 1948-69 VS. 1970-89

Employment			Hours		
PAC	Changing Industry Shares	Changing Industry Variances and Covariances	PAC	Changing Industry Shares	Changing Industry Variances and Covariances
1st	20%	79%	1st	-246%	297%
2nd	1%	98%	2nd	70%	45%
3rd	20%	97%	3rd	-10%	105%
4th	-5%	79%	4th	21%	73%
5th	160%	84%	5th	-7%	114%
6th	5%	89%	6th*	6%	97%
7th	23%	74%	7th	409%	220%
8th†	11%	80%	8th	28%	83%
9th	350%	-220%	9th	4%	96%
10th	57%	57%	10th	4%	90%
11th	30%	121%	11th	17%	75%
12th	-29%	147%	12th	3%	101%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 31

DECOMPOSITION OF CHANGE IN PARTIAL AUTOCORRELATIONS
OF LABOR INPUT GROWTH 1948-60 VS. 1970-82

Employment			Hours		
PAC	Changing Industry Shares	Changing Industry Variances and Covariances	PAC	Changing Industry Shares	Changing Industry Variances and Covariances
1st	20%	74%	1st	55%	59%
2nd	2%	101%	2nd	46%	68%
3rd	8%	100%	3rd	-7%	106%
4th	-3%	98%	4th	17%	84%
5th	13%	91%	5th	-14%	109%
6th	4%	84%	6th	3%	93%
7th	24%	63%	7th	-52%	62%
8th	48%	4%	8th	4%	103%
9th	12%	105%	9th	10%	105%
10th	58%	92%	10th	153%	38%
11th	9%	103%	11th	14%	93%
12th	-26%	133%	12th	12%	104%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 32

DECOMPOSITION OF CHANGE IN PARTIAL AUTOCORRELATIONS
OF LABOR INPUT GROWTH 1961-69 VS. 1983-89

Employment			Hours		
PAC	Changing Industry Shares	Changing Industry Variances and Covariances	PAC	Changing Industry Shares	Changing Industry Variances and Covariances
1st	-11%	70%	1st	-57%	162%
2nd	5%	107%	2nd	-73%	136%
3rd	-28%	131%	3rd	17%	75%
4th	-27%	187%	4th	-9%	101%
5th	-8%	119%	5th	-9%	109%
6th	-19%	109%	6th*	-10%	108%
7th	12%	43%	7th	-34%	149%
8th	-77%	149%	8th	-32%	107%
9th	-0%	103%	9th	58%	64%
10th	-12%	187%	10th	-4%	93%
11th	31%	-17%	11th	68%	85%
12th	36%	48%	12th	-1%	104%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 33

DECOMPOSITION OF CHANGE IN AR(8) REGRESSION COEFFICIENTS
OF LABOR INPUT GROWTH 1948-69 VS. 1970-89

Employment			Hours		
AR	Changing Industry Shares	Changing Industry Variances and Covariances	AR	Changing Industry Shares	Changing Industry Variances and Covariances
1st	198%	93%	1st	200%	-56%
2nd	-65%	38%	2nd	-199%	239%
3rd	43%	115%	3rd	-33%	136%
4th	-181%	86%	4th	76%	-50%
5th	14%	87%	5th*	2%	105%
6th	9%	84%	6th†	9%	99%
7th	13%	79%	7th	55%	109%
8th†	11%	80%	8th	28%	83%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 34

DECOMPOSITION OF CHANGE IN AR(8) REGRESSION COEFFICIENTS
OF LABOR INPUT GROWTH 1948-60 VS. 1970-82

Employment			Hours		
AR	Changing Industry Shares	Changing Industry Variances and Covariances	AR	Changing Industry Shares	Changing Industry Variances and Covariances
1st	25%	92%	1st	173%	-54%
2nd	11%	104%	2nd	-50%	137%
3rd	12%	97%	3rd	-23%	123%
4th	-50%	159%	4th	41%	57%
5th	9%	86%	5th†	-5%	103%
6th	10%	77%	6th	5%	97%
7th	33%	42%	7th	-15%	73%
8th	48%	4%	8th	4%	103%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 35

DECOMPOSITION OF CHANGE IN AR(8) REGRESSION COEFFICIENTS
OF LABOR INPUT GROWTH 1961-69 VS. 1983-89

Employment			Hours		
AR	Changing Industry Shares	Changing Industry Variances and Covariances	AR	Changing Industry Shares	Changing Industry Variances and Covariances
1st	-6%	89%	1st	-39%	149%
2nd	-11%	120%	2nd	-10%	111%
3rd	-26%	145%	3rd	6%	99%
4th	-10%	153%	4th†	-0%	103%
5th	39%	120%	5th*	-5%	108%
6th	-48%	152%	6th†	-12%	113%
7th	56%	-6%	7th	-29%	132%
8th	-77%	149%	8th	-32%	107%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 36

CORRELATIONS OF AGGREGATE EMPLOYMENT GROWTH
WITH AGGREGATE OUTPUT GROWTH

Output Lag	1948-89	1948-69	1970-89	1948-60	1970-82	1961-69	1982-89
0th	0.687*	0.685*	0.723†	0.740*	0.722†	0.488	0.627†
1st	0.616*	0.645*	0.594†	0.680†	0.571†	0.539	0.551*
2nd	0.417*	0.410*	0.433†	0.437*	0.390†	0.357	0.494*
3rd	0.236*	0.126*	0.405†	0.088	0.396*	0.138†	0.359†
4th	0.051	-0.083	0.242*	-0.160	0.232*	0.060	0.177
5th	-0.053	-0.170	0.127*	-0.259	0.131*	-0.035	0.151†
6th	-0.034	-0.107	0.066	-0.156	0.130†	-0.053	-0.026
7th	-0.023	-0.049	0.014	-0.035	0.088	0.007	-0.052
8th	-0.108	-0.050	-0.213	0.003	-0.127	0.087	-0.220*
9th	-0.039	0.047	-0.160	0.067†	-0.073	0.153	-0.236*
10th	0.014	0.079	-0.052	0.020	0.000	0.138†	-0.185†
11th	-0.023	0.035	-0.094	-0.075	-0.092	0.127*	-0.159
12th	-0.120	-0.071	-0.191†	-0.233*	-0.186*	0.070†	-0.084

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 37

CORRELATIONS OF AGGREGATE HOURS GROWTH WITH AGGREGATE OUTPUT GROWTH

Output Lag	1948-89	1948-69	1970-89	1948-60	1970-82	1961-69	1982-89
0th	0.717*	0.719*	0.741†	0.772*	0.740*	0.517	0.653*
1st	0.593*	0.609*	0.578†	0.628†	0.562†	0.555	0.515*
2nd	0.336*	0.348*	0.309	0.377*	0.266	0.265	0.405*
3rd	0.147*	0.040	0.281†	-0.008	0.282*	0.129	0.202
4th	-0.016	-0.140	0.166*	-0.217	0.179*	0.041	0.102
5th	-0.089	-0.217	0.087	-0.288	0.138*	-0.132	-0.023
6th	-0.074	-0.143	0.031	-0.165	0.110	-0.158	-0.003
7th	-0.031	-0.017	-0.074	-0.010	0.011	0.050	-0.090
8th	-0.131	-0.050	-0.256	0.007	-0.176	0.025	-0.237*
9th	-0.058	0.013	-0.139	0.048	-0.064	0.040	-0.239*
10th	0.035	0.086	-0.008	0.033	0.024	0.151*	-0.134
11th	-0.050	-0.025	-0.081	-0.125	-0.070	0.070	-0.187
12th	-0.155	-0.085	-0.159†	-0.231*	-0.149	0.015	-0.105

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 38

CHANGE IN CORRELATIONS OF LABOR INPUT GROWTH WITH OUTPUT GROWTH

	Employment			Hours		
Output Lag	1948-69 vs. 1970-89	1948-60 vs. 1970-82	1961-69 vs. 1983-89	1948-69 vs. 1970-89	1948-60 vs. 1970-82	1961-69 vs. 1983-89
0th	0.037	-0.018	0.139	0.022	-0.032	0.136
1st	-0.051	-0.109	0.012	-0.031	-0.066	-0.040
2nd	0.023	-0.047	0.136	-0.039	-0.111	0.140
3rd	0.279	0.308	0.221	0.241	0.290†	0.073
4th	0.324*	0.392*	0.116	0.306*	0.396*	0.061
5th	0.297†	0.391	0.186	0.304	0.426	0.108
6th	0.173	0.287	0.027	0.174	0.275	0.155
7th	0.063	0.123	-0.059	-0.057	0.020	-0.139
8th	-0.163	-0.130	-0.307*	-0.206	-0.183	-0.263†
9th	-0.207	-0.141	-0.389*	-0.152	-0.112	-0.279
10th	-0.131	-0.020	-0.323*	-0.094	-0.009	-0.285*
11th	-0.128	-0.017	-0.286†	-0.056	0.056	-0.257
12th	-0.120	0.047	-0.154	-0.074	0.082	-0.120

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 39

CORRELATIONS OF EMPLOYMENT GROWTH WITH OUTPUT GROWTH 1948-89 AND CHANGE IN AVERAGE SHARE 1948-69 VS. 1970-89 BY INDUSTRY

	Output Lag													Change in Share
Industry	0th	1st	2nd	3rd	4th*	5th†	6th	7th	8th	9th	10th	11th	12th	
Mining	0.282	0.156	-0.017	0.070	0.049	-0.088	0.040	-0.086	-0.081	-0.020	0.004	0.039	0.056	-0.5
Construction	0.518	0.563	0.258	0.146	0.074	-0.015	-0.103	-0.039	-0.177	-0.145	-0.059	-0.130	-0.076	-0.5
Durables	0.727	0.582	0.425	0.226	0.006	-0.063	-0.026	-0.037	-0.083	-0.019	0.048	0.002	-0.106	-4.5
Nondurables	0.602	0.526	0.309	0.093	-0.034	-0.148	-0.125	-0.041	-0.080	-0.043	0.056	0.058	-0.046	-4.6
Transportation	0.468	0.384	0.443	0.208	0.112	-0.010	0.043	0.013	-0.135	-0.033	-0.071	-0.021	-0.063	-2.0
Wholesale Trade	0.421	0.510	0.460	0.292	0.217	0.070	-0.023	-0.009	-0.133	-0.140	-0.034	-0.060	-0.056	-0.0
Retail Trade	0.492	0.507	0.335	0.180	0.115	-0.126	-0.025	-0.052	-0.208	-0.066	-0.012	-0.022	-0.099	1.8
F.I.R.E.	0.184	0.261	0.233	0.168	0.153	0.132	0.126	0.079	0.029	0.031	0.066	0.038	0.016	1.1
Services	0.292	0.372	0.237	0.189	0.058	-0.061	-0.051	-0.011	-0.074	-0.056	-0.011	-0.042	-0.100	6.6
Government	0.148	0.185	0.147	0.239	0.181	0.266	0.198	0.096	0.066	0.105	-0.048	-0.025	-0.124	2.7

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 40

CORRELATIONS OF HOURS GROWTH WITH OUTPUT GROWTH 1948-89 AND CHANGE IN AVERAGE SHARE 1948-69 VS. 1970-89 BY INDUSTRY

	Output Lag													Change in Share
Industry	0th	1st	2nd	3rd	4th*	5th	6th	7th	8th	9th	10th	11th	12th	
Mining	0.327	0.204	0.006	0.015	-0.011	-0.078	0.032	-0.095	-0.062	-0.048	0.010	0.004	0.077	-0.4
Construction	0.425	0.460	0.140	0.175	0.054	0.008	-0.085	0.001	-0.185	-0.130	-0.041	-0.129	-0.090	-0.2
Durables	0.779	0.550	0.346	0.158	-0.068	-0.096	-0.056	-0.041	-0.100	-0.031	0.057	-0.014	-0.113	-3.7
Nondurables	0.623	0.447	0.190	-0.052	-0.125	-0.180	-0.160	-0.125	-0.076	-0.017	0.100	0.046	-0.055	-3.9
Transportation	0.520	0.392	0.397	0.171	0.002	0.000	-0.037	-0.034	-0.102	-0.046	-0.042	-0.001	-0.093	-1.9
Wholesale Trade	0.457	0.551	0.407	0.202	0.170	0.010	-0.079	-0.038	-0.139	-0.137	-0.011	-0.067	-0.069	0.2
Retail Trade	0.500	0.460	0.249	0.088	0.059	-0.173	-0.093	-0.141	-0.287	-0.109	-0.035	0.020	-0.061	-0.2
F.I.R.E.	0.180	0.246	0.163	0.148	0.116	0.063	0.068	0.019	0.013	0.004	0.057	-0.026	0.049	1.3
Services	0.198	0.316	0.125	0.141	0.002	-0.058	-0.008	0.028	-0.009	-0.035	-0.112	-0.230	-0.068	5.6
Government	0.096	0.168	0.113	0.089	0.154	0.103	0.053	0.059	-0.045	0.002	0.046	-0.050	-0.056	3.2

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 41

PARTIAL CORRELATIONS OF AGGREGATE EMPLOYMENT GROWTH WITH AGGREGATE OUTPUT GROWTH

Output Lag	1948-89	1948-69	1970-89	1948-60	1970-82	1961-69	1983-89
0th	0.499*	0.560*	0.444*	0.627*	0.448*	0.312*	0.310
1st	0.308*	0.359*	0.267*	0.359*	0.268*	0.301†	0.196
2nd	0.128	0.120	0.148	0.127	0.144	0.130	0.118
3rd	0.069	-0.010	0.176	-0.071	0.183	0.058	0.087
4th	0.011	-0.019	0.084	-0.050	0.080	0.080	0.044
5th	-0.011	-0.027	0.047	-0.100	0.026	0.087	0.079
6th	0.015	0.021	0.041	0.021	0.029	0.051	-0.009
7th	0.023	0.002	0.046	0.011	0.052	0.010	-0.053
8th	-0.030	-0.063	0.013	-0.025	0.027	-0.036	-0.100
9th	0.035	0.062	0.030	0.065	0.046	0.013	-0.087
10th	0.016	0.034	0.041	0.025	0.047	-0.004	0.028
11th	-0.033	0.003	-0.017	-0.029	-0.036	0.075	-0.014
12th	-0.045	-0.050	0.009	-0.118	-0.029	0.087	0.016

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 42

PARTIAL CORRELATIONS OF AGGREGATE HOURS GROWTH WITH AGGREGATE OUTPUT GROWTH

Output Lag	1948-89	1948-69	1970-89	1948-60	1970-82	1961-69	1983-89
0th	0.651*	0.728*	0.580*	0.818*	0.579*	0.402*	0.431*
1st	0.349*	0.384*	0.322*	0.355*	0.326*	0.374*	0.229
2nd	0.080	0.088	0.086	0.111	0.079	0.074	0.087
3rd	0.028	-0.078	0.147	-0.173	0.158	0.082	0.020
4th	-0.014	-0.042	0.079	-0.066	0.084	0.105	0.055
5th	-0.024	-0.067	0.050	-0.150	0.053	0.007	0.012
6th	-0.016	-0.012	0.034	0.022	0.020	-0.018	0.038
7th	0.027	0.045	-0.011	0.025	0.007	0.059	-0.088
8th	-0.057	-0.099	0.000	-0.042	0.021	-0.114	-0.167
9th	0.026	0.021	0.069	0.049	0.085	-0.103	-0.120
10th	0.036	0.057	0.050	0.064	0.047	0.040	0.100
11th	-0.085	-0.058	-0.058	-0.109	-0.065	0.018	-0.067
12th	-0.037	-0.051	0.033	-0.111	-0.004	0.086	-0.002

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 43

CHANGE IN PARTIAL CORRELATIONS OF LABOR INPUT GROWTH WITH OUTPUT GROWTH

	Employment			Hours		
Output Lag	1948-69 vs. 1970-89	1948-60 vs. 1970-82	1961-69 vs. 1983-89	1948-69 vs. 1970-89	1948-60 vs. 1970-82	1961-69 vs. 1983-89
0th	-0.117	-0.179	-0.002	-0.148	-0.239†	0.029
1st	-0.093	-0.091	-0.105	-0.062	-0.029	-0.145
2nd	0.029	0.117	-0.012	-0.003	-0.032	0.013
3rd	0.186	0.254	0.029	0.225	0.331	-0.063
4th	0.103	0.130	-0.036	0.121	0.150	-0.050
5th	0.074	0.126	-0.008	0.117	0.203	0.005
6th	0.020	0.008	-0.060	0.046	-0.002	0.056
7th	0.044	0.041	-0.062	-0.056	-0.018	-0.147
8th	0.076	0.052	-0.063	0.099	0.063	-0.053
9th	-0.032	-0.019	-0.100	0.048	0.037	-0.017
10th	0.007	0.023	0.031	-0.007	-0.016	0.060
11th	-0.019	-0.008	-0.089	0.000	0.044	-0.084
12th	0.059	0.089	-0.071	0.085	0.108	-0.088

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 44

PARTIAL CORRELATION OF EMPLOYMENT GROWTH WITH OUTPUT GROWTH 1948-89
AND CHANGE IN AVERAGE SHARE 1948-69 VS. 1970-89 BY INDUSTRY

	Output Lag													Change in Share
Industry	0th	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	
Mining	1.066	0.274	-0.349	-0.399	-0.312	-0.342	0.309	-0.265	-0.041	0.149	-0.021	0.237	0.524	-0.5
Construction	0.946	0.798	0.070	0.094	0.167	0.043	-0.156	0.041	-0.194	-0.076	-0.031	-0.279	0.079	-0.5
Durables	1.498	0.764	0.407	0.199	-0.052	-0.008	0.090	0.044	-0.004	0.138	0.119	-0.028	-0.095	-4.5
Nondurables	0.519	0.307	0.082	-0.019	-0.022	-0.080	-0.050	0.034	-0.009	0.013	0.046	0.025	-0.014	-4.6
Transportation	0.487	0.265	0.334	0.086	0.080	0.018	0.112	0.072	-0.095	0.078	-0.014	0.044	0.009	-2.0
Wholesale Trade	0.251	0.247	0.180	0.089	0.100	0.040	0.002	0.037	-0.035	-0.017	0.039	-0.014	0.013	-0.0
Retail Trade	0.316	0.246	0.101	0.052	0.077	-0.068	0.043	0.015	-0.088	0.046	0.028	-0.006	-0.025	1.8
F.I.R.E.	0.068	0.082	0.057	0.034	0.044	0.043	0.041	0.021	0.011	0.026	0.036	0.010	0.011	1.1
Services	0.138	0.142	0.056	0.061	0.021	-0.010	0.015	0.034	0.001	0.015	0.023	0.000	-0.010	6.6
Government	0.052	0.058	0.025	0.092	0.046	0.104	0.050	-0.005	0.013	0.049	-0.068	-0.032	-0.078	2.7

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 45

PARTIAL CORRELATION OF HOURS GROWTH WITH OUTPUT GROWTH 1948-89
AND CHANGE IN AVERAGE SHARE 1948-69 VS. 1970-89 BY INDUSTRY

	Output Lag													Change in
Industry	0th	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	Share
Mining	1.458	0.483	-0.410	0.144	0.167	-0.205	0.337	-0.417	0.032	0.035	0.039	0.032	0.748	-0.4
Construction	1.103	0.925	-0.133	0.357	0.150	0.088	-0.203	0.151	-0.357	-0.103	0.005	-0.376	0.058	-0.2
Durables	1.947	0.784	0.283	0.147	-0.176	-0.025	0.041	0.060	-0.042	0.122	0.141	-0.097	-0.095	-3.7
Nondurables	0.757	0.314	-0.015	-0.156	-0.074	-0.103	-0.116	0.072	-0.015	0.038	0.094	-0.018	-0.016	-3.9
Transportation	0.678	0.318	0.343	0.080	-0.030	0.093	0.025	0.041	-0.043	0.057	-0.002	0.053	-0.050	-1.9
Wholesale Trade	0.312	0.305	0.153	0.042	0.109	0.017	-0.033	0.027	-0.040	-0.018	0.047	-0.047	0.005	0.2
Retail Trade	0.356	0.234	0.055	0.011	0.070	-0.098	-0.002	-0.045	-0.142	0.034	0.011	0.020	-0.012	-0.2
F.I.R.E.	0.091	0.107	0.041	0.050	0.048	0.025	0.035	0.006	0.020	0.019	0.040	-0.027	0.052	1.3
Services	0.127	0.173	0.018	0.071	0.002	-0.006	0.044	0.052	0.025	0.015	-0.046	-0.108	0.059	5.6
Government	0.072	0.137	0.042	0.037	0.134	0.056	0.002	0.035	-0.070	0.023	0.054	-0.110	-0.064	3.2

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 46

REGRESSION COEFFICIENTS OF AGGREGATE EMPLOYMENT GROWTH ON AGGREGATE OUTPUT GROWTH

Output Lag	1948-89	1948-69	1970-89	1948-60	1970-82	1961-69	1983-89
0th	0.380*	0.402*	0.378*	0.450*	0.390*	0.274	0.231
1st	0.257*	0.309*	0.218	0.268	0.221	0.308	0.178
2nd	0.107	0.130	0.099	0.166	0.096	0.121	0.085
3rd	0.069	0.003	0.153	-0.034	0.164	0.029	0.030
4th	0.011	-0.023	0.070	-0.010	0.073	0.059	0.037
5th	-0.021	-0.040	0.033	-0.111	0.016	0.070	0.095
6th	0.011	0.029	0.029	0.017	0.015	0.057	0.039
7th	0.033	0.025	0.043	0.023	0.047	0.015	-0.028
8th	-0.030	-0.063	0.013	-0.025	0.027	-0.036	-0.100

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 47

REGRESSION COEFFICIENTS OF AGGREGATE HOURS GROWTH ON AGGREGATE OUTPUT GROWTH

Output Lag	1948-89	1948-69	1970-89	1948-60	1970-82	1961-69	1983-89
0th	0.514*	0.549*	0.495*	0.631*	0.505*	0.358†	0.335*
1st	0.315*	0.343*	0.290*	0.263	0.298†	0.385*	0.241
2nd	0.075	0.120	0.043	0.196	0.038	0.052	0.073
3rd	0.034	-0.045	0.124	-0.117	0.137	0.027	-0.025
4th	-0.007	-0.030	0.063	-0.008	0.072	0.122	0.002
5th	-0.026	-0.077	0.043	-0.163	0.049	-0.020	0.026
6th	-0.018	-0.014	0.037	0.012	0.016	0.004	0.119
7th	0.046	0.082	-0.011	0.046	0.003	0.076	-0.046
8th	-0.057	-0.099	0.000	-0.042	0.021	-0.114	-0.167

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 48

CHANGE IN REGRESSION COEFFICIENTS OF LABOR INPUT GROWTH ON OUTPUT GROWTH

	Employment			Hours		
Output Lag	1948-69 vs. 1970-89	1948-60 vs. 1970-82	1961-69 vs. 1983-89	1948-69 vs. 1970-89	1948-60 vs. 1970-82	1961-69 vs. 1983-89
0th	-0.024	-0.060	-0.043	-0.054	-0.126	-0.023
1st	-0.091	-0.047	-0.129	-0.053	0.036	-0.144
2nd	-0.031	-0.070	-0.036	-0.077	-0.159	0.021
3rd	0.150	0.198	0.001	0.169	0.254	-0.053
4th	0.093	0.084	-0.052	0.093	0.079	-0.120
5th	0.073	0.127	0.025	0.120	0.211	0.046
6th	-0.001	-0.002	-0.018	0.051	0.004	0.123
7th	0.018	0.024	-0.043	-0.092	-0.043	-0.122
8th	0.076	0.052	-0.063	0.099	0.063	-0.053

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 49

REGRESSION COEFFICIENTS OF EMPLOYMENT GROWTH ON AGGREGATE OUTPUT GROWTH 1948-89 AND CHANGE IN AVERAGE SHARE 1948-69 VS. 1970-89 BY INDUSTRY

	Output Lag									Change in
Industry	0th	1st	2nd	3rd	4th	5th	6th	7th	8th	Share
Mining	1.025	0.361	-0.525	0.338	0.359	-0.409	0.398	-0.252	-0.041	-0.5
Construction	0.671	0.767	0.022	0.019	0.158	0.073	-0.143	0.101	-0.194	-0.5
Durables	1.210	0.609	0.357	0.226	-0.059	-0.042	0.077	0.045	-0.004	-4.5
Nondurables	0.400	0.272	0.084	-0.003	0.011	-0.069	-0.060	0.037	-0.009	-4.6
Transportation	0.371	0.156	0.315	0.066	0.056	-0.033	0.102	0.101	-0.095	-2.0
Wholesale Trade	0.166	0.187	0.145	0.054	0.086	0.032	-0.005	0.048	-0.035	-0.0
Retail Trade	0.220	0.208	0.079	0.036	0.086	-0.089	0.050	0.043	-0.088	1.8
F.I.R.E.	0.044	0.067	0.046	0.020	0.027	0.028	0.033	0.017	0.011	1.1
Services	0.092	0.117	0.035	0.059	0.025	-0.019	0.003	0.034	0.001	6.6
Government	0.046	0.053	-0.001	0.067	0.008	0.090	0.050	-0.009	0.013	2.7

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 50

REGRESSION COEFFICIENTS OF HOURS GROWTH ON AGGREGATE OUTPUT GROWTH 1948-89 AND CHANGE IN AVERAGE SHARE 1948-69 VS. 1970-89 BY INDUSTRY

	Output Lag									Change in
Industry	0th	1st	2nd	3rd	4th	5th	6th	7th	8th	Share
Mining	1.318	0.628	-0.484	0.105	0.164	-0.257	0.464	-0.426	0.032	-0.4
Construction	0.815	0.920	-0.250	0.280	0.125	0.108	-0.204	0.262	-0.357	-0.2
Durables	1.644	0.661	0.265	0.211	-0.173	-0.048	0.027	0.073	-0.042	-3.7
Nondurables	0.629	0.315	0.034	-0.122	-0.023	-0.076	-0.137	0.077	-0.015	-3.9
Transportation	0.542	0.203	0.333	0.081	-0.064	0.077	0.017	0.055	-0.043	-1.9
Wholesale Trade	0.204	0.257	0.127	0.003	0.106	0.021	-0.037	0.040	-0.040	0.2
Retail Trade	0.253	0.212	0.043	-0.010	0.084	-0.102	0.031	-0.000	-0.142	-0.2
F.I.R.E.	0.062	0.095	0.022	0.036	0.038	0.014	0.030	-0.000	0.020	1.3
Services	0.077	0.159	-0.002	0.079	0.004	-0.025	0.024	0.044	0.025	5.6
Government	0.032	0.130	0.022	-0.013	0.112	0.046	-0.000	0.057	-0.070	3.2

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 51

DECOMPOSITION OF CHANGE IN CORRELATIONS OF EMPLOYMENT GROWTH WITH OUTPUT GROWTH 1948-69 VS. 1970-89

Output Lag	Changing Industry Shares	Total Changing Second Moments	Changing Industry Variances	Changing Industry Covariances	Changing Industry Covariances with Output	Changing Output Variance
0th	-51%	143%	119%	183%	-257%	96%
1st	-7%	112%	-79%	-121%	371%	-63%
2nd	11%	52%	118%	182%	-336%	95%
3rd	5%	93%	6%	9%	73%	5%
4th*	6%	91%	2%	2%	85%	1%
5th†	5%	96%	-1%	-2%	97%	-1%
6th	6%	88%	-1%	-1%	90%	-1%
7th	12%	90%	-3%	-5%	101%	-3%
8th	0%	103%	5%	8%	82%	4%
9th	-0%	104%	2%	3%	97%	1%
10th	5%	90%	0%	0%	90%	0%
11th	6%	92%	1%	2%	87%	1%
12th	7%	94%	6%	10%	71%	5%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 52

DECOMPOSITION OF CHANGE IN CORRELATIONS OF EMPLOYMENT GROWTH WITH OUTPUT GROWTH 1948-60 VS. 1970-82

Output Lag	Changing Industry Shares	Total Changing Second Moments	Changing Industry Variances	Changing Industry Covariances	Changing Industry Covariances with Output	Changing Output Variance
0th	83%	14%	-346%	-532%	1261%	-366%
1st	-5%	105%	-50%	-77%	284%	-53%
2nd	-9%	122%	-77%	-119%	396%	-82%
3rd	4%	96%	6%	10%	73%	7%
4th*	4%	96%	1%	1%	93%	1%
5th	3%	99%	-2%	-3%	105%	-2%
6th	3%	96%	-1%	-2%	97%	-1%
7th	-1%	101%	-1%	-1%	98%	-1%
8th	5%	97%	5%	8%	80%	6%
9th	2%	105%	-1%	-1%	105%	-1%
10th	53%	-26%	-13%	-19%	-17%	-13%
11th	86%	3%	21%	32%	-150%	22%
12th	-28%	131%	-33%	-51%	266%	-35%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 53

DECOMPOSITION OF CHANGE IN CORRELATIONS OF EMPLOYMENT GROWTH WITH OUTPUT GROWTH 1961-69 VS. 1983-89

Output Lag	Changing Industry Shares	Total Changing Second Moments	Changing Industry Variances	Changing Industry Covariances	Changing Industry Covariances with Output	Changing Output Variance
0th	-32%	137%	30%	85%	-83%	101%
1st	-40%	221%	388%	1114%	-2218%	1323%
2nd	-5%	115%	23%	67%	-60%	80%
3rd	8%	92%	7%	20%	30%	24%
4th	14%	84%	0%	1%	29%	1%
5th	12%	87%	-2%	-5%	72%	-6%
6th	156%	15%	-37%	-107%	123%	-127%
7th	-26%	117%	12%	35%	90%	42%
8th*	-2%	102%	2%	5%	85%	6%
9th*	-4%	101%	-1%	-2%	92%	-3%
10th*	0%	103%	-1%	-3%	93%	-4%
11th†	1%	99%	-3%	-8%	92%	-9%
12th	-7%	117%	-3%	-8%	108%	-10%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 54

DECOMPOSITION OF CHANGE IN CORRELATIONS OF HOURS GROWTH WITH OUTPUT GROWTH 1948-69 VS. 1970-89

Output Lag	Changing Industry Shares	Total Changing Second Moments	Changing Industry Variances	Changing Industry Covariances	Changing Industry Covariances with Output	Changing Output Variance
0th	-114%	179%	215%	345%	-550%	168%
1st	-14%	104%	-129%	-207%	531%	-101%
2nd	1%	106%	-57%	-91%	289%	-44%
3rd	6%	93%	4%	7%	78%	4%
4th*	7%	90%	0%	0%	89%	0%
5th	4%	97%	-2%	-3%	101%	-1%
6th	5%	92%	-3%	-5%	100%	-2%
7th	-14%	106%	5%	8%	84%	4%
8th	1%	102%	5%	8%	83%	4%
9th	2%	100%	3%	5%	90%	3%
10th	8%	90%	-2%	-3%	97%	-1%
11th	32%	75%	7%	11%	51%	5%
12th	2%	99%	10%	16%	64%	8%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 55

DECOMPOSITION OF CHANGE IN CORRELATIONS OF HOURS GROWTH WITH OUTPUT GROWTH 1948-60 VS. 1970-82

Output Lag	Changing Industry Shares	Total Changing Second Moments	Changing Industry Variances	Changing Industry Covariances	Changing Industry Covariances with Output	Changing Output Variance
0th	58%	52%	-209%	-395%	873%	-217%
1st	-6%	103%	-80%	-152%	416%	-83%
2nd	-3%	101%	-27%	-51%	202%	-28%
3rd†	2%	98%	4%	8%	82%	4%
4th*	7%	94%	-1%	-1%	96%	-1%
5th	0%	100%	-2%	-5%	107%	-3%
6th	4%	99%	-2%	-4%	103%	-2%
7th	-15%	114%	-13%	-24%	121%	-13%
8th	3%	99%	4%	8%	81%	4%
9th	-3%	101%	-1%	-2%	98%	-1%
10th	3%	-56%	-62%	-118%	39%	-65%
11th	-25%	125%	-11%	-20%	188%	-11%
12th	-10%	109%	-18%	-35%	188%	-19%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 56

DECOMPOSITION OF CHANGE IN CORRELATIONS OF HOURS GROWTH WITH OUTPUT GROWTH 1961-69 VS. 1983-89

Output Lag	Changing Industry Shares	Total Changing Second Moments	Changing Industry Variances	Changing Industry Covariances	Changing Industry Covariances with Output	Changing Output Variance
0th	-56%	148%	47%	49%	-60%	106%
1st	1%	63%	-166%	-173%	697%	-374%
2nd	-14%	119%	24%	25%	0%	55%
3rd	62%	72%	19%	20%	-42%	44%
4th	33%	83%	-7%	-7%	28%	-15%
5th	17%	93%	-20%	-21%	125%	-45%
6th	15%	92%	-14%	-15%	116%	-32%
7th	-2%	94%	5%	5%	85%	11%
8th†	2%	99%	4%	4%	74%	9%
9th	4%	92%	2%	2%	72%	4%
10th*	3%	102%	-4%	-4%	99%	-8%
11th	6%	93%	-2%	-2%	79%	-5%
12th	2%	95%	1%	1%	74%	1%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 57

DECOMPOSITION OF CHANGE IN PARTIAL CORRELATIONS OF LABOR INPUT GROWTH WITH OUTPUT GROWTH 1948-69 VS. 1970-89

	Employment			Hours			
PAC	Changing Industry Shares	Changing Industry Variances & Covariances	Changing Output Variance	PAC	Changing Industry Shares	Changing Industry Variances & Covariances	Changing Output Variance
0th	81%	57%	-43%	0th	75%	73%	-45%
1st	47%	134%	-84%	1st	56%	196%	-167%
2nd	-72%	-28%	186%	2nd	451%	2048%	-2447%
3rd	-2%	105%	-2%	3rd	2%	106%	-10%
4th	4%	158%	-77%	4th	12%	175%	-97%
5th	9%	170%	-75%	5th	5%	154%	-61%
6th	-6%	121%	-102%	6th	10%	91%	-20%
7th	-3%	25%	87%	7th	0%	209%	-105%
8th	3%	-140%	252%	8th	3%	-141%	263%
9th	17%	407%	-369%	9th	-11%	-122%	274%
10th	-89%	-340%	826%	10th	127%	331%	-622%
11th	8%	61%	76%	11th	-8404%	39595%	-57231%
12th	2%	-39%	121%	12th	5%	-31%	100%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 58

DECOMPOSITION OF CHANGE IN PARTIAL CORRELATIONS OF LABOR INPUT GROWTH WITH OUTPUT GROWTH 1948-60 VS. 1970-82

Employment				Hours			
PAC	Changing Industry Shares	Changing Industry Variances & Covariances	Changing Output Variance	PAC	Changing Industry Shares	Changing Industry Variances & Covariances	Changing Output Variance
0th	58%	94%	-55%	0th†	47%	108%	-54%
1st	51%	210%	-164%	1st	123%	627%	-684%
2nd	-129%	-348%	572%	2nd	30%	379%	-337%
3rd	-2%	100%	4%	3rd	-0%	102%	-5%
4th	4%	181%	-90%	4th	15%	203%	-121%
5th	10%	156%	-66%	5th	1%	145%	-50%
6th	-11%	1091%	-1268%	6th	-340%	-3847%	4828%
7th	-17%	85%	16%	7th	41%	336%	-178%
8th	-8%	-218%	370%	8th	-7%	-258%	411%
9th	49%	454%	-569%	9th	-12%	-64%	353%
10th	-70%	255%	109%	10th	68%	-255%	-34%
11th	50%	-755%	705%	11th	-11%	322%	-186%
12th	-2%	102%	-35%	12th	-1%	89%	-43%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 59

DECOMPOSITION OF CHANGE IN PARTIAL CORRELATIONS OF LABOR INPUT GROWTH WITH OUTPUT GROWTH 1961-69 VS. 1983-89

Employment				Hours			
PAC	Changing Industry Shares	Changing Industry Variances & Covariances	Changing Output Variance	PAC	Changing Industry Shares	Changing Industry Variances & Covariances	Changing Output Variance
0th	3811%	3352%	-8563%	0th	-393%	-207%	765%
1st	43%	138%	-126%	1st	27%	139%	-103%
2nd	196%	81%	-94%	2nd	-138%	378%	-400%
3rd	-23%	244%	-318%	3rd	-25%	-2%	205%
4th	5%	58%	203%	4th	5%	76%	121%
5th	126%	-508%	528%	5th	-165%	1800%	-2009%
6th	-30%	45%	73%	6th	35%	150%	-130%
7th	-14%	95%	16%	7th	-2%	104%	-36%
8th	-30%	217%	-116%	8th	-57%	270%	-204%
9th	-18%	173%	-152%	9th	-93%	398%	-718%
10th	14%	-400%	575%	10th	-19%	-297%	416%
11th	15%	158%	-97%	11th	32%	127%	-108%
12th	-1%	175%	27%	12th	5%	91%	102%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 60

DECOMPOSITION OF CHANGE IN REGRESSION COEFFICIENTS OF LABOR INPUT GROWTH ON OUTPUT GROWTH 1948-69 VS. 1970-89

Employment				Hours			
Lag	Changing Industry Shares	Changing Industry Variances & Covariances	Changing Output Variance	Lag	Changing Industry Shares	Changing Industry Variances & Covariances	Changing Output Variance
0th	319%	-8%	-283%	0th	177%	69%	-166%
1st	39%	137%	-84%	1st	57%	186%	-173%
2nd	63%	246%	-207%	2nd	18%	180%	-109%
3rd	-4%	84%	20%	3rd	-0%	79%	14%
4th	2%	119%	-43%	4th	13%	138%	-72%
5th	10%	150%	-52%	5th	4%	144%	-49%
6th	203%	-5649%	8607%	6th	8%	191%	-110%
7th	-11%	246%	-105%	7th	1%	79%	24%
8th	3%	-140%	252%	8th	3%	-141%	263%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 61

DECOMPOSITION OF CHANGE IN REGRESSION COEFFICIENTS OF LABOR INPUT GROWTH ON OUTPUT GROWTH 1948-60 VS. 1970-82

Employment				Hours			
Lag	Changing Industry Shares	Changing Industry Variances & Covariances	Changing Output Variance	Lag	Changing Industry Shares	Changing Industry Variances & Covariances	Changing Output Variance
0th	147%	119%	-214%	0th	77%	127%	-135%
1st	78%	338%	-362%	1st	-90%	-326%	589%
2nd	28%	212%	-145%	2nd	6%	150%	-71%
3rd	-4%	86%	19%	3rd	-3%	83%	15%
4th	0%	168%	-87%	4th	25%	207%	-169%
5th	10%	126%	-39%	5th	0%	126%	-36%
6th	-100%	-4524%	6008%	6th	260%	3018%	-3432%
7th	-23%	310%	-225%	7th	14%	14%	101%
8th	-8%	-218%	370%	8th	-7%	-258%	411%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 62

DECOMPOSITION OF CHANGE IN REGRESSION COEFFICIENTS OF LABOR INPUT GROWTH ON OUTPUT GROWTH 1961-69 VS. 1983-89

Employment				Hours			
Lag	Changing Industry Shares	Changing Industry Variances & Covariances	Changing Output Variance	Lag	Changing Industry Shares	Changing Industry Variances & Covariances	Changing Output Variance
0th	161%	-33%	-37%	0th	451%	-115%	-294%
1st	30%	117%	-92%	1st	27%	131%	-100%
2nd	53%	95%	-122%	2nd	-94%	208%	-70%
3rd	239%	3379%	-6398%	3rd	-50%	46%	78%
4th	1%	78%	108%	4th	2%	84%	16%
5th	-51%	157%	-39%	5th	-17%	179%	-157%
6th	-71%	-57%	281%	6th	11%	113%	-79%
7th	-13%	86%	40%	7th	2%	106%	-36%
8th	-30%	217%	-116%	8th	-57%	270%	-204%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 63

STANDARD DEVIATION OF OUTPUT GROWTH

Period	Standard Deviation (As a percent)
1948-69	1.255
1970-89	1.063
Change	-0.192
T-Statistic	-1.092
(P-Value)	(0.278)
Period	
1948-60	1.546
1970-82	1.206
Change	-0.340
T-Statistic	-1.671
(P-Value)	(0.101)
Period	
1961-69	0.763
1983-89	0.605
Change	-0.157
T-Statistic	-1.114
(P-Value)	(0.275)

TABLE 64

STANDARD DEVIATION OF OUTPUT GROWTH AND
CHANGE IN AVERAGE SHARE BY INDUSTRY

Industry	Standard Deviation (As a percent) 1948-89	Change in Average Share 1948-69 to 1970-89
Agriculture	4.155	-2.2
Mining	3.688	0.1
Construction	2.464	-0.1
Durables	5.592	-3.3
Nonelectrical Machinery	9.568	-0.2
Nondurables	2.475	-3.0
Transportation	4.803	-1.2
Communications	1.954	0.7
E.G.A.S.S.	3.676	0.5
Wholesale Trade	2.725	0.2
Retail Trade	1.294	-0.5
F.I.R.E.	0.471	2.5
Services	0.675	4.5
General Government	1.459	1.8
Government Enterprise	1.719	0.2

TABLE 65

AUTOCORRELATIONS OF AGGREGATE OUTPUT GROWTH

Auto-Correlation	1948-89	1948-69	1970-89	1948-60	1970-82	1961-69	1983-89
1st	0.314*	0.348*	0.234*	0.385*	0.209*	0.162	0.411*
2nd	0.132*	0.158*	0.062	0.163†	0.033	0.150	0.348*
3rd	0.068	-0.099	0.285*	-0.135	0.294*	-0.092	0.246
4th	-0.102	-0.234*	0.057	-0.272†	0.077	-0.185	0.111
5th	-0.216*	-0.269*	-0.172*	-0.319†	-0.113	-0.096	0.037
6th	-0.102	-0.121	-0.116	-0.121	-0.094	-0.109	0.026
7th	-0.059	-0.091	-0.032	-0.066	0.008	0.169†	-0.073
8th	-0.152*	-0.024	-0.361*	0.011	-0.335*	0.054	-0.179*
9th	-0.046	0.044	-0.218	0.081	-0.251	-0.044	-0.089
10th	0.099	0.114	0.063	0.031	0.091	0.093	-0.200*
11th	-0.001	0.049	-0.119	-0.040	-0.051	-0.049	-0.039
12th	-0.116	-0.073	-0.245*	-0.202*	-0.274*	-0.029	-0.035

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 66

CHANGE IN AUTOCORRELATIONS OF OUTPUT GROWTH

Auto-Correlation	1948-69 vs. 1970-89	1948-60 vs. 1970-82	1961-69 vs. 1983-89
1st	-0.114	-0.176	0.249
2nd	-0.096	-0.130	0.198
3rd	0.384*	0.429*	0.339
4th	0.291†	0.349†	0.296
5th	0.097	0.205	0.133
6th	0.004	0.027	0.134
7th	0.059	0.074	-0.242†
8th	-0.336*	-0.346*	-0.232*
9th	-0.262	-0.332†	-0.045
10th	-0.051	0.060	-0.293*
11th	-0.168	-0.011	0.010
12th	-0.172	-0.072	-0.006

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 67

AUTOCORRELATIONS OF OUTPUT GROWTH 1948-89 AND CHANGES IN AVERAGE SHARE 1948-69 VS. 1970-89 BY INDUSTRY

	Autocorrelations												Change in
Industry	1st	2nd	3rd*	4th†	5th	6th	7th	8th*	9th	10th	11th	12th	Share
Agriculture	-0.245	-0.004	-0.353	0.438	-0.240	0.016	-0.146	0.261	-0.092	-0.052	-0.107	0.159	-2.2
Mining	0.152	0.004	-0.205	-0.254	-0.200	0.075	0.068	-0.003	0.068	0.008	-0.061	-0.097	0.1
Construction	0.040	0.142	0.307	0.057	0.023	0.015	0.027	-0.017	-0.010	0.116	-0.023	-0.054	-0.1
Durables	-0.157	0.022	-0.047	-0.024	-0.148	0.078	-0.063	-0.049	-0.089	0.225	-0.047	-0.065	-3.3
Nonelectical	-0.730	0.703	-0.492	0.362	-0.284	0.116	-0.123	0.041	-0.086	0.078	-0.085	0.112	-0.2
Nondurables	-0.093	-0.086	0.122	-0.126	-0.104	-0.045	0.025	-0.144	-0.029	0.036	0.060	-0.124	-3.0
Transportation	-0.559	0.387	-0.117	0.015	0.001	-0.144	0.186	-0.290	0.153	-0.129	0.140	-0.187	-1.2
Communication	-0.004	-0.175	-0.289	0.022	0.193	0.036	-0.024	-0.104	0.089	-0.005	-0.028	-0.137	0.7
E.G.A.S.S.	-0.313	-0.222	0.382	-0.052	-0.160	0.194	0.002	-0.003	0.135	0.023	-0.156	0.186	0.5
Wholesale Trade	-0.276	0.095	-0.014	-0.082	-0.042	-0.124	0.020	-0.105	0.095	0.079	0.015	-0.103	0.2
Retail Trade	0.375	0.362	0.007	-0.169	-0.200	-0.224	-0.036	-0.093	0.104	-0.018	0.046	-0.135	-0.5
F.I.R.E.	0.827	0.597	0.362	0.142	0.037	0.027	0.063	0.068	0.092	0.113	0.133	0.163	2.5
Services	0.037	0.370	0.136	-0.010	0.009	-0.085	-0.000	-0.049	-0.039	-0.054	0.002	-0.053	4.5
Gen.Government	0.584	0.350	0.286	0.082	0.006	-0.031	0.022	0.078	0.022	0.000	-0.109	-0.139	1.8
Government Ent.	-0.296	0.169	0.129	-0.047	0.152	-0.247	0.066	-0.032	0.103	-0.121	0.087	-0.012	0.2

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 68

PARTIAL AUTOCORRELATIONS OF AGGREGATE OUTPUT GROWTH

Partial Auto-Correlation	1948-89	1948-69	1970-89	1948-60	1970-82	1961-69	1983-89
1st	0.314*	0.348*	0.234*	0.385*	0.209	0.162	0.411*
2nd	0.037	0.042	0.008	0.017	-0.011	0.127	0.215
3rd	0.018	-0.189†	0.284*	-0.239	0.302*	-0.140	0.058
4th	-0.148†	-0.179†	-0.083	-0.181	-0.053	-0.180	-0.073
5th	-0.169*	-0.124	-0.195†	-0.144	-0.124	-0.011	-0.061
6th	0.029	0.044	-0.134	0.084	-0.150	-0.050	0.014
7th	0.010	-0.072	0.029	-0.069	0.046	0.189	-0.087
8th	-0.140†	-0.064	-0.303*	-0.073	-0.331*	-0.012	-0.162
9th	-0.002	0.010	-0.009	0.024	-0.050	-0.163	0.059
10th	0.113	0.070	0.120	-0.069	0.148	0.131	-0.110
11th	-0.059	-0.050	-0.018	-0.083	0.084	0.012	0.141
12th	-0.178*	-0.164	-0.217†	-0.240	-0.243	-0.064	0.014

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 69

CHANGE IN PARTIAL AUTOCORRELATIONS OF OUTPUT GROWTH

Auto-Correlation	1948-69 vs. 1970-89	1948-60 vs. 1970-82	1961-69 vs. 1983-89
1st	-0.114	-0.176	0.249
2nd	-0.034	-0.028	0.088
3rd	0.474*	0.541*	0.198
4th	0.097	0.128	0.108
5th	-0.070	0.020	-0.051
6th	-0.178	-0.233	0.064
7th	0.101	0.115	-0.276
8th	-0.239	-0.258	-0.150
9th	-0.018	-0.074	0.222
10th	0.050	0.218	-0.240
11th	0.032	0.167	0.129
12th	-0.053	-0.002	0.078

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 70

PARTIAL AUTOCORRELATIONS OF OUTPUT GROWTH 1948-89 AND CHANGES IN AVERAGE SHARE 1948-69 VS. 1970-89 BY INDUSTRY

Industry	Partial Autocorrelations												Change in Share
	1st	2nd	3rd*	4th	5th	6th	7th	8th	9th	10th	11th	12th	
Agriculture	-0.245	-0.068	-0.396	0.302	-0.189	-0.138	0.059	-0.033	0.045	-0.089	-0.074	0.039	-2.2
Mining	0.152	-0.020	-0.207	-0.205	-0.153	0.087	-0.034	-0.138	0.036	0.013	-0.061	-0.121	0.1
Construction	0.040	0.141	0.303	0.033	-0.067	-0.103	0.004	0.008	0.017	0.130	-0.015	-0.102	-0.1
Durables	-0.157	-0.002	-0.045	-0.040	-0.162	0.028	-0.053	-0.089	-0.128	0.179	0.118	-0.120	-3.3
Nonelectical	-0.730	0.363	0.245	-0.176	-0.150	-0.182	-0.098	0.076	-0.073	-0.006	0.012	0.009	-0.2
Nondurables	-0.093	-0.095	0.106	-0.116	-0.109	-0.102	0.020	-0.155	-0.072	-0.042	0.075	-0.161	-3.0
Transportation	-0.559	0.108	0.200	-0.022	-0.079	-0.221	0.089	-0.112	-0.148	-0.059	0.171	-0.108	-1.2
Communication	-0.004	-0.175	-0.300	-0.030	0.101	-0.039	0.026	-0.022	0.097	-0.036	-0.042	-0.116	0.7
E.G.A.S.S.	-0.313	-0.354	0.225	0.124	0.007	0.068	0.032	0.140	0.175	0.153	-0.123	0.037	0.5
Wholesale Trade	-0.276	0.020	0.019	-0.090	-0.096	-0.164	-0.056	-0.123	0.017	0.098	0.036	-0.161	0.2
Retail Trade	0.375	0.257	-0.237	-0.264	-0.005	-0.004	0.123	-0.127	0.062	-0.082	0.002	-0.183	-0.5
F.I.R.E.	0.827	-0.274	-0.140	-0.118	0.197	0.113	0.017	-0.194	0.144	0.087	0.103	-0.031	2.5
Services	0.037	0.369	0.132	-0.173	-0.110	-0.044	0.073	0.022	-0.055	-0.081	0.040	0.005	4.5
Gen.Government	0.584	0.013	0.115	-0.201	0.119	-0.052	0.153	0.039	-0.075	-0.053	-0.182	0.040	1.8
Government Ent.	0.296	0.089	0.222	0.036	0.106	-0.240	-0.124	-0.014	0.239	-0.021	0.046	-0.098	0.2

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 71

REGRESSION COEFFICIENTS FROM AN AR(8) MODEL OF OUTPUT GROWTH

Lag	1948-89	1948-69	1970-89	1948-60	1970-82	1961-69	1983-89
1st	0.285*	0.289*	0.224*	0.326†	0.228	0.144	0.298†
2nd	0.055	0.109	-0.046	0.110	-0.093	0.163	0.217
3rd	0.043	-0.126	0.282*	-0.160	0.322*	-0.083	0.079
4th	-0.112	-0.163	-0.057	-0.162	-0.063	-0.150	-0.056
5th	-0.168*	-0.136	-0.062	-0.173	0.028	-0.036	-0.033
6th	0.033	0.072	-0.141	0.113	-0.173	-0.073	0.076
7th	0.050	-0.053	0.095	-0.045	0.117	0.190	-0.037
8th	-0.140†	-0.064	-0.303*	-0.073	-0.331*	-0.012	-0.162

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 72

CHANGE IN AR(8) REGRESSION COEFFICIENTS
OF OUTPUT GROWTH

Lag	1948-69 vs. 1970-89	1948-60 vs. 1970-82	1961-69 vs. 1983-89
1st	-0.065	-0.098	0.154
2nd	-0.155	-0.202	0.054
3rd	0.408*	0.482*	0.163
4th	0.107	0.099	0.094
5th	0.074	0.201	0.003
6th	-0.213	-0.286	0.149
7th	0.148	0.161	-0.227
8th	-0.239	-0.258	-0.150

* Significant at the 5% Level.
† Significant at the 10% Level.

TABLE 73

AR(8) MODEL OF OUTPUT GROWTH 1948-89 AND CHANGE IN AVERAGE SHARE 1948-69 VS 1970-89 BY INDUSTRY

Industry	Lag								Change in Share
	1st	2nd	3rd*	4th	5th	6th	7th	8th	
Agriculture	-0.129	-0.134	-0.398	0.276	-0.209	-0.134	0.054	-0.033	-2.2
Mining	0.089	0.011	-0.187	-0.219	-0.183	0.090	-0.021	0.138	0.1
Construction	0.023	0.151	0.345	0.045	-0.072	-0.104	0.004	0.008	-0.1
Durables	-0.164	-0.023	-0.069	-0.074	-0.163	0.117	-0.067	-0.089	-3.3
Nonelectical	-0.575	0.531	0.275	-0.111	-0.215	-0.276	-0.054	0.076	-0.2
Nondurables	-0.098	-0.110	0.079	-0.155	-0.102	-0.114	0.004	-0.155	-3.0
Transportation	-0.505	0.212	0.228	-0.038	-0.184	-0.147	0.032	-0.112	-1.2
Communication	-0.058	-0.156	-0.291	-0.022	0.096	-0.041	0.025	-0.022	0.7
E.G.A.S.S.	-0.380	-0.249	0.241	0.115	0.006	0.113	0.084	0.140	0.5
Wholesale Trade	-0.309	-0.022	-0.027	-0.125	-0.142	-0.181	-0.094	-0.123	0.2
Retail Trade	0.292	0.402	-0.121	-0.274	-0.068	0.014	0.158	-0.127	-0.5
F.I.R.E.	1.001	-0.085	0.028	-0.357	0.086	0.076	0.210	-0.194	2.5
Services	-0.024	0.444	0.196	-0.164	-0.146	-0.052	0.073	0.022	4.5
Gen.Government	0.605	-0.081	0.274	-0.243	0.051	-0.141	0.129	0.039	1.8
Government Ent.	-0.307	0.135	0.282	0.131	0.054	-0.272	-0.128	-0.014	0.2

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 74

DECOMPOSITION OF CHANGE IN STANDARD DEVIATION OF OUTPUT GROWTH

Comparison	Changing Industry Shares	Changing Industry Variances	Changing Industry Covariances
1948-69 vs. 1970-89	107%	21%	-19%
1948-60 vs. 1970-82	70%	21%	8%
1961-69 vs. 1983-89	76%	41%	-4%

TABLE 75

DECOMPOSITION OF CHANGE IN AUTOCORRELATIONS OF OUTPUT GROWTH 1948-69 VS. 1970-89

AC	Changing Industry Shares	Changing Industry Variances	Changing Industry Covariances
1st	-64%	-3%	148%
2nd	-64%	34%	123%
3rd*	4%	15%	71%
4th†	1%	35%	59%
5th	4%	-28%	109%
6th	-519%	366%	250%
7th	-56%	-55%	194%
8th*	6%	21%	73%
9th	7%	25%	51%
10th	78%	88%	-72%
11th	9%	11%	70%
12th	5%	28%	58%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 76

DECOMPOSITION OF CHANGE IN AUTOCORRELATIONS OF OUTPUT GROWTH 1948-60 VS. 1970-82

AC	Changing Industry Shares	Changing Industry Variances	Changing Industry Covariances
1st	-40%	26%	110%
2nd	-59%	11%	151%
3rd*	3%	17%	67%
4th†	3%	37%	54%
5th	7%	-9%	97%
6th	-22%	127%	25%
7th	-47%	-68%	206%
8th*	1%	11%	87%
9th†	5%	41%	37%
10th	-73%	8%	184%
11th	160%	160%	-439%
12th	21%	-33%	80%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 77

DECOMPOSITION OF CHANGE IN AUTOCORRELATIONS OF OUTPUT GROWTH 1961-69 VS. 1983-89

AC	Changing Industry Shares	Changing Industry Variances	Changing Industry Covariances
1st	25%	161%	-69%
2nd	4%	-31%	127%
3rd	9%	58%	46%
4th	2%	-41%	144%
5th	-13%	82%	15%
6th	-23%	-84%	190%
7th†	0%	16%	95%
8th*	21%	39%	40%
9th	-110%	-198%	423%
10th*	9%	51%	31%
11th	238%	295%	-424%
12th	-68%	1092%	-989%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 78

DECOMPOSITION OF CHANGE IN PARTIAL AUTOCORRELATIONS OF OUTPUT GROWTH

	1948-69 vs. 1970-89			1948-60 vs. 1970-82			1961-69 vs. 1983-89	
PAC	Changing Industry Shares	Changing Industry Variances and Covariances	PAC	Changing Industry Shares	Changing Industry Variances and Covariances	PAC	Changing Industry Shares	Changing Industry Variances and Covariances
1st	-64%	146%	1st	-40%	136%	1st	56%	51%
2nd	-62%	182%	2nd	-136%	266%	2nd	-15%	115%
3rd*	-4%	94%	3rd*	-5%	94%	3rd	1%	94%
4th	-15%	120%	4th	-1%	98%	4th	-2%	106%
5th	-11%	120%	5th	77%	73%	5th	-2%	95%
6th	-5%	79%	6th	-10%	85%	6th	17%	34%
7th	-7%	83%	7th	-9%	100%	7th	-4%	125%
8th	4%	101%	8th	-3%	110%	8th	3%	100%
9th	-80%	58%	9th	6%	77%	9th	22%	101%
10th	-22%	108%	10th	-4%	95%	10th	26%	131%
11th	-44%	98%	11th	-5%	90%	11th	4%	75%
12th	34%	23%	12th	1113%	-1875%	12th	15%	84%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 79

DECOMPOSITION OF CHANGE IN AR(8) COEFFICIENTS OF OUTPUT GROWTH

1948-69 vs. 1970-89			1948-60 vs. 1970-82			1961-69 vs. 1983-89		
PAC	Changing Industry Shares	Changing Industry Variances and Covariances	PAC	Changing Industry Shares	Changing Industry Variances and Covariances	PAC	Changing Industry Shares	Changing Industry Variances and Covariances
1st	-94%	186%	1st	-58%	167%	1st	24%	76%
2nd	-18%	110%	2nd	-25%	114%	2nd	-4%	103%
3rd*	-1%	86%	3rd*	-2%	87%	3rd	3%	88%
4th	-6%	133%	4th	6%	113%	4th	-3%	107%
5th	7%	41%	5th	2%	84%	5th	17%	83%
6th	-8%	84%	6th	-11%	94%	6th	15%	39%
7th	4%	84%	7th	-2%	99%	7th	-18%	142%
8th	4%	101%	8th	-3%	110%	8th	3%	100%

* Change in Aggregate Significant at the 5% Level.
† Change in Aggregate Significant at the 10% Level.

TABLE 80

SUMMARY OF RESULTS FOR LABOR INPUT GROWTH

Statistic	Employment				Hours			
	Order	Comparison	*	†	Order	Comparison	*	†
Standard Deviation		48-69 vs. 70-89	↓	49%		48-69 vs. 70-89	↓	44%
		48-60 vs. 70-82	↓	44%		48-60 vs. 70-82	↓	35%
Autocorrelations	3rd	48-69 vs. 70-89	↑	14%	4th	48-69 vs. 70-89	↑	11%
	4th	48-69 vs. 70-89	↑	12%	5th	48-69 vs. 70-89	↑	8%
	5th	48-69 vs. 70-89	↑	12%	10th	48-69 vs. 70-89	↓	9%
	9th	48-69 vs. 70-89	↓	6%				
	10th	48-69 vs. 70-89	↓	7%	4th	48-60 vs. 70-82	↑	9%
	11th	48-69 vs. 70-89	↓	9%	5th	48-60 vs. 70-82	↑	4%
	12th	48-69 vs. 70-89	↓	3%				
					7th	61-69 vs. 83-89	↓	-13%
	3rd	48-60 vs. 70-82	↑	9%	10th	61-69 vs. 83-89	↓	-5%
	4th	48-60 vs. 70-82	↑	7%	11th	61-69 vs. 83-89	↓	-6%
	5th	48-60 vs. 70-82	↑	5%				
	6th	48-60 vs. 70-82	↑	4%				
	6th	61-69 vs. 83-89	↓	-18%				
	7th	61-69 vs. 83-89	↓	-11%				
	8th	61-69 vs. 83-89	↓	-12%				
	9th	61-69 vs. 83-89	↓	-12%				
	10th	61-69 vs. 83-89	↓	-12%				
Partial Autocorrelations	8th	48-69 vs. 70-89	↓	11%	6th	48-69 vs. 70-89	↓	6%
					6th	61-69 vs. 83-89	↓	-10%
Regression Coefficients		48-69 vs. 70-89	↓	11%	5th	48-69 vs. 70-89	↑	2%
					6th	48-69 vs. 70-89	↓	9%
					5th	48-60 vs. 70-82	↑	-5%
					4th	61-69 vs. 83-89	↓	-0%
					5th	61-69 vs. 83-89	↑	-5%
					6th	61-69 vs. 83-89	↓	-12%

* Direction of Change
† Percent of Change Attributable to Changing Industrial Composition

TABLE 81

SUMMARY OF RESULTS FOR RELATIONSHIP BETWEEN LABOR INPUT GROWTH AND OUTPUT GROWTH

Statistic	Employment				Hours			
	Order	Comparison	*	†	Order	Comparison	*	†
Correlations	4th	48-69 vs. 70-89	↑	6%	4th	48-69 vs. 70-89	↑	7%
	5th	48-69 vs. 70-89	↑	5%				
					3rd	48-60 vs. 70-82	↑	2%
	4th	48-60 vs. 70-82	↑	4%	4th	48-60 vs. 70-82	↑	7%
	8th	61-69 vs. 83-89	↓	-2%	8th	61-69 vs. 83-89	↓	2%
	9th	61-69 vs. 83-89	↓	-4%	10th	61-69 vs. 83-89	↓	3%
	10th	61-69 vs. 83-89	↓	0%				
	11th	61-69 vs. 83-89	↓	1%				
Partial Autocorrelations					0th	48-60 vs. 70-82	↓	47%
Regression Coefficients								

* Direction of Change
† Percent of Change Attributable to Changing Industrial Composition

TABLE 82

SUMMARY OF RESULTS FOR OUTPUT GROWTH

Statistic	Order	Comparison	*	†
Standard Deviation		48-60 vs. 70-82	↓	70%
Autocorrelations	3rd	48-69 vs. 70-89	↑	4%
	4th	48-69 vs. 70-89	↑	1%
	8th	48-69 vs. 70-89	↓	6%
	3rd	48-60 vs. 70-82	↑	3%
	4th	48-60 vs. 70-82	↑	3%
	8th	48-60 vs. 70-82	↓	1%
	9th	48-60 vs. 70-82	↓	5%
	7th	61-69 vs. 83-89	↓	0%
	8th	61-69 vs. 83-89	↓	21%
	10th	61-69 vs. 83-89	↓	9%
Partial Autocorrelations	3rd	48-69 vs. 70-89	↑	-4%
	3rd	48-60 vs. 70-82	↑	-5%
Regression Coefficients	3rd	48-69 vs. 70-89	↑	-1%
	3rd	48-60 vs. 70-82	↑	-2%

* Direction of Change
† Percent of Change Attributable to Changing Industrial Composition

TABLE 83

RELATED SERIES AND MODEL ESTIMATED IN DISTRIBUTION OF INDUSTRY GPO FLOWS

Industry	Related Series	Estimated Model
Agriculture	National Income without Capital Consumption Adjustment (Deflator: Producer Price Index, Farm Products)	VAR(2)
Mining	National Income without Capital Consumption Adjustment (Deflator: Producer Price Index, Fuels and Related Products and Power) Index of Industrial Production, Mining	Multivariate Random Walk with Drift
Construction	National Income without Capital Consumption Adjustment (Deflator: Consumer Price Index, All Items) GDP by Major Type of Product in Constant Dollars, Structures	VAR(3)
Manufacturing Durables	National Income without Capital Consumption Adjustment (Deflator: Producer Price Index, Durable Manufactures) Index of Industrial Production, Manufacturing Durables GDP by Major Type of Product in Constant Dollars, Durable Goods	VAR(4)
Manufacturing Nonelectrical Machinery	National Income without Capital Consumption Adjustment (Durables) (Deflator: Producer Price Index, Durable Manufactures) Index of Industrial Production, Nonelectrical Machinery GDP by Major Type of Product in Constant Dollars, Durable Goods	VAR(4)
Manufacturing Nondurables	National Income without Capital Consumption Adjustment (Deflator: Producer Price Index, Materials for Nondurable Manufacturing) Index of Industrial Production, Manufacturing Nondurables GDP by Major Type of Product in Constant Dollars, Nondurable Goods	VAR(1)
Transportation	National Income without Capital Consumption Adjustment (Deflator: Consumer Price Index, Transportation) Index of Industrial Production, Transportation Equipment	VAR(1)
Communication	National Income without Capital Consumption Adjustment	VAR(3)

TABLE 83--*Continued*

RELATED SERIES AND MODEL ESTIMATED IN DISTRIBUTION OF INDUSTRY GPO FLOWS

Industry	Related Series	Estimated Model
E.G.A.S.S.	National Income without Capital Consumption Adjustment (Deflator: Consumer Price Index, Gas and Electricity) Index of Industrial Production, Utilities	VAR(2)
Wholesale Trade	National Income without Capital Consumption Adjustment (Deflator: Producer Price Index, Finished Consumer Goods)	VAR(1)
Retail Trade	National Income without Capital Consumption Adjustment (Deflator: Consumer Price Index, All Items)	Multivariate Random Walk with Drift
F.I.R.E.	National Income without Capital Consumption Adjustment (Deflator: Consumer Price Index, Services)	Multivariate Random Walk with Drift
Services	National Income without Capital Consumption Adjustment (Deflator: Consumer Price Index, Services)	VAR(3)
General Government	National Income without Capital Consumption Adjustment GDP by Sector in Constant Dollars, General Government	VAR(2)
Government Enterprise	National Income without Capital Consumption Adjustment (Government) (Deflator: Consumer Price Index, Services)	VAR(4)

TABLE 84

QUARTERLY GPO ESTIMATES: AGRICULTURE
(BILLIONS OF 1987 DOLLARS, ANNUAL RATE)

1947:Q1	51.9	1956:Q1	60.6	1965:Q1	60.2	1974:Q1	67.0	1983:Q1	75.2
1947:Q2	51.3	1956:Q2	60.2	1965:Q2	59.6	1974:Q2	55.9	1983:Q2	72.1
1947:Q3	50.4	1956:Q3	60.6	1965:Q3	58.6	1974:Q3	61.1	1983:Q3	63.4
1947:Q4	51.9	1956:Q4	60.2	1965:Q4	59.0	1974:Q4	64.1	1983:Q4	63.0
1948:Q1	52.1	1957:Q1	58.5	1966:Q1	56.8	1975:Q1	64.7	1984:Q1	67.9
1948:Q2	53.0	1957:Q2	58.5	1966:Q2	55.8	1975:Q2	62.3	1984:Q2	73.9
1948:Q3	57.4	1957:Q3	58.7	1966:Q3	54.3	1975:Q3	65.8	1984:Q3	70.6
1948:Q4	55.7	1957:Q4	59.0	1966:Q4	55.6	1975:Q4	67.5	1984:Q4	74.0
1949:Q1	55.1	1958:Q1	60.0	1967:Q1	58.0	1976:Q1	65.1	1985:Q1	78.7
1949:Q2	52.6	1958:Q2	61.9	1967:Q2	57.2	1976:Q2	62.4	1985:Q2	82.5
1949:Q3	54.2	1958:Q3	60.3	1967:Q3	58.4	1976:Q3	62.8	1985:Q3	83.8
1949:Q4	55.2	1958:Q4	60.9	1967:Q4	59.8	1976:Q4	64.3	1985:Q4	84.6
1950:Q1	57.4	1959:Q1	59.7	1968:Q1	57.5	1977:Q1	63.2	1986:Q1	82.4
1950:Q2	57.0	1959:Q2	58.1	1968:Q2	55.9	1977:Q2	63.1	1986:Q2	84.4
1950:Q3	57.2	1959:Q3	58.0	1968:Q3	56.3	1977:Q3	63.8	1986:Q3	84.5
1950:Q4	57.3	1959:Q4	58.4	1968:Q4	56.8	1977:Q4	64.7	1986:Q4	86.6
1951:Q1	55.6	1960:Q1	60.4	1969:Q1	57.3	1978:Q1	58.6	1987:Q1	87.4
1951:Q2	54.6	1960:Q2	59.3	1969:Q2	56.3	1978:Q2	60.1	1987:Q2	89.5
1951:Q3	56.3	1960:Q3	61.4	1969:Q3	58.6	1978:Q3	60.2	1987:Q3	86.5
1951:Q4	56.7	1960:Q4	61.9	1969:Q4	60.2	1978:Q4	59.2	1987:Q4	90.5
1952:Q1	55.1	1961:Q1	60.6	1970:Q1	61.7	1979:Q1	60.0	1988:Q1	88.6
1952:Q2	57.1	1961:Q2	59.7	1970:Q2	59.8	1979:Q2	62.2	1988:Q2	92.3
1952:Q3	58.0	1961:Q3	59.8	1970:Q3	60.7	1979:Q3	61.8	1988:Q3	79.6
1952:Q4	58.3	1961:Q4	60.3	1970:Q4	62.8	1979:Q4	66.1	1988:Q4	80.3
1953:Q1	57.1	1962:Q1	60.4	1971:Q1	63.4	1980:Q1	63.7	1989:Q1	81.0
1953:Q2	60.0	1962:Q2	59.3	1971:Q2	61.2	1980:Q2	61.4	1989:Q2	93.7
1953:Q3	58.8	1962:Q3	59.4	1971:Q3	63.0	1980:Q3	60.7	1989:Q3	88.1
1953:Q4	60.2	1962:Q4	59.7	1971:Q4	63.7	1980:Q4	67.6	1989:Q4	89.5
1954:Q1	60.3	1963:Q1	60.2	1972:Q1	64.1	1981:Q1	70.6	1990:Q1	92.6
1954:Q2	61.0	1963:Q2	59.4	1972:Q2	59.6	1981:Q2	73.0	1990:Q2	93.6
1954:Q3	59.7	1963:Q3	59.7	1972:Q3	65.2	1981:Q3	73.9	1990:Q3	96.4
1954:Q4	61.7	1963:Q4	59.8	1972:Q4	63.4	1981:Q4	73.6	1990:Q4	94.4
1955:Q1	60.9	1964:Q1	59.0	1973:Q1	65.4	1982:Q1	73.6		
1955:Q2	61.9	1964:Q2	56.7	1973:Q2	56.6	1982:Q2	73.7		
1955:Q3	61.5	1964:Q3	57.8	1973:Q3	64.3	1982:Q3	73.2		
1955:Q4	61.6	1964:Q4	58.6	1973:Q4	64.0	1982:Q4	72.7		

TABLE 85

QUARTERLY GPO ESTIMATES: MINING
(BILLIONS OF 1987 DOLLARS, ANNUAL RATE)

1947:Q1	44.1	1956:Q1	63.5	1965:Q1	71.5	1974:Q1	87.0	1983:Q1	69.0
1947:Q2	43.8	1956:Q2	64.5	1965:Q2	71.8	1974:Q2	87.3	1983:Q2	69.2
1947:Q3	45.4	1956:Q3	63.1	1965:Q3	72.6	1974:Q3	87.1	1983:Q3	72.4
1947:Q4	46.2	1956:Q4	64.3	1965:Q4	73.7	1974:Q4	83.5	1983:Q4	75.3
1948:Q1	46.6	1957:Q1	64.3	1966:Q1	74.8	1975:Q1	86.1	1984:Q1	79.0
1948:Q2	47.6	1957:Q2	64.5	1966:Q2	74.8	1975:Q2	83.3	1984:Q2	82.9
1948:Q3	49.9	1957:Q3	64.2	1966:Q3	77.1	1975:Q3	81.2	1984:Q3	84.3
1948:Q4	49.3	1957:Q4	61.7	1966:Q4	77.7	1975:Q4	82.3	1984:Q4	82.2
1949:Q1	47.1	1958:Q1	58.8	1967:Q1	78.6	1976:Q1	83.3	1985:Q1	82.1
1949:Q2	45.7	1958:Q2	56.1	1967:Q2	79.0	1976:Q2	81.9	1985:Q2	81.5
1949:Q3	41.0	1958:Q3	59.4	1967:Q3	80.8	1976:Q3	81.8	1985:Q3	84.1
1949:Q4	40.2	1958:Q4	61.5	1967:Q4	79.8	1976:Q4	82.2	1985:Q4	85.6
1950:Q1	42.3	1959:Q1	62.5	1968:Q1	80.8	1977:Q1	81.7	1986:Q1	88.8
1950:Q2	48.0	1959:Q2	64.8	1968:Q2	83.4	1977:Q2	84.8	1986:Q2	84.1
1950:Q3	50.7	1959:Q3	60.3	1968:Q3	83.8	1977:Q3	84.5	1986:Q3	82.9
1950:Q4	51.6	1959:Q4	61.7	1968:Q4	82.3	1977:Q4	83.1	1986:Q4	76.5
1951:Q1	52.0	1960:Q1	62.5	1969:Q1	83.4	1978:Q1	77.5	1987:Q1	77.3
1951:Q2	52.9	1960:Q2	63.3	1969:Q2	85.1	1978:Q2	90.6	1987:Q2	80.8
1951:Q3	54.1	1960:Q3	62.1	1969:Q3	85.9	1978:Q3	87.5	1987:Q3	84.1
1951:Q4	55.1	1960:Q4	61.7	1969:Q4	86.8	1978:Q4	84.7	1987:Q4	90.0
1952:Q1	55.9	1961:Q1	61.2	1970:Q1	86.9	1979:Q1	75.0	1988:Q1	96.6
1952:Q2	51.5	1961:Q2	62.1	1970:Q2	87.8	1979:Q2	72.7	1988:Q2	96.7
1952:Q3	53.0	1961:Q3	64.0	1970:Q3	89.3	1979:Q3	71.2	1988:Q3	94.6
1952:Q4	55.4	1961:Q4	65.9	1970:Q4	91.9	1979:Q4	72.6	1988:Q4	90.0
1953:Q1	55.2	1962:Q1	65.4	1971:Q1	89.9	1980:Q1	77.9	1989:Q1	86.5
1953:Q2	56.0	1962:Q2	65.0	1971:Q2	89.5	1980:Q2	81.0	1989:Q2	83.8
1953:Q3	56.9	1962:Q3	64.7	1971:Q3	87.8	1980:Q3	81.2	1989:Q3	81.8
1953:Q4	55.0	1962:Q4	64.6	1971:Q4	83.3	1980:Q4	82.3	1989:Q4	84.3
1954:Q1	54.5	1963:Q1	66.0	1972:Q1	90.2	1981:Q1	76.9	1990:Q1	86.2
1954:Q2	54.9	1963:Q2	67.6	1972:Q2	88.6	1981:Q2	69.4	1990:Q2	90.7
1954:Q3	55.0	1963:Q3	68.6	1972:Q3	88.5	1981:Q3	76.2	1990:Q3	86.8
1954:Q4	56.0	1963:Q4	68.3	1972:Q4	88.5	1981:Q4	76.3	1990:Q4	87.6
1955:Q1	58.5	1964:Q1	69.1	1973:Q1	88.7	1982:Q1	75.9		
1955:Q2	60.4	1964:Q2	70.0	1973:Q2	86.0	1982:Q2	75.2		
1955:Q3	61.3	1964:Q3	69.6	1973:Q3	89.0	1982:Q3	71.7		
1955:Q4	63.3	1964:Q4	71.0	1973:Q4	89.6	1982:Q4	69.7		

TABLE 86

QUARTERLY GPO ESTIMATES: CONSTRUCTION
(BILLIONS OF 1987 DOLLARS, ANNUAL RATE)

1947:Q1	77.3	1956:Q1	162.3	1965:Q1	222.9	1974:Q1	197.2	1983:Q1	166.6
1947:Q2	91.4	1956:Q2	163.7	1965:Q2	220.4	1974:Q2	190.5	1983:Q2	167.7
1947:Q3	101.9	1956:Q3	165.2	1965:Q3	222.1	1974:Q3	182.2	1983:Q3	170.7
1947:Q4	92.6	1956:Q4	168.6	1965:Q4	230.2	1974:Q4	180.4	1983:Q4	175.2
1948:Q1	101.1	1957:Q1	164.9	1966:Q1	221.2	1975:Q1	174.0	1984:Q1	180.8
1948:Q2	106.0	1957:Q2	162.5	1966:Q2	232.7	1975:Q2	170.2	1984:Q2	188.8
1948:Q3	105.2	1957:Q3	161.6	1966:Q3	222.9	1975:Q3	173.3	1984:Q3	193.4
1948:Q4	104.2	1957:Q4	169.5	1966:Q4	221.9	1975:Q4	173.4	1984:Q4	201.1
1949:Q1	104.8	1958:Q1	166.3	1967:Q1	223.2	1976:Q1	177.1	1985:Q1	206.8
1949:Q2	102.9	1958:Q2	169.4	1967:Q2	216.5	1976:Q2	184.2	1985:Q2	205.6
1949:Q3	102.0	1958:Q3	171.3	1967:Q3	222.6	1976:Q3	184.3	1985:Q3	215.0
1949:Q4	103.7	1958:Q4	175.9	1967:Q4	219.3	1976:Q4	185.8	1985:Q4	212.5
1950:Q1	108.7	1959:Q1	182.3	1968:Q1	219.9	1977:Q1	187.0	1986:Q1	206.5
1950:Q2	111.2	1959:Q2	181.9	1968:Q2	221.2	1977:Q2	191.3	1986:Q2	210.5
1950:Q3	117.3	1959:Q3	184.0	1968:Q3	219.0	1977:Q3	191.6	1986:Q3	211.4
1950:Q4	125.5	1959:Q4	193.7	1968:Q4	219.6	1977:Q4	193.6	1986:Q4	209.4
1951:Q1	124.6	1960:Q1	184.2	1969:Q1	215.2	1978:Q1	193.8	1987:Q1	211.0
1951:Q2	129.2	1960:Q2	186.5	1969:Q2	215.1	1978:Q2	197.6	1987:Q2	214.7
1951:Q3	129.7	1960:Q3	194.0	1969:Q3	211.1	1978:Q3	197.6	1987:Q3	215.0
1951:Q4	129.7	1960:Q4	189.4	1969:Q4	208.7	1978:Q4	206.2	1987:Q4	212.0
1952:Q1	135.1	1961:Q1	186.8	1970:Q1	199.7	1979:Q1	203.9	1988:Q1	212.1
1952:Q2	132.3	1961:Q2	192.8	1970:Q2	193.9	1979:Q2	198.2	1988:Q2	211.6
1952:Q3	134.0	1961:Q3	190.6	1970:Q3	193.0	1979:Q3	197.2	1988:Q3	210.2
1952:Q4	134.4	1961:Q4	193.2	1970:Q4	190.6	1979:Q4	202.2	1988:Q4	211.2
1953:Q1	139.8	1962:Q1	197.5	1971:Q1	186.4	1980:Q1	196.0	1989:Q1	215.7
1953:Q2	137.1	1962:Q2	200.3	1971:Q2	189.3	1980:Q2	185.2	1989:Q2	212.9
1953:Q3	137.7	1962:Q3	199.0	1971:Q3	187.8	1980:Q3	179.3	1989:Q3	209.5
1953:Q4	139.7	1962:Q4	200.7	1971:Q4	189.3	1980:Q4	181.2	1989:Q4	213.5
1954:Q1	139.8	1963:Q1	202.9	1972:Q1	190.2	1981:Q1	177.0	1990:Q1	210.9
1954:Q2	144.0	1963:Q2	202.8	1972:Q2	193.9	1981:Q2	176.5	1990:Q2	211.5
1954:Q3	144.6	1963:Q3	205.2	1972:Q3	194.7	1981:Q3	176.0	1990:Q3	209.8
1954:Q4	148.6	1963:Q4	209.9	1972:Q4	191.8	1981:Q4	169.5	1990:Q4	201.8
1955:Q1	146.8	1964:Q1	210.7	1973:Q1	199.3	1982:Q1	167.1		
1955:Q2	153.6	1964:Q2	218.1	1973:Q2	199.6	1982:Q2	167.5		
1955:Q3	157.9	1964:Q3	214.1	1973:Q3	199.3	1982:Q3	164.5		
1955:Q4	158.0	1964:Q4	216.6	1973:Q4	189.6	1982:Q4	160.6		

TABLE 87

QUARTERLY GPO ESTIMATES: MANUFACTURING DURABLES
(BILLIONS OF 1987 DOLLARS, ANNUAL RATE)

1947:Q1	128.2	1956:Q1	190.7	1965:Q1	268.6	1974:Q1	349.6	1983:Q1	308.7
1947:Q2	129.9	1956:Q2	198.9	1965:Q2	267.1	1974:Q2	337.9	1983:Q2	322.8
1947:Q3	121.8	1956:Q3	190.0	1965:Q3	265.4	1974:Q3	331.3	1983:Q3	352.0
1947:Q4	135.6	1956:Q4	199.0	1965:Q4	285.7	1974:Q4	320.0	1983:Q4	352.0
1948:Q1	137.4	1957:Q1	205.7	1966:Q1	294.4	1975:Q1	283.0	1984:Q1	378.2
1948:Q2	132.8	1957:Q2	203.4	1966:Q2	295.6	1975:Q2	294.0	1984:Q2	363.7
1948:Q3	127.2	1957:Q3	200.3	1966:Q3	287.8	1975:Q3	310.1	1984:Q3	395.4
1948:Q4	138.6	1957:Q4	185.4	1966:Q4	300.4	1975:Q4	304.8	1984:Q4	392.6
1949:Q1	127.5	1958:Q1	167.2	1967:Q1	288.4	1976:Q1	332.8	1985:Q1	388.3
1949:Q2	123.3	1958:Q2	164.5	1967:Q2	298.3	1976:Q2	326.1	1985:Q2	384.3
1949:Q3	132.4	1958:Q3	172.6	1967:Q3	292.5	1976:Q3	330.4	1985:Q3	393.9
1949:Q4	112.9	1958:Q4	184.0	1967:Q4	295.1	1976:Q4	330.3	1985:Q4	385.5
1950:Q1	125.0	1959:Q1	183.8	1968:Q1	294.9	1977:Q1	348.2	1986:Q1	394.3
1950:Q2	138.1	1959:Q2	207.7	1968:Q2	313.1	1977:Q2	356.1	1986:Q2	390.8
1950:Q3	169.4	1959:Q3	191.0	1968:Q3	309.2	1977:Q3	360.2	1986:Q3	392.9
1950:Q4	164.2	1959:Q4	188.7	1968:Q4	322.4	1977:Q4	363.7	1986:Q4	400.4
1951:Q1	155.9	1960:Q1	206.0	1969:Q1	311.9	1978:Q1	364.0	1987:Q1	406.7
1951:Q2	171.9	1960:Q2	192.3	1969:Q2	315.6	1978:Q2	384.5	1987:Q2	417.3
1951:Q3	176.1	1960:Q3	189.5	1969:Q3	315.8	1978:Q3	363.3	1987:Q3	420.9
1951:Q4	170.2	1960:Q4	181.0	1969:Q4	321.5	1978:Q4	383.5	1987:Q4	410.1
1952:Q1	175.1	1961:Q1	169.5	1970:Q1	284.0	1979:Q1	381.3	1988:Q1	428.9
1952:Q2	168.0	1961:Q2	189.5	1970:Q2	303.3	1979:Q2	371.3	1988:Q2	431.8
1952:Q3	162.7	1961:Q3	192.3	1970:Q3	282.3	1979:Q3	362.1	1988:Q3	446.3
1952:Q4	195.3	1961:Q4	205.8	1970:Q4	263.1	1979:Q4	365.2	1988:Q4	451.9
1953:Q1	204.3	1962:Q1	199.8	1971:Q1	284.0	1980:Q1	359.2	1989:Q1	446.6
1953:Q2	202.2	1962:Q2	210.0	1971:Q2	296.5	1980:Q2	325.5	1989:Q2	438.6
1953:Q3	196.9	1962:Q3	206.4	1971:Q3	279.5	1980:Q3	320.2	1989:Q3	440.0
1953:Q4	182.2	1962:Q4	216.3	1971:Q4	291.8	1980:Q4	360.6	1989:Q4	436.4
1954:Q1	176.8	1963:Q1	213.5	1972:Q1	292.1	1981:Q1	356.6	1990:Q1	440.1
1954:Q2	169.3	1963:Q2	235.6	1972:Q2	319.9	1981:Q2	357.8	1990:Q2	436.2
1954:Q3	173.1	1963:Q3	223.1	1972:Q3	305.4	1981:Q3	343.8	1990:Q3	435.5
1954:Q4	180.5	1963:Q4	237.3	1972:Q4	343.4	1981:Q4	327.1	1990:Q4	420.7
1955:Q1	190.9	1964:Q1	235.1	1973:Q1	348.7	1982:Q1	323.1		
1955:Q2	201.5	1964:Q2	248.7	1973:Q2	350.5	1982:Q2	339.9		
1955:Q3	203.9	1964:Q3	243.6	1973:Q3	342.7	1982:Q3	333.6		
1955:Q4	203.9	1964:Q4	253.0	1973:Q4	365.3	1982:Q4	289.2		

TABLE 88

QUARTERLY GPO ESTIMATES: MANUFACTURING NONELECTRICAL MACHINERY
(BILLIONS OF 1987 DOLLARS, ANNUAL RATE)

1947:Q1	35.9	1956:Q1	42.3	1965:Q1	54.4	1974:Q1	83.4	1983:Q1	65.6
1947:Q2	23.3	1956:Q2	39.3	1965:Q2	53.0	1974:Q2	79.4	1983:Q2	64.6
1947:Q3	35.5	1956:Q3	43.4	1965:Q3	57.7	1974:Q3	80.5	1983:Q3	67.3
1947:Q4	23.7	1956:Q4	41.4	1965:Q4	55.5	1974:Q4	74.6	1983:Q4	73.5
1948:Q1	36.8	1957:Q1	43.1	1966:Q1	62.7	1975:Q1	72.9	1984:Q1	68.5
1948:Q2	25.8	1957:Q2	39.0	1966:Q2	58.1	1975:Q2	69.3	1984:Q2	77.4
1948:Q3	36.5	1957:Q3	38.2	1966:Q3	66.5	1975:Q3	71.4	1984:Q3	73.9
1948:Q4	26.0	1957:Q4	36.8	1966:Q4	57.8	1975:Q4	76.3	1984:Q4	79.5
1949:Q1	32.0	1958:Q1	32.8	1967:Q1	65.0	1976:Q1	72.2	1985:Q1	77.2
1949:Q2	25.6	1958:Q2	32.5	1967:Q2	60.0	1976:Q2	78.9	1985:Q2	82.8
1949:Q3	26.5	1958:Q3	32.6	1967:Q3	60.8	1976:Q3	76.3	1985:Q3	75.6
1949:Q4	27.2	1958:Q4	34.5	1967:Q4	61.0	1976:Q4	81.4	1985:Q4	80.0
1950:Q1	26.0	1959:Q1	36.6	1968:Q1	61.9	1977:Q1	79.7	1986:Q1	74.3
1950:Q2	29.9	1959:Q2	39.9	1968:Q2	60.1	1977:Q2	82.9	1986:Q2	74.0
1950:Q3	28.7	1959:Q3	39.1	1968:Q3	62.4	1977:Q3	83.5	1986:Q3	75.1
1950:Q4	33.2	1959:Q4	38.9	1968:Q4	62.9	1977:Q4	85.4	1986:Q4	79.1
1951:Q1	34.6	1960:Q1	39.9	1969:Q1	65.8	1978:Q1	85.4	1987:Q1	82.7
1951:Q2	37.0	1960:Q2	39.4	1969:Q2	62.2	1978:Q2	83.2	1987:Q2	86.5
1951:Q3	38.4	1960:Q3	36.7	1969:Q3	67.6	1978:Q3	93.4	1987:Q3	91.0
1951:Q4	43.3	1960:Q4	38.2	1969:Q4	62.1	1978:Q4	82.7	1987:Q4	94.5
1952:Q1	40.9	1961:Q1	37.7	1970:Q1	70.2	1979:Q1	91.0	1988:Q1	94.3
1952:Q2	42.6	1961:Q2	37.0	1970:Q2	63.0	1979:Q2	87.5	1988:Q2	98.9
1952:Q3	42.3	1961:Q3	40.4	1970:Q3	64.5	1979:Q3	84.4	1988:Q3	93.8
1952:Q4	41.9	1961:Q4	39.5	1970:Q4	60.2	1979:Q4	85.9	1988:Q4	102.2
1953:Q1	43.7	1962:Q1	44.1	1971:Q1	60.5	1980:Q1	82.3	1989:Q1	100.2
1953:Q2	41.8	1962:Q2	40.9	1971:Q2	57.6	1980:Q2	85.8	1989:Q2	105.4
1953:Q3	40.5	1962:Q3	46.0	1971:Q3	63.5	1980:Q3	80.2	1989:Q3	101.3
1953:Q4	38.5	1962:Q4	41.2	1971:Q4	58.9	1980:Q4	80.7	1989:Q4	103.7
1954:Q1	37.5	1963:Q1	46.3	1972:Q1	69.9	1981:Q1	85.3	1990:Q1	103.1
1954:Q2	37.7	1963:Q2	40.7	1972:Q2	60.3	1981:Q2	81.3	1990:Q2	102.3
1954:Q3	35.3	1963:Q3	48.2	1972:Q3	76.3	1981:Q3	85.4	1990:Q3	101.0
1954:Q4	36.5	1963:Q4	44.4	1972:Q4	66.6	1981:Q4	78.9	1990:Q4	101.7
1955:Q1	36.5	1964:Q1	50.9	1973:Q1	79.9	1982:Q1	78.4		
1955:Q2	36.7	1964:Q2	47.3	1973:Q2	72.2	1982:Q2	68.5		
1955:Q3	38.4	1964:Q3	53.8	1973:Q3	82.2	1982:Q3	69.3		
1955:Q4	38.5	1964:Q4	49.3	1973:Q4	76.4	1982:Q4	65.9		

TABLE 89

QUARTERLY GPO ESTIMATES: MANUFACTURING NONDURABLES
(BILLIONS OF 1987 DOLLARS, ANNUAL RATE)

1947:Q1	106.0	1956:Q1	143.1	1965:Q1	198.7	1974:Q1	269.8	1983:Q1	321.2
1947:Q2	101.1	1956:Q2	144.3	1965:Q2	202.3	1974:Q2	267.4	1983:Q2	329.9
1947:Q3	102.9	1956:Q3	142.8	1965:Q3	204.5	1974:Q3	262.7	1983:Q3	334.1
1947:Q4	103.3	1956:Q4	143.7	1965:Q4	211.9	1974:Q4	262.3	1983:Q4	342.5
1948:Q1	106.4	1957:Q1	144.5	1966:Q1	210.9	1975:Q1	248.6	1984:Q1	337.7
1948:Q2	109.3	1957:Q2	144.5	1966:Q2	216.5	1975:Q2	249.4	1984:Q2	339.4
1948:Q3	108.9	1957:Q3	145.0	1966:Q3	214.7	1975:Q3	263.9	1984:Q3	328.5
1948:Q4	110.6	1957:Q4	142.3	1966:Q4	221.8	1975:Q4	272.5	1984:Q4	329.5
1949:Q1	107.4	1958:Q1	139.7	1967:Q1	216.7	1976:Q1	280.8	1985:Q1	337.0
1949:Q2	107.0	1958:Q2	140.4	1967:Q2	212.8	1976:Q2	282.1	1985:Q2	338.3
1949:Q3	107.1	1958:Q3	145.5	1967:Q3	213.3	1976:Q3	283.2	1985:Q3	350.0
1949:Q4	111.9	1958:Q4	148.8	1967:Q4	217.4	1976:Q4	286.1	1985:Q4	346.9
1950:Q1	114.9	1959:Q1	153.3	1968:Q1	228.2	1977:Q1	295.7	1986:Q1	342.7
1950:Q2	113.8	1959:Q2	157.5	1968:Q2	227.1	1977:Q2	303.9	1986:Q2	344.5
1950:Q3	118.7	1959:Q3	159.0	1968:Q3	226.9	1977:Q3	309.1	1986:Q3	345.7
1950:Q4	122.7	1959:Q4	158.6	1968:Q4	229.2	1977:Q4	297.0	1986:Q4	360.6
1951:Q1	122.2	1960:Q1	158.4	1969:Q1	237.2	1978:Q1	300.2	1987:Q1	356.9
1951:Q2	124.0	1960:Q2	161.0	1969:Q2	234.9	1978:Q2	321.9	1987:Q2	370.2
1951:Q3	128.5	1960:Q3	158.3	1969:Q3	234.5	1978:Q3	315.6	1987:Q3	384.8
1951:Q4	123.4	1960:Q4	156.8	1969:Q4	236.5	1978:Q4	313.4	1987:Q4	391.8
1952:Q1	121.7	1961:Q1	159.6	1970:Q1	236.0	1979:Q1	321.4	1988:Q1	384.8
1952:Q2	125.1	1961:Q2	159.1	1970:Q2	232.7	1979:Q2	325.1	1988:Q2	383.4
1952:Q3	126.1	1961:Q3	162.8	1970:Q3	233.5	1979:Q3	321.8	1988:Q3	383.9
1952:Q4	128.1	1961:Q4	167.7	1970:Q4	238.0	1979:Q4	311.1	1988:Q4	398.5
1953:Q1	133.5	1962:Q1	169.4	1971:Q1	239.5	1980:Q1	313.9	1989:Q1	395.1
1953:Q2	128.6	1962:Q2	170.5	1971:Q2	241.2	1980:Q2	301.1	1989:Q2	392.2
1953:Q3	129.1	1962:Q3	171.5	1971:Q3	244.9	1980:Q3	287.0	1989:Q3	387.7
1953:Q4	127.9	1962:Q4	176.5	1971:Q4	252.1	1980:Q4	304.8	1989:Q4	382.7
1954:Q1	126.0	1963:Q1	177.9	1972:Q1	256.2	1981:Q1	317.3	1990:Q1	394.7
1954:Q2	127.4	1963:Q2	182.0	1972:Q2	262.0	1981:Q2	307.7	1990:Q2	393.8
1954:Q3	130.2	1963:Q3	189.9	1972:Q3	262.1	1981:Q3	335.0	1990:Q3	382.2
1954:Q4	132.1	1963:Q4	188.2	1972:Q4	266.1	1981:Q4	311.6	1990:Q4	381.9
1955:Q1	132.4	1964:Q1	191.6	1973:Q1	284.0	1982:Q1	311.8		
1955:Q2	140.3	1964:Q2	192.3	1973:Q2	278.2	1982:Q2	322.4		
1955:Q3	140.7	1964:Q3	195.3	1973:Q3	282.0	1982:Q3	321.0		
1955:Q4	141.5	1964:Q4	194.5	1973:Q4	294.5	1982:Q4	322.1		

TABLE 90

QUARTERLY GPO ESTIMATES: TRANSPORTATION
(BILLIONS OF 1987 DOLLARS, ANNUAL RATE)

1947:Q1	73.2	1956:Q1	71.4	1965:Q1	76.3	1974:Q1	112.4	1983:Q1	124.2
1947:Q2	77.1	1956:Q2	71.8	1965:Q2	84.9	1974:Q2	110.4	1983:Q2	123.7
1947:Q3	74.5	1956:Q3	69.3	1965:Q3	82.4	1974:Q3	108.6	1983:Q3	130.3
1947:Q4	73.9	1956:Q4	68.5	1965:Q4	89.1	1974:Q4	110.1	1983:Q4	131.8
1948:Q1	75.6	1957:Q1	70.1	1966:Q1	86.4	1975:Q1	104.6	1984:Q1	135.0
1948:Q2	72.8	1957:Q2	69.3	1966:Q2	93.9	1975:Q2	95.5	1984:Q2	137.3
1948:Q3	68.7	1957:Q3	69.7	1966:Q3	87.2	1975:Q3	106.3	1984:Q3	137.6
1948:Q4	67.0	1957:Q4	69.3	1966:Q4	92.8	1975:Q4	103.8	1984:Q4	136.3
1949:Q1	65.3	1958:Q1	65.8	1967:Q1	90.8	1976:Q1	109.8	1985:Q1	135.7
1949:Q2	60.7	1958:Q2	63.8	1967:Q2	88.4	1976:Q2	108.5	1985:Q2	138.4
1949:Q3	61.2	1958:Q3	64.5	1967:Q3	91.2	1976:Q3	114.6	1985:Q3	136.4
1949:Q4	60.1	1958:Q4	63.6	1967:Q4	87.1	1976:Q4	109.7	1985:Q4	138.8
1950:Q1	58.4	1959:Q1	68.9	1968:Q1	92.6	1977:Q1	112.5	1986:Q1	135.9
1950:Q2	61.8	1959:Q2	66.3	1968:Q2	92.0	1977:Q2	116.0	1986:Q2	141.9
1950:Q3	65.8	1959:Q3	69.7	1968:Q3	95.3	1977:Q3	117.5	1986:Q3	143.2
1950:Q4	72.2	1959:Q4	65.5	1968:Q4	93.2	1977:Q4	122.6	1986:Q4	149.5
1951:Q1	67.5	1960:Q1	65.1	1969:Q1	97.4	1978:Q1	112.8	1987:Q1	150.4
1951:Q2	72.9	1960:Q2	72.6	1969:Q2	94.7	1978:Q2	122.9	1987:Q2	156.7
1951:Q3	68.2	1960:Q3	64.1	1969:Q3	98.1	1978:Q3	124.6	1987:Q3	148.7
1951:Q4	71.3	1960:Q4	71.5	1969:Q4	96.7	1978:Q4	124.2	1987:Q4	155.5
1952:Q1	68.7	1961:Q1	65.6	1970:Q1	100.5	1979:Q1	129.6	1988:Q1	147.0
1952:Q2	69.7	1961:Q2	67.6	1970:Q2	89.1	1979:Q2	125.2	1988:Q2	151.7
1952:Q3	66.0	1961:Q3	69.0	1970:Q3	102.3	1979:Q3	123.8	1988:Q3	153.1
1952:Q4	65.9	1961:Q4	69.3	1970:Q4	90.2	1979:Q4	126.8	1988:Q4	150.1
1953:Q1	69.3	1962:Q1	71.7	1971:Q1	89.1	1980:Q1	122.6	1989:Q1	155.1
1953:Q2	66.5	1962:Q2	68.6	1971:Q2	99.0	1980:Q2	120.6	1989:Q2	151.9
1953:Q3	67.4	1962:Q3	71.7	1971:Q3	92.5	1980:Q3	114.5	1989:Q3	157.4
1953:Q4	65.3	1962:Q4	70.4	1971:Q4	99.3	1980:Q4	123.1	1989:Q4	155.1
1954:Q1	63.3	1963:Q1	73.6	1972:Q1	97.9	1981:Q1	117.1	1990:Q1	161.0
1954:Q2	60.9	1963:Q2	73.9	1972:Q2	104.8	1981:Q2	115.1	1990:Q2	163.7
1954:Q3	63.6	1963:Q3	75.3	1972:Q3	100.6	1981:Q3	119.0	1990:Q3	160.3
1954:Q4	62.1	1963:Q4	75.0	1972:Q4	106.6	1981:Q4	114.6	1990:Q4	158.8
1955:Q1	64.3	1964:Q1	76.4	1973:Q1	106.1	1982:Q1	116.0		
1955:Q2	67.5	1964:Q2	74.5	1973:Q2	109.9	1982:Q2	113.3		
1955:Q3	69.2	1964:Q3	78.8	1973:Q3	106.8	1982:Q3	119.7		
1955:Q4	70.6	1964:Q4	76.6	1973:Q4	113.9	1982:Q4	113.2		

TABLE 91

QUARTERLY GPO ESTIMATES: COMMUNICATIONS
(BILLIONS OF 1987 DOLLARS, ANNUAL RATE)

1947:Q1	9.5	1956:Q1	18.0	1965:Q1	31.0	1974:Q1	61.0	1983:Q1	105.4
1947:Q2	7.8	1956:Q2	18.0	1965:Q2	31.1	1974:Q2	62.7	1983:Q2	109.7
1947:Q3	9.8	1956:Q3	18.5	1965:Q3	32.1	1974:Q3	63.1	1983:Q3	103.9
1947:Q4	10.5	1956:Q4	18.7	1965:Q4	33.1	1974:Q4	65.0	1983:Q4	111.7
1948:Q1	10.9	1957:Q1	19.4	1966:Q1	33.7	1975:Q1	64.2	1984:Q1	118.3
1948:Q2	11.0	1957:Q2	19.7	1966:Q2	34.4	1975:Q2	65.2	1984:Q2	119.0
1948:Q3	10.4	1957:Q3	19.7	1966:Q3	35.4	1975:Q3	66.8	1984:Q3	114.9
1948:Q4	10.8	1957:Q4	20.0	1966:Q4	35.7	1975:Q4	66.1	1984:Q4	113.1
1949:Q1	10.9	1958:Q1	20.1	1967:Q1	36.4	1976:Q1	67.2	1985:Q1	115.0
1949:Q2	11.5	1958:Q2	20.2	1967:Q2	37.1	1976:Q2	68.3	1985:Q2	115.9
1949:Q3	11.4	1958:Q3	20.4	1967:Q3	37.9	1976:Q3	69.5	1985:Q3	116.8
1949:Q4	11.2	1958:Q4	20.9	1967:Q4	38.2	1976:Q4	71.0	1985:Q4	116.2
1950:Q1	11.5	1959:Q1	21.5	1968:Q1	38.9	1977:Q1	71.0	1986:Q1	118.7
1950:Q2	11.7	1959:Q2	21.9	1968:Q2	38.9	1977:Q2	73.4	1986:Q2	117.4
1950:Q3	12.2	1959:Q3	21.9	1968:Q3	40.8	1977:Q3	73.4	1986:Q3	117.1
1950:Q4	12.1	1959:Q4	22.1	1968:Q4	42.4	1977:Q4	76.2	1986:Q4	118.4
1951:Q1	12.7	1960:Q1	22.4	1969:Q1	43.6	1978:Q1	79.1	1987:Q1	122.7
1951:Q2	13.1	1960:Q2	23.0	1969:Q2	44.3	1978:Q2	80.5	1987:Q2	129.4
1951:Q3	13.7	1960:Q3	23.6	1969:Q3	44.5	1978:Q3	81.7	1987:Q3	130.5
1951:Q4	13.8	1960:Q4	23.6	1969:Q4	45.3	1978:Q4	81.5	1987:Q4	128.1
1952:Q1	13.8	1961:Q1	23.8	1970:Q1	46.5	1979:Q1	82.6	1988:Q1	128.8
1952:Q2	13.5	1961:Q2	23.9	1970:Q2	48.2	1979:Q2	85.6	1988:Q2	133.4
1952:Q3	14.0	1961:Q3	24.2	1970:Q3	49.2	1979:Q3	88.0	1988:Q3	138.4
1952:Q4	14.7	1961:Q4	25.0	1970:Q4	50.4	1979:Q4	88.5	1988:Q4	139.8
1953:Q1	15.1	1962:Q1	25.5	1971:Q1	51.2	1980:Q1	90.7	1989:Q1	133.7
1953:Q2	15.6	1962:Q2	25.7	1971:Q2	51.2	1980:Q2	91.8	1989:Q2	135.3
1953:Q3	15.5	1962:Q3	26.1	1971:Q3	50.2	1980:Q3	96.4	1989:Q3	132.7
1953:Q4	15.5	1962:Q4	26.2	1971:Q4	51.6	1980:Q4	98.7	1989:Q4	141.1
1954:Q1	15.4	1963:Q1	27.0	1972:Q1	54.6	1981:Q1	97.5	1990:Q1	140.1
1954:Q2	15.6	1963:Q2	27.4	1972:Q2	55.5	1981:Q2	97.0	1990:Q2	140.2
1954:Q3	16.0	1963:Q3	28.0	1972:Q3	56.3	1981:Q3	100.0	1990:Q3	140.4
1954:Q4	16.2	1963:Q4	28.3	1972:Q4	56.9	1981:Q4	100.6	1990:Q4	141.3
1955:Q1	16.6	1964:Q1	28.6	1973:Q1	58.0	1982:Q1	99.7		
1955:Q2	17.2	1964:Q2	29.3	1973:Q2	59.6	1982:Q2	100.6		
1955:Q3	17.7	1964:Q3	29.3	1973:Q3	61.4	1982:Q3	100.9		
1955:Q4	17.8	1964:Q4	30.1	1973:Q4	60.8	1982:Q4	103.2		

TABLE 92

QUARTERLY GPO ESTIMATES: E.G.A.S.S.
(BILLIONS OF 1987 DOLLARS, ANNUAL RATE)

1947:Q1	18.4	1956:Q1	40.3	1965:Q1	69.3	1974:Q1	118.6	1983:Q1	113.6
1947:Q2	18.4	1956:Q2	40.6	1965:Q2	68.1	1974:Q2	117.4	1983:Q2	127.3
1947:Q3	17.7	1956:Q3	40.6	1965:Q3	69.9	1974:Q3	115.4	1983:Q3	110.7
1947:Q4	19.0	1956:Q4	41.7	1965:Q4	70.4	1974:Q4	122.0	1983:Q4	116.1
1948:Q1	19.6	1957:Q1	42.1	1966:Q1	71.2	1975:Q1	123.9	1984:Q1	124.6
1948:Q2	20.1	1957:Q2	43.3	1966:Q2	74.2	1975:Q2	125.7	1984:Q2	129.2
1948:Q3	20.7	1957:Q3	44.1	1966:Q3	74.5	1975:Q3	122.8	1984:Q3	116.8
1948:Q4	20.9	1957:Q4	44.7	1966:Q4	74.9	1975:Q4	123.7	1984:Q4	128.3
1949:Q1	21.9	1958:Q1	44.7	1967:Q1	77.7	1976:Q1	122.7	1985:Q1	125.0
1949:Q2	22.9	1958:Q2	45.0	1967:Q2	74.4	1976:Q2	118.8	1985:Q2	128.7
1949:Q3	22.3	1958:Q3	45.3	1967:Q3	77.7	1976:Q3	127.8	1985:Q3	134.1
1949:Q4	22.8	1958:Q4	46.6	1967:Q4	79.9	1976:Q4	122.4	1985:Q4	127.0
1950:Q1	23.8	1959:Q1	48.4	1968:Q1	81.7	1977:Q1	120.7	1986:Q1	126.0
1950:Q2	23.8	1959:Q2	49.2	1968:Q2	84.2	1977:Q2	128.7	1986:Q2	131.3
1950:Q3	24.3	1959:Q3	49.9	1968:Q3	85.9	1977:Q3	121.7	1986:Q3	124.4
1950:Q4	25.9	1959:Q4	51.9	1968:Q4	87.5	1977:Q4	123.9	1986:Q4	124.4
1951:Q1	26.9	1960:Q1	52.4	1969:Q1	87.4	1978:Q1	124.2	1987:Q1	136.4
1951:Q2	27.6	1960:Q2	53.2	1969:Q2	91.2	1978:Q2	121.6	1987:Q2	140.3
1951:Q3	28.7	1960:Q3	54.5	1969:Q3	91.2	1978:Q3	122.0	1987:Q3	138.7
1951:Q4	30.1	1960:Q4	53.5	1969:Q4	90.9	1978:Q4	125.3	1987:Q4	144.1
1952:Q1	29.4	1961:Q1	55.1	1970:Q1	92.2	1979:Q1	126.7	1988:Q1	143.5
1952:Q2	30.0	1961:Q2	55.3	1970:Q2	93.6	1979:Q2	121.4	1988:Q2	146.7
1952:Q3	31.4	1961:Q3	56.6	1970:Q3	90.7	1979:Q3	121.6	1988:Q3	148.0
1952:Q4	31.1	1961:Q4	57.6	1970:Q4	94.2	1979:Q4	122.9	1988:Q4	147.2
1953:Q1	31.9	1962:Q1	58.3	1971:Q1	98.7	1980:Q1	117.8	1989:Q1	151.3
1953:Q2	33.3	1962:Q2	59.0	1971:Q2	99.0	1980:Q2	122.6	1989:Q2	151.7
1953:Q3	32.6	1962:Q3	58.0	1971:Q3	98.7	1980:Q3	127.3	1989:Q3	158.2
1953:Q4	34.0	1962:Q4	61.1	1971:Q4	100.1	1980:Q4	118.8	1989:Q4	149.6
1954:Q1	35.3	1963:Q1	61.2	1972:Q1	98.9	1981:Q1	121.8	1990:Q1	152.3
1954:Q2	35.6	1963:Q2	61.9	1972:Q2	97.2	1981:Q2	126.8	1990:Q2	163.8
1954:Q3	36.9	1963:Q3	62.5	1972:Q3	107.3	1981:Q3	116.0	1990:Q3	149.6
1954:Q4	36.9	1963:Q4	63.1	1972:Q4	105.4	1981:Q4	123.3	1990:Q4	153.6
1955:Q1	37.1	1964:Q1	64.6	1973:Q1	107.5	1982:Q1	118.9		
1955:Q2	37.3	1964:Q2	66.4	1973:Q2	118.9	1982:Q2	120.4		
1955:Q3	38.3	1964:Q3	67.2	1973:Q3	122.5	1982:Q3	116.5		
1955:Q4	38.9	1964:Q4	67.6	1973:Q4	114.0	1982:Q4	104.6		

TABLE 93

QUARTERLY GPO ESTIMATES: WHOLESALE TRADE
(BILLIONS OF 1987 DOLLARS, ANNUAL RATE)

1947:Q1	45.5	1956:Q1	64.0	1965:Q1	98.2	1974:Q1	149.0	1983:Q1	216.3
1947:Q2	45.0	1956:Q2	66.4	1965:Q2	100.9	1974:Q2	156.7	1983:Q2	223.9
1947:Q3	45.2	1956:Q3	67.9	1965:Q3	98.6	1974:Q3	143.6	1983:Q3	226.3
1947:Q4	46.7	1956:Q4	66.9	1965:Q4	102.6	1974:Q4	156.2	1983:Q4	232.1
1948:Q1	46.8	1957:Q1	68.0	1966:Q1	106.2	1975:Q1	154.3	1984:Q1	254.0
1948:Q2	46.6	1957:Q2	67.3	1966:Q2	104.9	1975:Q2	150.7	1984:Q2	255.2
1948:Q3	46.3	1957:Q3	67.7	1966:Q3	105.7	1975:Q3	155.9	1984:Q3	264.1
1948:Q4	46.6	1957:Q4	66.8	1966:Q4	108.2	1975:Q4	158.9	1984:Q4	269.1
1949:Q1	46.7	1958:Q1	65.0	1967:Q1	110.1	1976:Q1	162.0	1985:Q1	265.4
1949:Q2	46.0	1958:Q2	65.9	1967:Q2	110.2	1976:Q2	157.2	1985:Q2	269.9
1949:Q3	46.9	1958:Q3	69.7	1967:Q3	112.4	1976:Q3	159.8	1985:Q3	277.5
1949:Q4	46.6	1958:Q4	71.6	1967:Q4	114.1	1976:Q4	160.9	1985:Q4	281.3
1950:Q1	50.1	1959:Q1	72.7	1968:Q1	115.2	1977:Q1	162.5	1986:Q1	301.3
1950:Q2	49.9	1959:Q2	75.6	1968:Q2	119.6	1977:Q2	174.6	1986:Q2	305.1
1950:Q3	54.1	1959:Q3	75.3	1968:Q3	121.8	1977:Q3	179.8	1986:Q3	318.5
1950:Q4	52.7	1959:Q4	74.6	1968:Q4	121.6	1977:Q4	165.0	1986:Q4	307.3
1951:Q1	53.6	1960:Q1	77.2	1969:Q1	122.3	1978:Q1	178.9	1987:Q1	306.4
1951:Q2	52.8	1960:Q2	75.8	1969:Q2	124.0	1978:Q2	184.6	1987:Q2	297.1
1951:Q3	52.2	1960:Q3	76.5	1969:Q3	124.2	1978:Q3	189.5	1987:Q3	304.7
1951:Q4	53.9	1960:Q4	76.5	1969:Q4	127.1	1978:Q4	191.6	1987:Q4	306.9
1952:Q1	54.1	1961:Q1	75.8	1970:Q1	125.4	1979:Q1	193.4	1988:Q1	308.5
1952:Q2	54.6	1961:Q2	78.1	1970:Q2	125.6	1979:Q2	197.7	1988:Q2	311.5
1952:Q3	56.1	1961:Q3	79.9	1970:Q3	127.6	1979:Q3	197.2	1988:Q3	307.8
1952:Q4	56.5	1961:Q4	81.7	1970:Q4	129.1	1979:Q4	196.3	1988:Q4	325.9
1953:Q1	56.6	1962:Q1	82.6	1971:Q1	131.3	1980:Q1	193.4	1989:Q1	327.1
1953:Q2	57.6	1962:Q2	83.4	1971:Q2	131.6	1980:Q2	186.5	1989:Q2	334.7
1953:Q3	56.3	1962:Q3	85.1	1971:Q3	136.8	1980:Q3	186.9	1989:Q3	330.4
1953:Q4	54.8	1962:Q4	84.8	1971:Q4	138.5	1980:Q4	197.4	1989:Q4	325.7
1954:Q1	55.6	1963:Q1	85.5	1972:Q1	142.5	1981:Q1	202.3	1990:Q1	326.6
1954:Q2	55.5	1963:Q2	87.0	1972:Q2	144.2	1981:Q2	202.2	1990:Q2	330.8
1954:Q3	56.2	1963:Q3	88.2	1972:Q3	148.1	1981:Q3	205.5	1990:Q3	315.8
1954:Q4	59.8	1963:Q4	89.2	1972:Q4	149.6	1981:Q4	222.8	1990:Q4	321.4
1955:Q1	60.9	1964:Q1	91.6	1973:Q1	153.6	1982:Q1	215.0		
1955:Q2	62.7	1964:Q2	92.6	1973:Q2	146.2	1982:Q2	221.6		
1955:Q3	64.4	1964:Q3	93.6	1973:Q3	149.3	1982:Q3	218.2		
1955:Q4	64.7	1964:Q4	93.8	1973:Q4	156.8	1982:Q4	220.2		

TABLE 94

QUARTERLY GPO ESTIMATES: RETAIL TRADE
(BILLIONS OF 1987 DOLLARS, ANNUAL RATE)

1947:Q1	119.2	1956:Q1	163.0	1965:Q1	216.0	1974:Q1	289.4	1983:Q1	353.7
1947:Q2	118.6	1956:Q2	164.2	1965:Q2	218.0	1974:Q2	287.7	1983:Q2	362.7
1947:Q3	119.3	1956:Q3	166.3	1965:Q3	221.8	1974:Q3	284.1	1983:Q3	371.0
1947:Q4	122.0	1956:Q4	165.8	1965:Q4	226.2	1974:Q4	279.7	1983:Q4	379.2
1948:Q1	120.9	1957:Q1	167.3	1966:Q1	229.3	1975:Q1	282.5	1984:Q1	387.6
1948:Q2	122.8	1957:Q2	167.2	1966:Q2	231.0	1975:Q2	285.2	1984:Q2	398.1
1948:Q3	123.6	1957:Q3	168.7	1966:Q3	232.0	1975:Q3	289.2	1984:Q3	402.2
1948:Q4	125.2	1957:Q4	166.7	1966:Q4	232.3	1975:Q4	293.1	1984:Q4	409.5
1949:Q1	126.5	1958:Q1	163.5	1967:Q1	232.0	1976:Q1	301.1	1985:Q1	411.1
1949:Q2	127.7	1958:Q2	164.4	1967:Q2	232.6	1976:Q2	303.0	1985:Q2	418.5
1949:Q3	128.7	1958:Q3	166.9	1967:Q3	234.9	1976:Q3	306.5	1985:Q3	426.5
1949:Q4	130.5	1958:Q4	171.4	1967:Q4	236.3	1976:Q4	309.2	1985:Q4	436.3
1950:Q1	136.4	1959:Q1	173.2	1968:Q1	242.5	1977:Q1	310.7	1986:Q1	453.3
1950:Q2	139.8	1959:Q2	176.0	1968:Q2	245.3	1977:Q2	315.8	1986:Q2	455.9
1950:Q3	141.6	1959:Q3	176.1	1968:Q3	247.7	1977:Q3	322.9	1986:Q3	459.9
1950:Q4	140.6	1959:Q4	177.9	1968:Q4	246.7	1977:Q4	327.5	1986:Q4	451.7
1951:Q1	143.6	1960:Q1	178.3	1969:Q1	246.5	1978:Q1	332.4	1987:Q1	443.4
1951:Q2	138.2	1960:Q2	180.3	1969:Q2	247.4	1978:Q2	340.6	1987:Q2	441.2
1951:Q3	138.7	1960:Q3	178.6	1969:Q3	247.7	1978:Q3	340.7	1987:Q3	442.4
1951:Q4	139.3	1960:Q4	176.7	1969:Q4	246.8	1978:Q4	343.9	1987:Q4	444.1
1952:Q1	138.1	1961:Q1	176.5	1970:Q1	248.3	1979:Q1	341.8	1988:Q1	456.8
1952:Q2	142.7	1961:Q2	176.6	1970:Q2	250.0	1979:Q2	338.0	1988:Q2	464.0
1952:Q3	143.1	1961:Q3	177.5	1970:Q3	251.3	1979:Q3	334.5	1988:Q3	471.2
1952:Q4	148.6	1961:Q4	180.6	1970:Q4	251.3	1979:Q4	332.0	1988:Q4	477.5
1953:Q1	148.7	1962:Q1	185.8	1971:Q1	254.9	1980:Q1	325.7	1989:Q1	481.9
1953:Q2	149.9	1962:Q2	189.1	1971:Q2	256.9	1980:Q2	318.0	1989:Q2	482.9
1953:Q3	149.6	1962:Q3	191.0	1971:Q3	263.0	1980:Q3	321.1	1989:Q3	486.1
1953:Q4	147.0	1962:Q4	192.4	1971:Q4	267.3	1980:Q4	322.6	1989:Q4	484.1
1954:Q1	146.2	1963:Q1	194.1	1972:Q1	271.0	1981:Q1	331.6	1990:Q1	481.3
1954:Q2	147.0	1963:Q2	195.2	1972:Q2	274.8	1981:Q2	332.1	1990:Q2	481.0
1954:Q3	151.9	1963:Q3	196.4	1972:Q3	280.1	1981:Q3	334.0	1990:Q3	474.5
1954:Q4	154.5	1963:Q4	198.8	1972:Q4	287.6	1981:Q4	330.0	1990:Q4	475.7
1955:Q1	160.1	1964:Q1	202.8	1973:Q1	294.8	1982:Q1	331.7		
1955:Q2	160.7	1964:Q2	206.3	1973:Q2	296.6	1982:Q2	335.9		
1955:Q3	163.0	1964:Q3	210.6	1973:Q3	297.9	1982:Q3	338.6		
1955:Q4	163.8	1964:Q4	212.9	1973:Q4	297.1	1982:Q4	346.3		

TABLE 95

QUARTERLY GPO ESTIMATES: F.I.R.E.
(BILLIONS OF 1987 DOLLARS, ANNUAL RATE)

1947:Q1	144.9	1956:Q1	236.3	1965:Q1	363.4	1974:Q1	539.5	1983:Q1	716.9
1947:Q2	146.1	1956:Q2	239.2	1965:Q2	368.7	1974:Q2	543.7	1983:Q2	723.9
1947:Q3	147.7	1956:Q3	242.4	1965:Q3	373.5	1974:Q3	547.6	1983:Q3	731.1
1947:Q4	149.7	1956:Q4	246.1	1965:Q4	378.1	1974:Q4	548.7	1983:Q4	739.3
1948:Q1	151.5	1957:Q1	250.1	1966:Q1	381.7	1975:Q1	548.6	1984:Q1	750.2
1948:Q2	153.2	1957:Q2	253.5	1966:Q2	385.2	1975:Q2	550.7	1984:Q2	760.4
1948:Q3	154.8	1957:Q3	256.4	1966:Q3	388.8	1975:Q3	554.5	1984:Q3	766.5
1948:Q4	156.1	1957:Q4	258.3	1966:Q4	392.6	1975:Q4	560.8	1984:Q4	770.5
1949:Q1	157.4	1958:Q1	259.5	1967:Q1	396.8	1976:Q1	567.4	1985:Q1	775.5
1949:Q2	158.9	1958:Q2	261.5	1967:Q2	401.1	1976:Q2	573.4	1985:Q2	777.2
1949:Q3	160.9	1958:Q3	264.4	1967:Q3	405.4	1976:Q3	578.4	1985:Q3	776.9
1949:Q4	163.6	1958:Q4	268.4	1967:Q4	409.4	1976:Q4	582.9	1985:Q4	776.5
1950:Q1	166.8	1959:Q1	272.7	1968:Q1	413.6	1977:Q1	587.7	1986:Q1	774.3
1950:Q2	169.7	1959:Q2	277.6	1968:Q2	419.1	1977:Q2	592.3	1986:Q2	774.5
1950:Q3	172.5	1959:Q3	282.2	1968:Q3	425.3	1977:Q3	599.4	1986:Q3	776.4
1950:Q4	174.8	1959:Q4	286.4	1968:Q4	432.4	1977:Q4	606.3	1986:Q4	782.7
1951:Q1	176.7	1960:Q1	290.2	1969:Q1	441.1	1978:Q1	615.7	1987:Q1	793.6
1951:Q2	179.0	1960:Q2	293.5	1969:Q2	447.3	1978:Q2	626.2	1987:Q2	804.7
1951:Q3	181.5	1960:Q3	296.5	1969:Q3	451.4	1978:Q3	635.9	1987:Q3	814.8
1951:Q4	184.7	1960:Q4	299.2	1969:Q4	453.5	1978:Q4	645.7	1987:Q4	825.7
1952:Q1	187.7	1961:Q1	301.8	1970:Q1	453.6	1979:Q1	654.0	1988:Q1	833.8
1952:Q2	190.9	1961:Q2	304.9	1970:Q2	455.5	1979:Q2	663.6	1988:Q2	843.5
1952:Q3	194.0	1961:Q3	308.5	1970:Q3	458.8	1979:Q3	672.0	1988:Q3	852.1
1952:Q4	196.8	1961:Q4	312.7	1970:Q4	464.4	1979:Q4	679.4	1988:Q4	860.1
1953:Q1	199.4	1962:Q1	317.1	1971:Q1	470.3	1980:Q1	686.9	1989:Q1	867.0
1953:Q2	201.9	1962:Q2	321.7	1971:Q2	476.9	1980:Q2	690.4	1989:Q2	870.4
1953:Q3	204.3	1962:Q3	325.7	1971:Q3	483.1	1980:Q3	693.8	1989:Q3	870.3
1953:Q4	206.6	1962:Q4	329.1	1971:Q4	488.0	1980:Q4	699.8	1989:Q4	868.9
1954:Q1	208.8	1963:Q1	332.1	1972:Q1	493.1	1981:Q1	703.2	1990:Q1	866.0
1954:Q2	211.5	1963:Q2	335.2	1972:Q2	497.4	1981:Q2	703.0	1990:Q2	866.2
1954:Q3	214.8	1963:Q3	338.4	1972:Q3	503.6	1981:Q3	706.5	1990:Q3	869.1
1954:Q4	218.7	1963:Q4	341.6	1972:Q4	509.9	1981:Q4	706.7	1990:Q4	874.5
1955:Q1	223.3	1964:Q1	344.9	1973:Q1	516.2	1982:Q1	703.7		
1955:Q2	227.3	1964:Q2	348.5	1973:Q2	521.8	1982:Q2	707.3		
1955:Q3	230.7	1964:Q3	352.7	1973:Q3	527.7	1982:Q3	709.6		
1955:Q4	233.7	1964:Q4	357.6	1973:Q4	534.2	1982:Q4	713.8		

TABLE 96

QUARTERLY GPO ESTIMATES: SERVICES
(BILLIONS OF 1987 DOLLARS, ANNUAL RATE)

1947:Q1	163.1	1956:Q1	219.1	1965:Q1	327.0	1974:Q1	481.3	1983:Q1	637.7
1947:Q2	178.8	1956:Q2	222.6	1965:Q2	331.6	1974:Q2	480.3	1983:Q2	644.0
1947:Q3	176.0	1956:Q3	224.0	1965:Q3	333.3	1974:Q3	482.1	1983:Q3	650.9
1947:Q4	175.4	1956:Q4	226.9	1965:Q4	339.8	1974:Q4	481.6	1983:Q4	660.8
1948:Q1	179.1	1957:Q1	228.7	1966:Q1	343.4	1975:Q1	485.6	1984:Q1	670.4
1948:Q2	176.5	1957:Q2	233.3	1966:Q2	350.3	1975:Q2	485.5	1984:Q2	681.2
1948:Q3	180.0	1957:Q3	235.8	1966:Q3	354.7	1975:Q3	489.2	1984:Q3	692.1
1948:Q4	178.6	1957:Q4	236.2	1966:Q4	358.1	1975:Q4	492.0	1984:Q4	702.4
1949:Q1	178.1	1958:Q1	239.0	1967:Q1	363.6	1976:Q1	500.2	1985:Q1	709.1
1949:Q2	178.0	1958:Q2	241.7	1967:Q2	366.3	1976:Q2	505.8	1985:Q2	717.4
1949:Q3	177.5	1958:Q3	240.8	1967:Q3	368.9	1976:Q3	513.0	1985:Q3	726.0
1949:Q4	181.0	1958:Q4	244.1	1967:Q4	370.2	1976:Q4	517.9	1985:Q4	730.1
1950:Q1	182.7	1959:Q1	248.3	1968:Q1	375.0	1977:Q1	525.4	1986:Q1	741.9
1950:Q2	184.0	1959:Q2	252.1	1968:Q2	377.8	1977:Q2	532.8	1986:Q2	745.5
1950:Q3	186.2	1959:Q3	255.7	1968:Q3	382.1	1977:Q3	542.5	1986:Q3	754.4
1950:Q4	188.4	1959:Q4	260.4	1968:Q4	386.8	1977:Q4	550.8	1986:Q4	759.2
1951:Q1	189.4	1960:Q1	260.3	1969:Q1	391.4	1978:Q1	560.4	1987:Q1	769.4
1951:Q2	189.7	1960:Q2	263.6	1969:Q2	395.7	1978:Q2	570.1	1987:Q2	774.9
1951:Q3	189.4	1960:Q3	263.3	1969:Q3	401.2	1978:Q3	576.5	1987:Q3	786.4
1951:Q4	189.9	1960:Q4	266.4	1969:Q4	405.9	1978:Q4	582.7	1987:Q4	799.4
1952:Q1	193.0	1961:Q1	269.4	1970:Q1	406.0	1979:Q1	587.7	1988:Q1	797.7
1952:Q2	192.7	1961:Q2	271.3	1970:Q2	409.9	1979:Q2	587.2	1988:Q2	811.1
1952:Q3	193.1	1961:Q3	275.5	1970:Q3	410.5	1979:Q3	595.4	1988:Q3	817.2
1952:Q4	193.4	1961:Q4	278.9	1970:Q4	411.6	1979:Q4	596.6	1988:Q4	828.2
1953:Q1	194.8	1962:Q1	281.6	1971:Q1	414.7	1980:Q1	601.3	1989:Q1	835.7
1953:Q2	196.5	1962:Q2	286.8	1971:Q2	415.5	1980:Q2	607.1	1989:Q2	846.3
1953:Q3	198.0	1962:Q3	289.3	1971:Q3	420.3	1980:Q3	610.2	1989:Q3	848.2
1953:Q4	201.2	1962:Q4	292.8	1971:Q4	424.6	1980:Q4	612.7	1989:Q4	857.1
1954:Q1	201.1	1963:Q1	297.0	1972:Q1	431.6	1981:Q1	622.5	1990:Q1	863.4
1954:Q2	201.4	1963:Q2	298.5	1972:Q2	438.9	1981:Q2	620.6	1990:Q2	871.8
1954:Q3	201.3	1963:Q3	303.1	1972:Q3	447.3	1981:Q3	626.5	1990:Q3	877.3
1954:Q4	204.4	1963:Q4	305.6	1972:Q4	455.0	1981:Q4	623.2	1990:Q4	879.4
1955:Q1	206.6	1964:Q1	312.4	1973:Q1	462.7	1982:Q1	624.8		
1955:Q2	208.6	1964:Q2	316.9	1973:Q2	469.4	1982:Q2	625.0		
1955:Q3	215.5	1964:Q3	322.4	1973:Q3	474.8	1982:Q3	630.8		
1955:Q4	216.9	1964:Q4	326.3	1973:Q4	477.6	1982:Q4	631.6		

TABLE 97

QUARTERLY GPO ESTIMATES: GENERAL GOVERNMENT
(BILLIONS OF 1987 DOLLARS, ANNUAL RATE)

1947:Q1	197.4	1956:Q1	259.4	1965:Q1	320.2	1974:Q1	399.7	1983:Q1	445.3
1947:Q2	160.3	1956:Q2	258.8	1965:Q2	322.5	1974:Q2	402.3	1983:Q2	447.5
1947:Q3	170.1	1956:Q3	261.8	1965:Q3	328.0	1974:Q3	402.8	1983:Q3	448.0
1947:Q4	176.7	1956:Q4	264.3	1965:Q4	333.7	1974:Q4	404.6	1983:Q4	448.8
1948:Q1	166.8	1957:Q1	264.1	1966:Q1	339.6	1975:Q1	406.5	1984:Q1	450.1
1948:Q2	170.8	1957:Q2	264.5	1966:Q2	346.3	1975:Q2	407.3	1984:Q2	450.2
1948:Q3	176.0	1957:Q3	267.2	1966:Q3	354.1	1975:Q3	407.7	1984:Q3	452.5
1948:Q4	178.9	1957:Q4	265.0	1966:Q4	362.3	1975:Q4	408.3	1984:Q4	454.4
1949:Q1	183.0	1958:Q1	262.0	1967:Q1	368.1	1976:Q1	408.3	1985:Q1	457.4
1949:Q2	183.8	1958:Q2	263.4	1967:Q2	368.6	1976:Q2	409.5	1985:Q2	460.5
1949:Q3	185.1	1958:Q3	268.5	1967:Q3	371.3	1976:Q3	410.7	1985:Q3	463.8
1949:Q4	183.4	1958:Q4	270.4	1967:Q4	375.4	1976:Q4	413.0	1985:Q4	465.5
1950:Q1	180.4	1959:Q1	268.3	1968:Q1	378.1	1977:Q1	413.7	1986:Q1	466.2
1950:Q2	184.0	1959:Q2	266.5	1968:Q2	384.3	1977:Q2	414.0	1986:Q2	468.5
1950:Q3	191.2	1959:Q3	268.8	1968:Q3	387.5	1977:Q3	416.1	1986:Q3	471.0
1950:Q4	207.7	1959:Q4	270.3	1968:Q4	386.0	1977:Q4	418.6	1986:Q4	473.5
1951:Q1	225.3	1960:Q1	272.1	1969:Q1	388.4	1978:Q1	420.2	1987:Q1	475.1
1951:Q2	239.0	1960:Q2	276.6	1969:Q2	392.4	1978:Q2	423.8	1987:Q2	477.1
1951:Q3	259.9	1960:Q3	279.5	1969:Q3	395.1	1978:Q3	425.6	1987:Q3	480.1
1951:Q4	264.1	1960:Q4	279.0	1969:Q4	395.7	1978:Q4	427.2	1987:Q4	482.4
1952:Q1	264.2	1961:Q1	283.0	1970:Q1	394.4	1979:Q1	429.6	1988:Q1	484.2
1952:Q2	270.3	1961:Q2	285.5	1970:Q2	389.9	1979:Q2	432.4	1988:Q2	485.8
1952:Q3	272.4	1961:Q3	287.0	1970:Q3	392.2	1979:Q3	433.3	1988:Q3	488.8
1952:Q4	268.0	1961:Q4	293.9	1970:Q4	392.5	1979:Q4	434.7	1988:Q4	490.8
1953:Q1	267.2	1962:Q1	298.0	1971:Q1	392.1	1980:Q1	437.0	1989:Q1	492.7
1953:Q2	268.7	1962:Q2	297.3	1971:Q2	391.1	1980:Q2	440.9	1989:Q2	494.7
1953:Q3	267.9	1962:Q3	298.8	1971:Q3	392.0	1980:Q3	442.1	1989:Q3	498.5
1953:Q4	265.5	1962:Q4	299.1	1971:Q4	392.3	1980:Q4	441.2	1989:Q4	501.7
1954:Q1	261.9	1963:Q1	299.4	1972:Q1	391.2	1981:Q1	441.8	1990:Q1	505.2
1954:Q2	260.6	1963:Q2	303.9	1972:Q2	388.5	1981:Q2	445.2	1990:Q2	508.7
1954:Q3	260.9	1963:Q3	307.8	1972:Q3	392.0	1981:Q3	444.5	1990:Q3	511.8
1954:Q4	261.0	1963:Q4	308.7	1972:Q4	394.4	1981:Q4	444.2	1990:Q4	513.5
1955:Q1	259.9	1964:Q1	310.0	1973:Q1	394.0	1982:Q1	444.1		
1955:Q2	257.0	1964:Q2	314.6	1973:Q2	393.8	1982:Q2	445.0		
1955:Q3	256.4	1964:Q3	317.5	1973:Q3	393.7	1982:Q3	444.2		
1955:Q4	259.8	1964:Q4	319.0	1973:Q4	395.7	1982:Q4	443.4		

TABLE 98

QUARTERLY GPO ESTIMATES: GOVERNMENT ENTERPRISE
(BILLIONS OF 1987 DOLLARS, ANNUAL RATE)

1947:Q1	29.6	1956:Q1	33.9	1965:Q1	45.0	1974:Q1	56.3	1983:Q1	63.6
1947:Q2	32.0	1956:Q2	33.8	1965:Q2	46.2	1974:Q2	57.0	1983:Q2	65.0
1947:Q3	30.8	1956:Q3	33.6	1965:Q3	46.8	1974:Q3	57.0	1983:Q3	65.8
1947:Q4	31.0	1956:Q4	34.2	1965:Q4	47.9	1974:Q4	57.0	1983:Q4	66.1
1948:Q1	32.2	1957:Q1	33.9	1966:Q1	49.1	1975:Q1	57.5	1984:Q1	65.2
1948:Q2	32.4	1957:Q2	34.0	1966:Q2	49.7	1975:Q2	57.7	1984:Q2	65.2
1948:Q3	32.7	1957:Q3	35.1	1966:Q3	49.7	1975:Q3	57.8	1984:Q3	65.5
1948:Q4	32.8	1957:Q4	35.1	1966:Q4	50.3	1975:Q4	57.6	1984:Q4	64.7
1949:Q1	32.9	1958:Q1	34.7	1967:Q1	51.1	1976:Q1	58.0	1985:Q1	65.1
1949:Q2	32.3	1958:Q2	34.3	1967:Q2	50.8	1976:Q2	58.2	1985:Q2	65.4
1949:Q3	32.6	1958:Q3	34.9	1967:Q3	51.1	1976:Q3	58.4	1985:Q3	66.2
1949:Q4	31.3	1958:Q4	35.5	1967:Q4	50.8	1976:Q4	58.5	1985:Q4	66.1
1950:Q1	31.5	1959:Q1	35.2	1968:Q1	51.2	1977:Q1	59.0	1986:Q1	66.5
1950:Q2	32.4	1959:Q2	35.6	1968:Q2	51.6	1977:Q2	60.0	1986:Q2	66.7
1950:Q3	30.4	1959:Q3	36.3	1968:Q3	50.6	1977:Q3	60.5	1986:Q3	66.6
1950:Q4	33.5	1959:Q4	36.9	1968:Q4	51.2	1977:Q4	60.9	1986:Q4	66.7
1951:Q1	31.2	1960:Q1	37.3	1969:Q1	51.6	1978:Q1	62.7	1987:Q1	66.0
1951:Q2	33.0	1960:Q2	38.3	1969:Q2	51.5	1978:Q2	64.2	1987:Q2	66.5
1951:Q3	34.3	1960:Q3	38.2	1969:Q3	51.9	1978:Q3	64.7	1987:Q3	67.0
1951:Q4	33.8	1960:Q4	38.1	1969:Q4	52.8	1978:Q4	64.6	1987:Q4	67.3
1952:Q1	34.3	1961:Q1	38.9	1970:Q1	51.6	1979:Q1	65.5	1988:Q1	67.4
1952:Q2	34.2	1961:Q2	38.5	1970:Q2	51.7	1979:Q2	66.2	1988:Q2	68.3
1952:Q3	35.2	1961:Q3	38.5	1970:Q3	52.7	1979:Q3	66.4	1988:Q3	69.1
1952:Q4	34.6	1961:Q4	39.2	1970:Q4	52.5	1979:Q4	66.3	1988:Q4	69.2
1953:Q1	34.7	1962:Q1	39.3	1971:Q1	52.4	1980:Q1	67.3	1989:Q1	69.0
1953:Q2	34.4	1962:Q2	40.0	1971:Q2	52.8	1980:Q2	69.2	1989:Q2	69.5
1953:Q3	34.8	1962:Q3	40.5	1971:Q3	53.6	1980:Q3	69.6	1989:Q3	70.7
1953:Q4	34.3	1962:Q4	39.9	1971:Q4	53.6	1980:Q4	68.4	1989:Q4	70.8
1954:Q1	33.7	1963:Q1	40.3	1972:Q1	53.8	1981:Q1	69.1	1990:Q1	70.8
1954:Q2	33.2	1963:Q2	41.3	1972:Q2	54.1	1981:Q2	69.1	1990:Q2	71.9
1954:Q3	33.4	1963:Q3	42.0	1972:Q3	54.6	1981:Q3	67.5	1990:Q3	72.5
1954:Q4	34.0	1963:Q4	41.9	1972:Q4	54.5	1981:Q4	65.7	1990:Q4	72.7
1955:Q1	34.3	1964:Q1	42.7	1973:Q1	55.4	1982:Q1	63.8		
1955:Q2	33.5	1964:Q2	43.4	1973:Q2	55.8	1982:Q2	63.4		
1955:Q3	34.0	1964:Q3	43.6	1973:Q3	55.4	1982:Q3	62.5		
1955:Q4	34.5	1964:Q4	44.4	1973:Q4	55.5	1982:Q4	62.7		

Fig. 1. Estimated Spectrum of Employment Growth

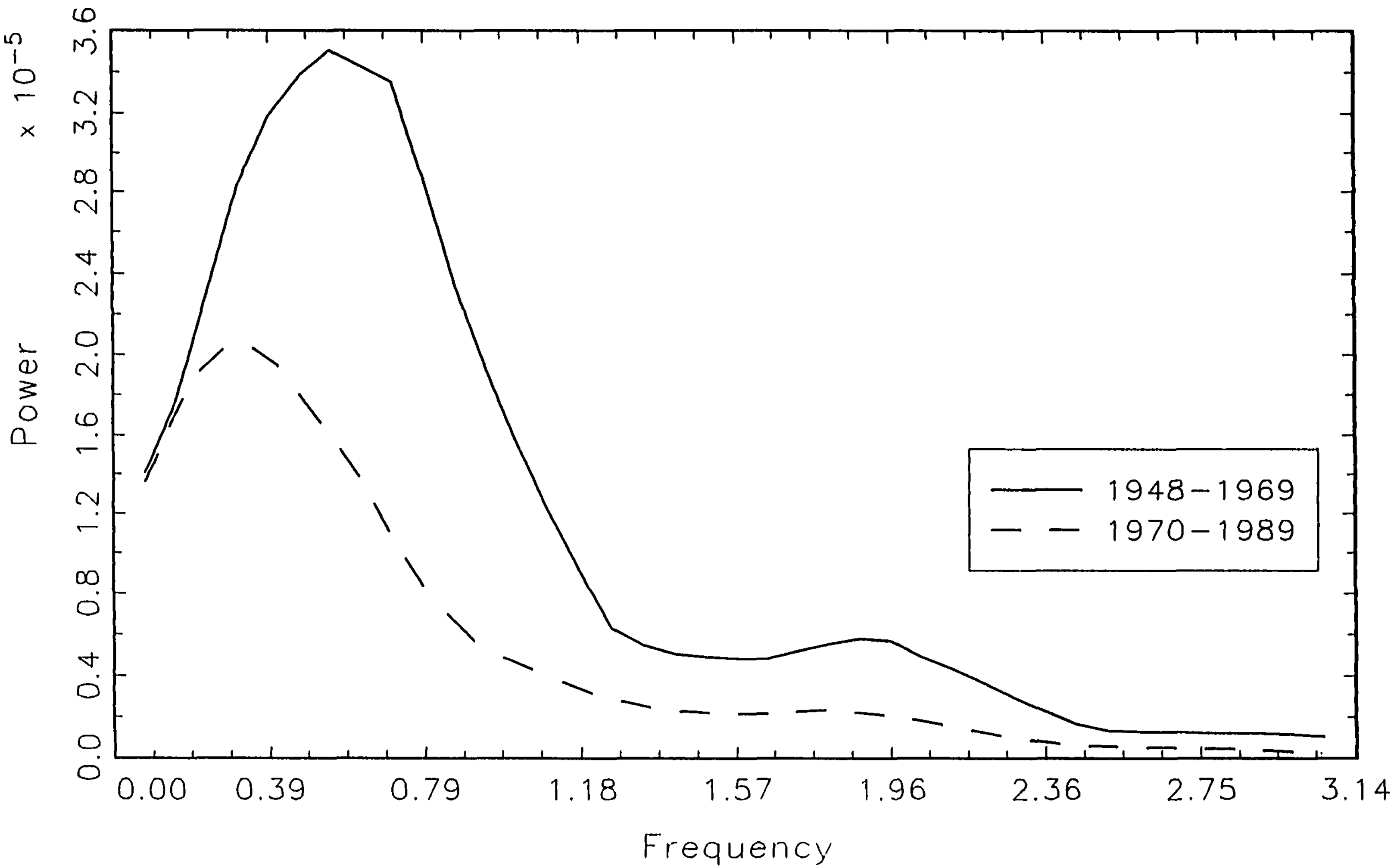


Fig. 2. Estimated Spectrum of Employment Growth

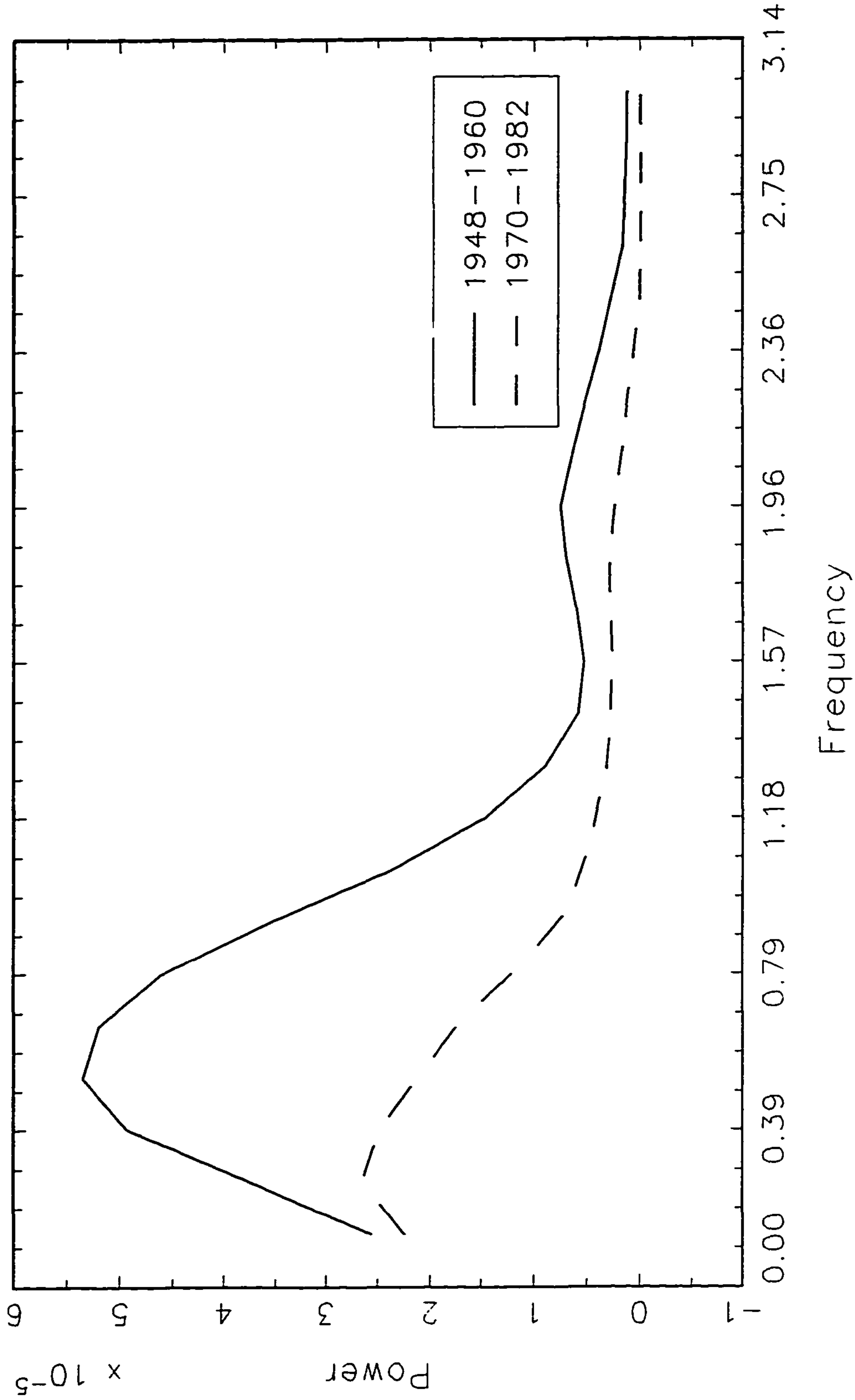


Fig. 3. Estimated Spectrum of Hours Growth

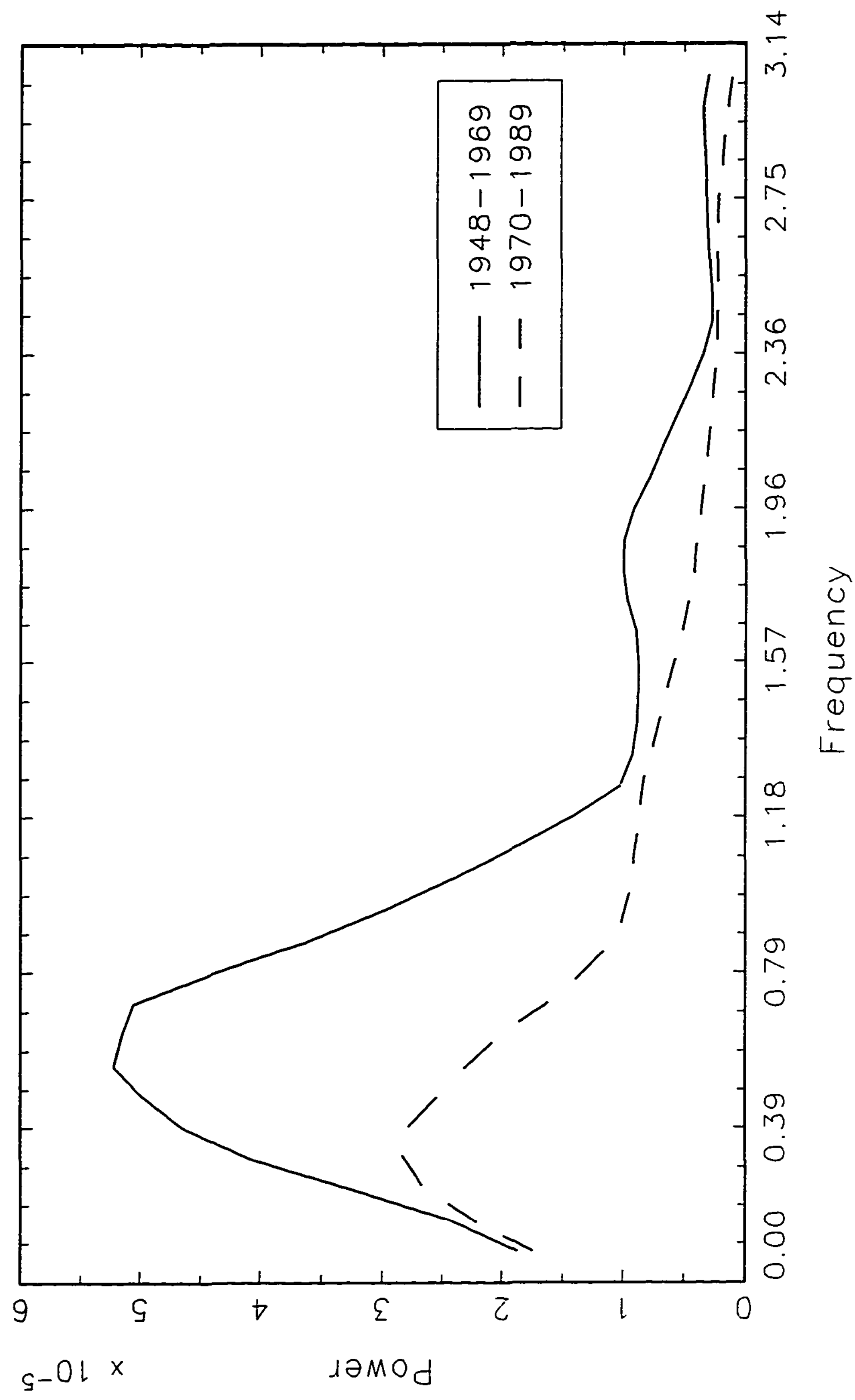


Fig. 4. Estimated Spectrum of Hours Growth

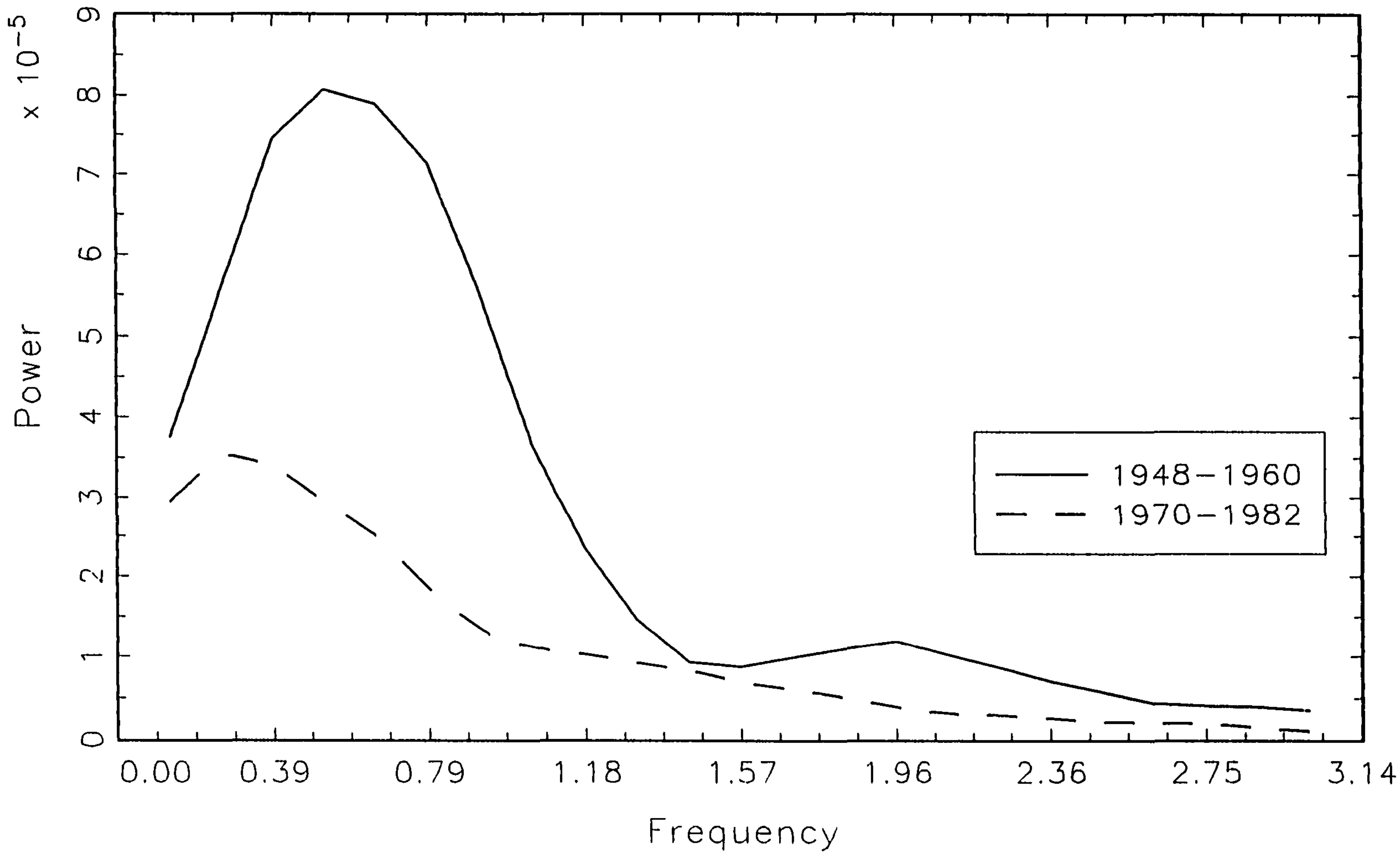


Fig. 5. Effect of Changing Composition on
Estimated Spectrum of Employment Growth

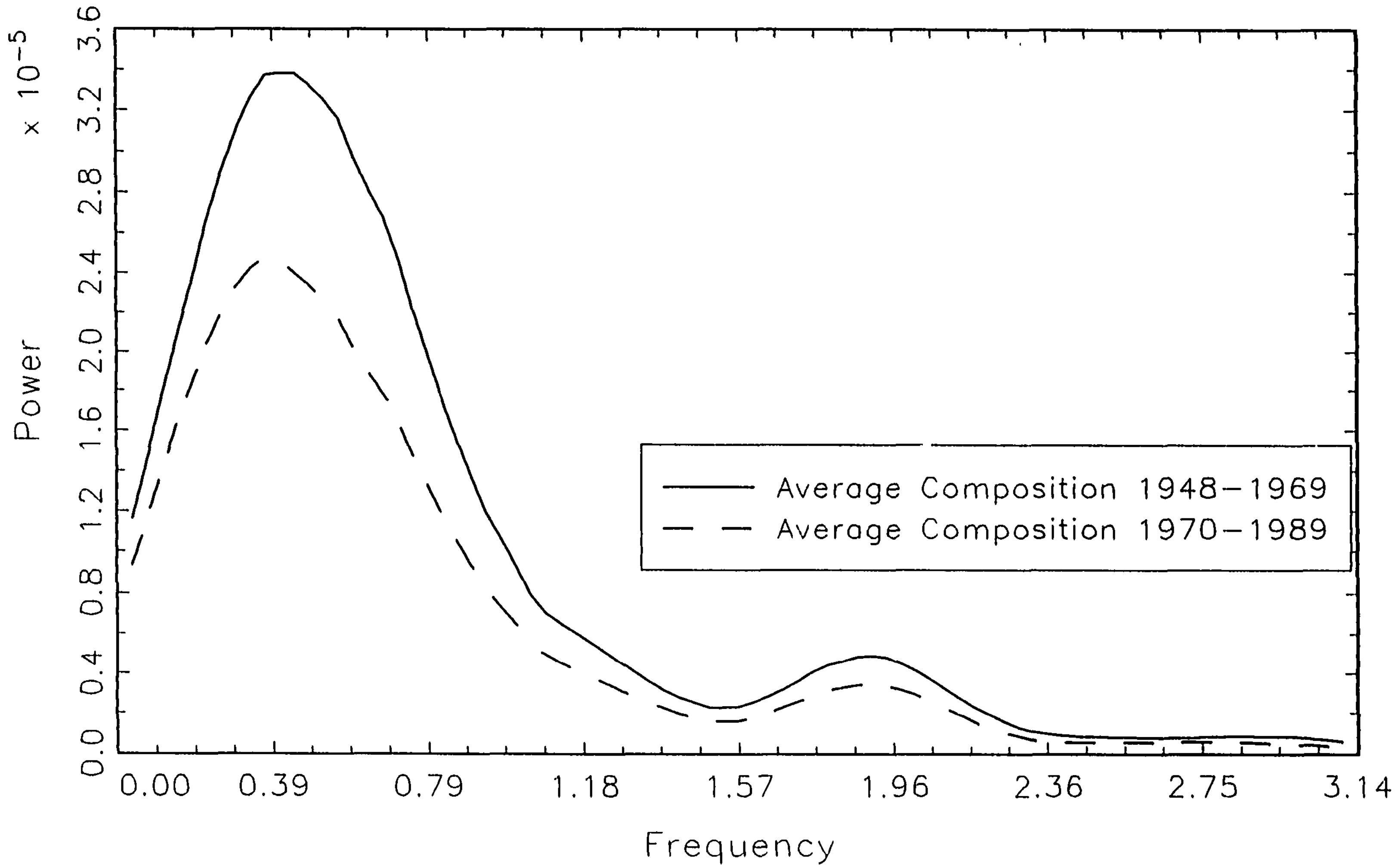


Fig. 6. Effect of Changing Autocovariances on Estimated Spectrum of Employment Growth

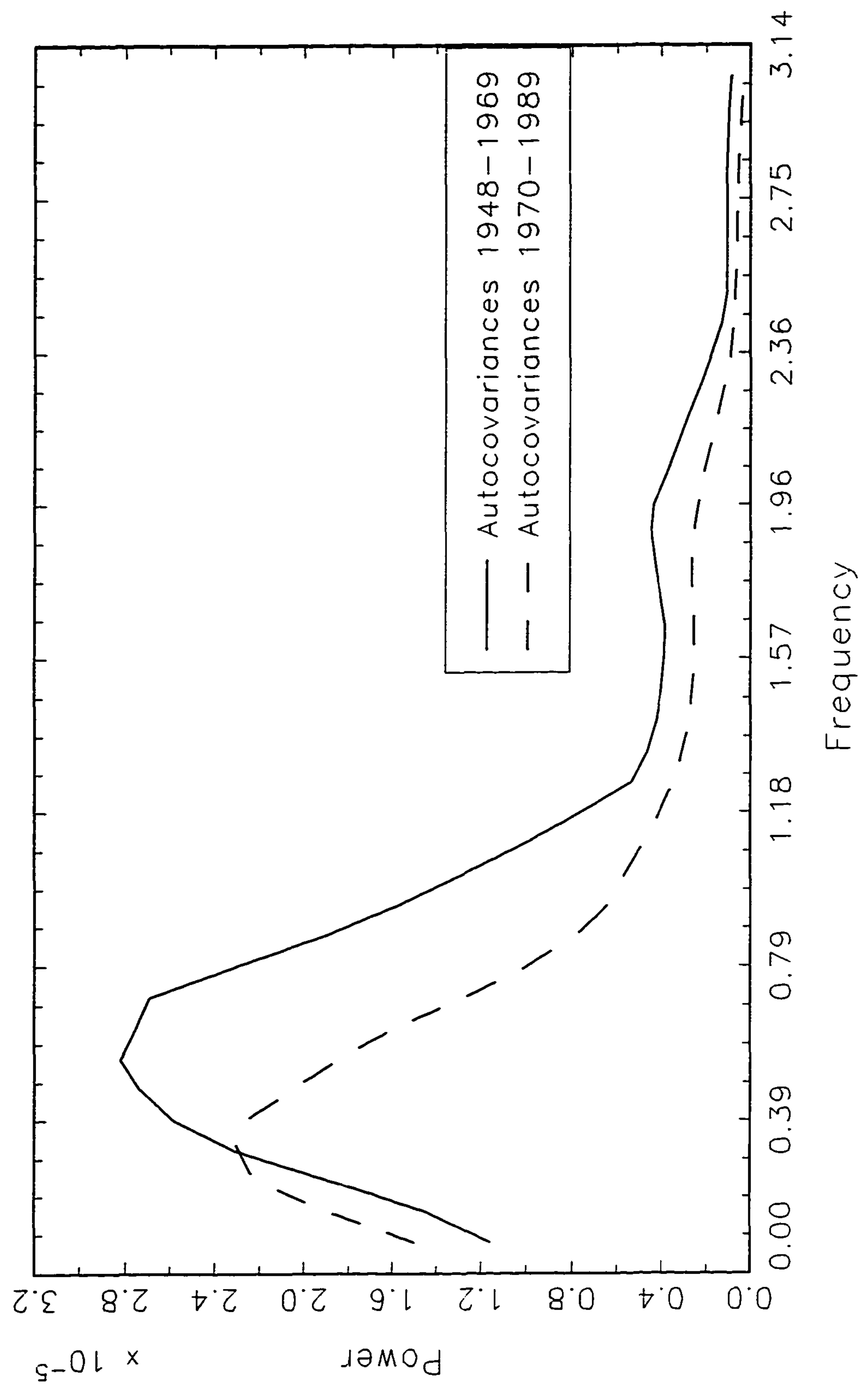


Fig. 7. Decomposition of Change in Estimated Spectrum of Employment Growth Between 1948–1969 and 1970–1989

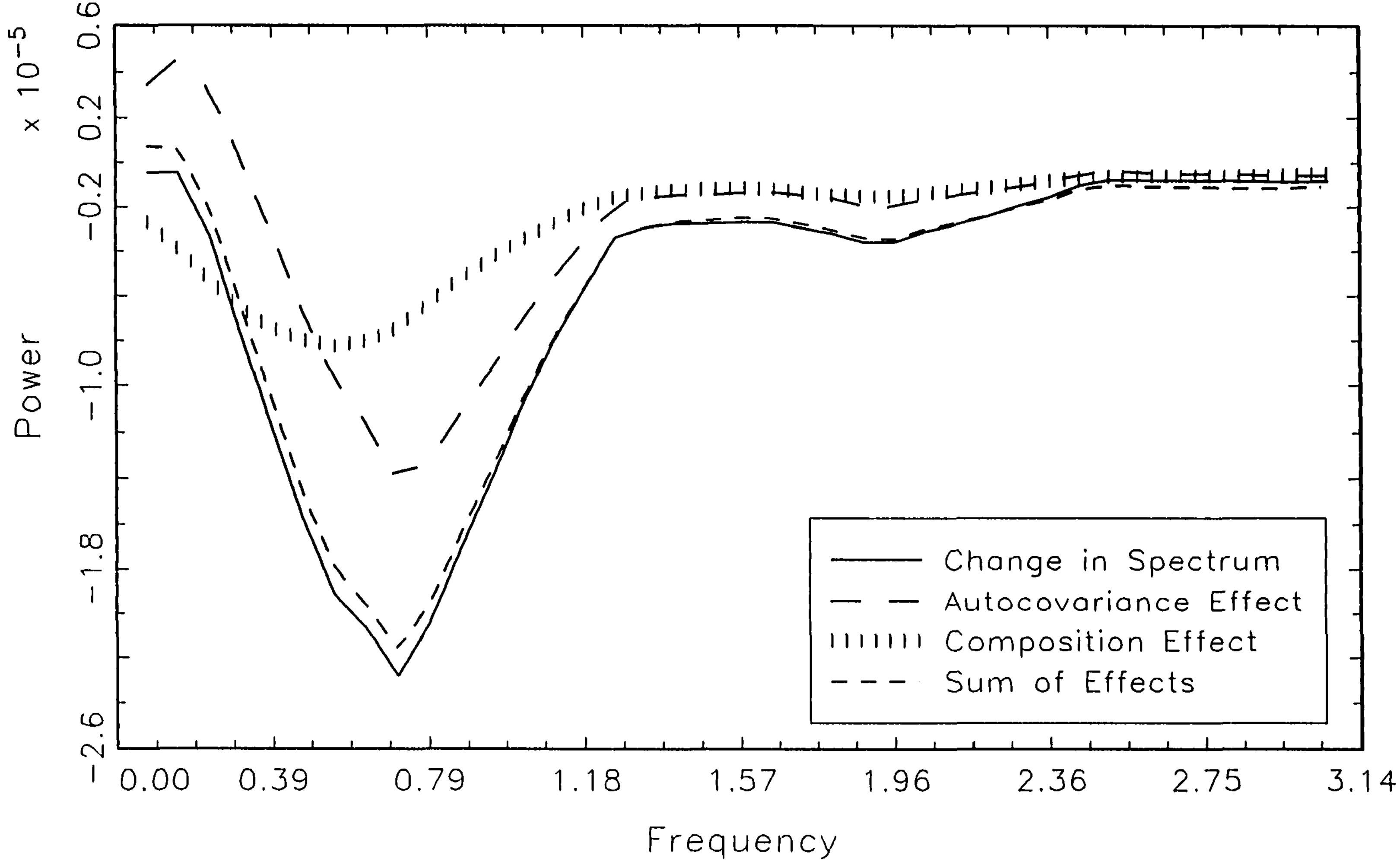


Fig. 8. Decomposition of Change in Estimated Spectrum of Employment Growth Between 1948–1960 and 1970–1982

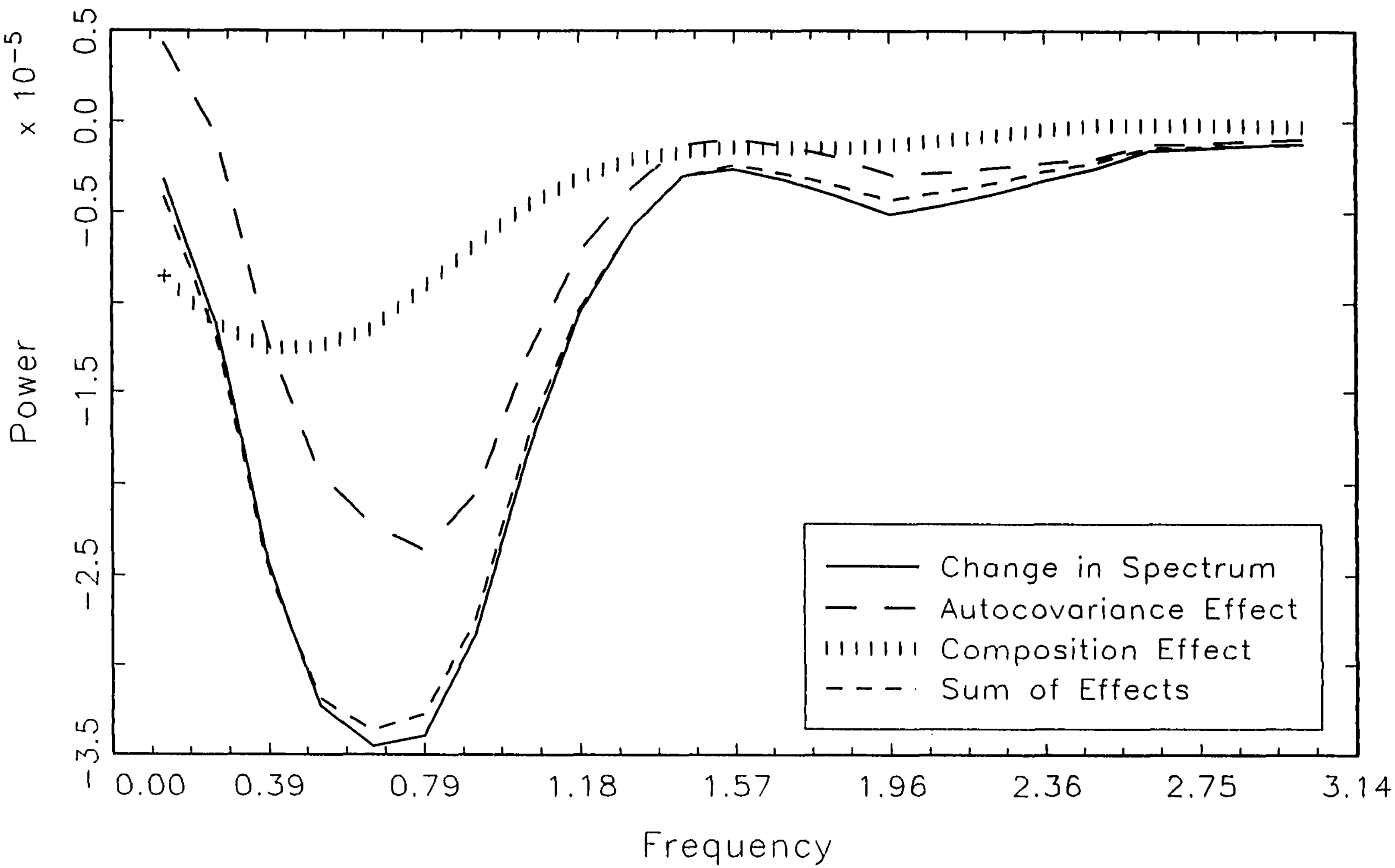


Fig. 9. Effect of Changing Composition on Estimated Spectrum of Hours Growth

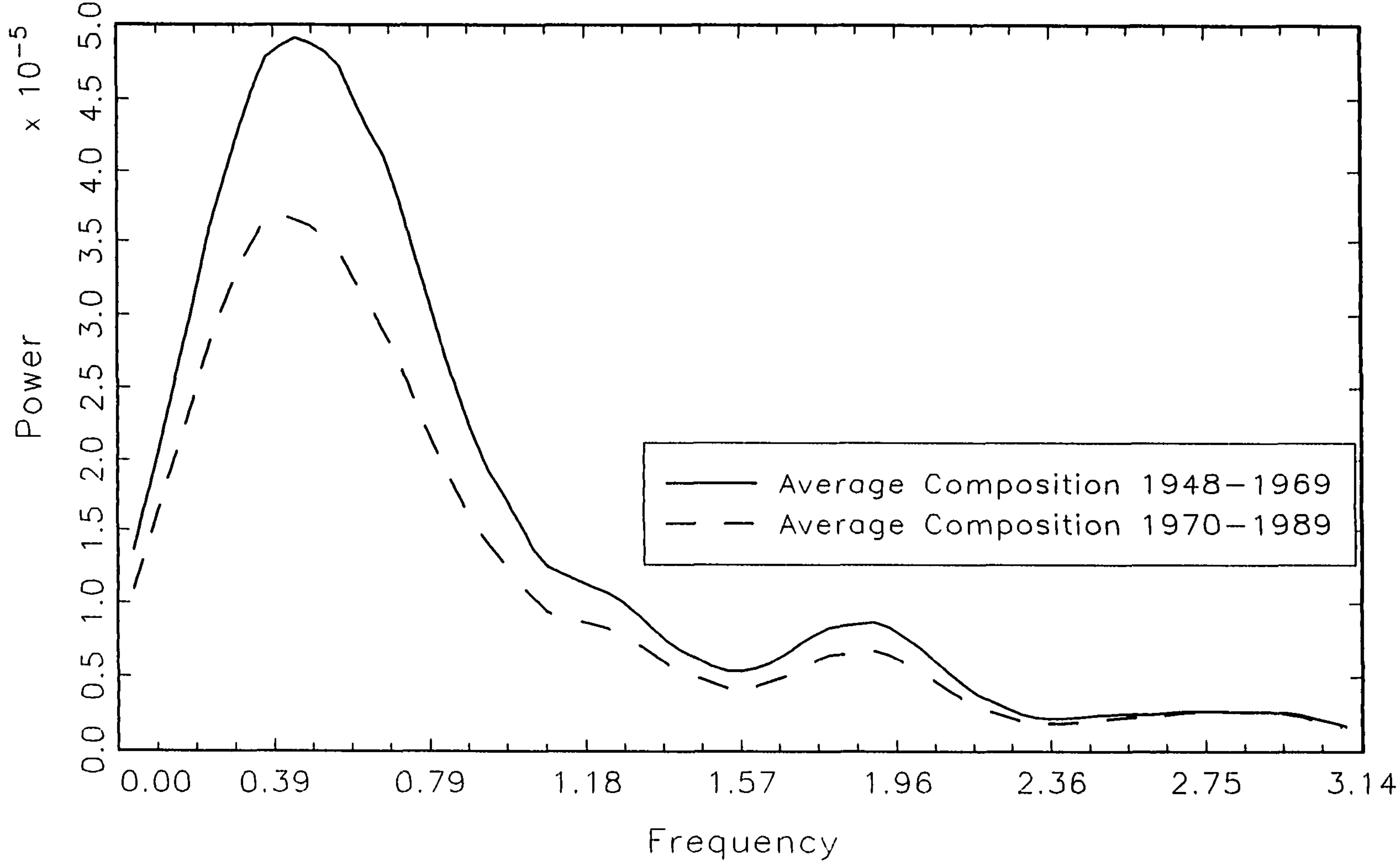


Fig. 10. Effect of Changing Autocovariances on
Estimated Spectrum of Hours Growth

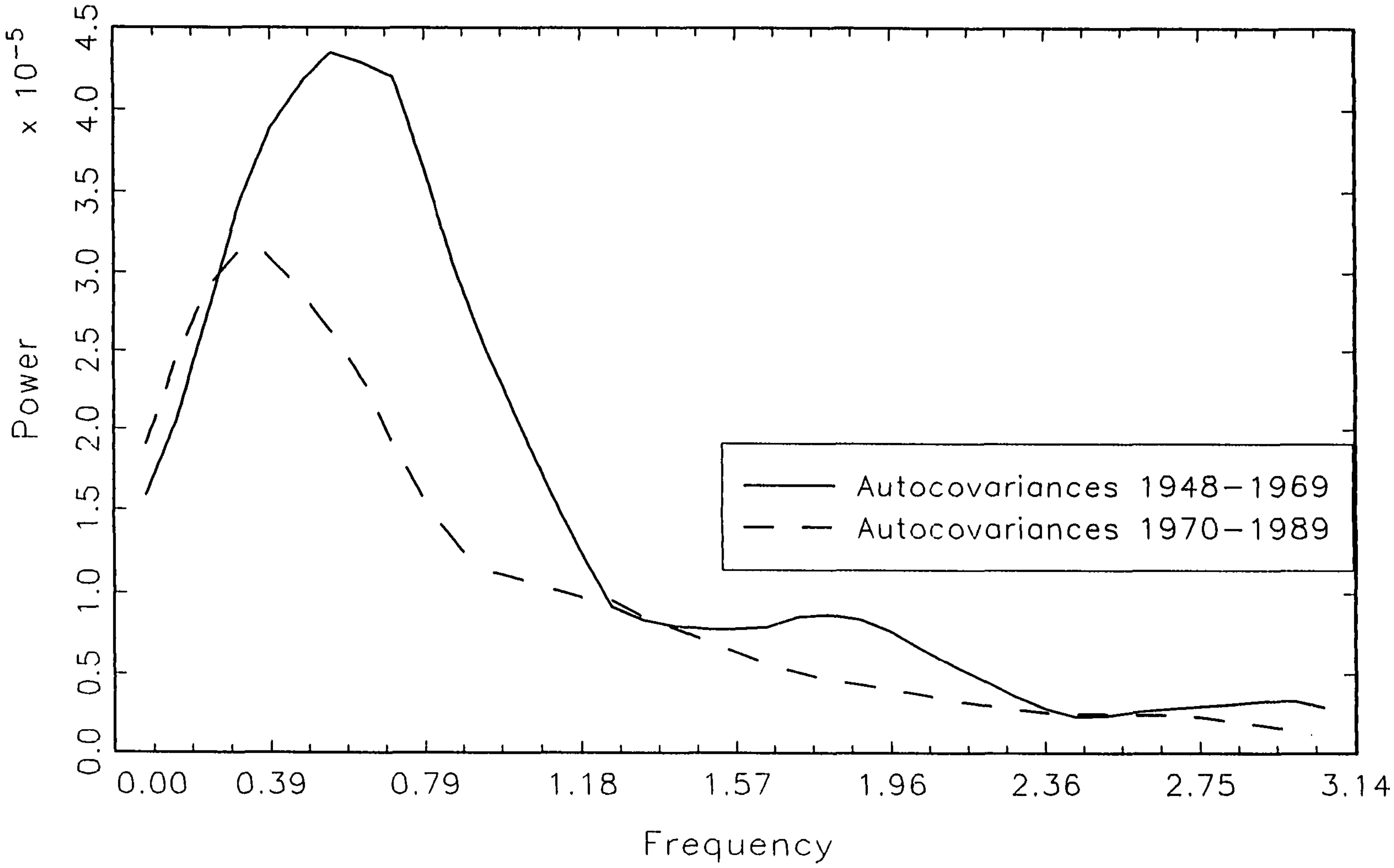


Fig. 11. Decomposition of Change in Estimated Spectrum of Hours Growth Between 1948–1969 and 1970–1989

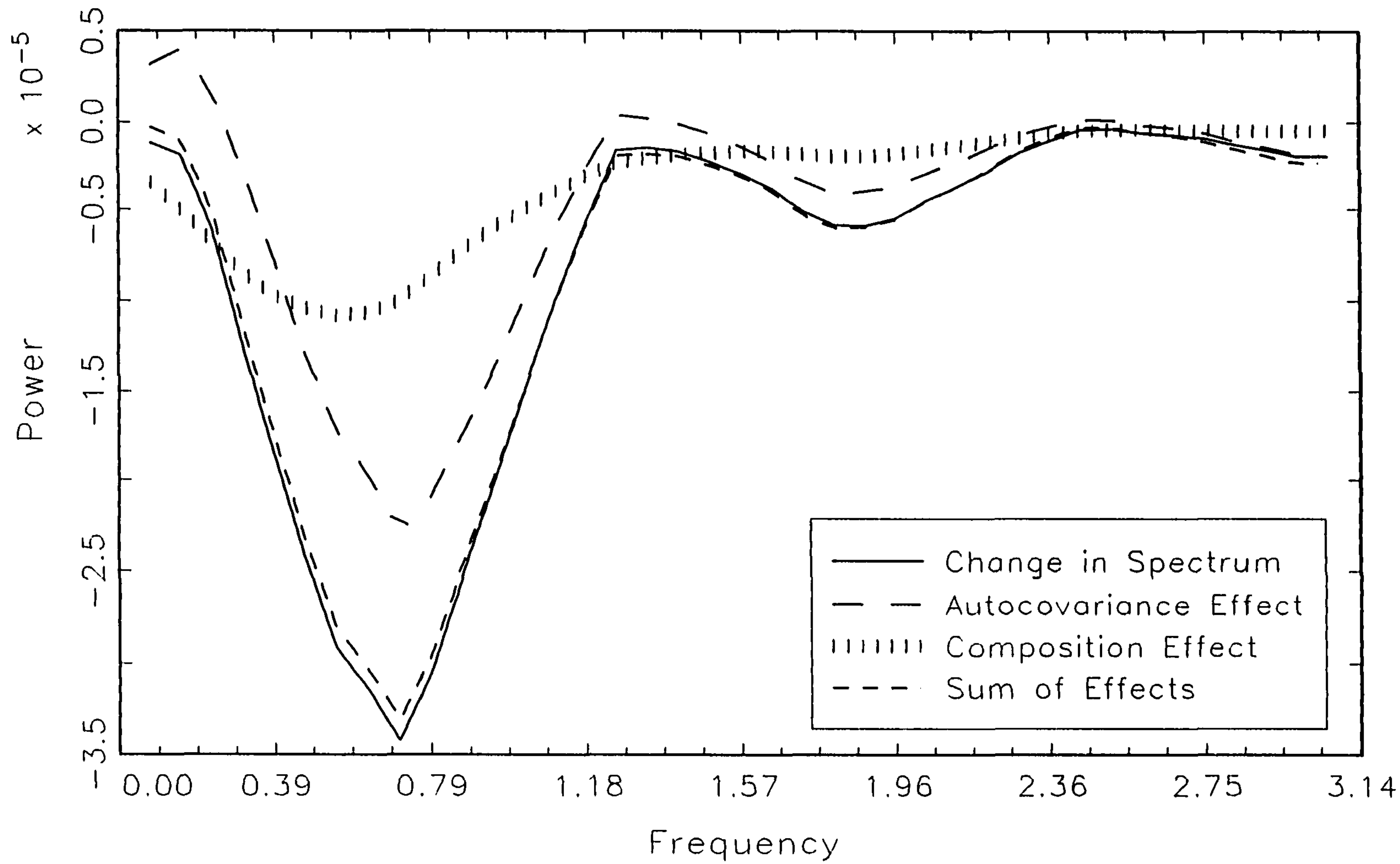


Fig. 12. Decomposition of Change in Estimated Spectrum of Hours Growth Between 1948–1960 and 1970–1982

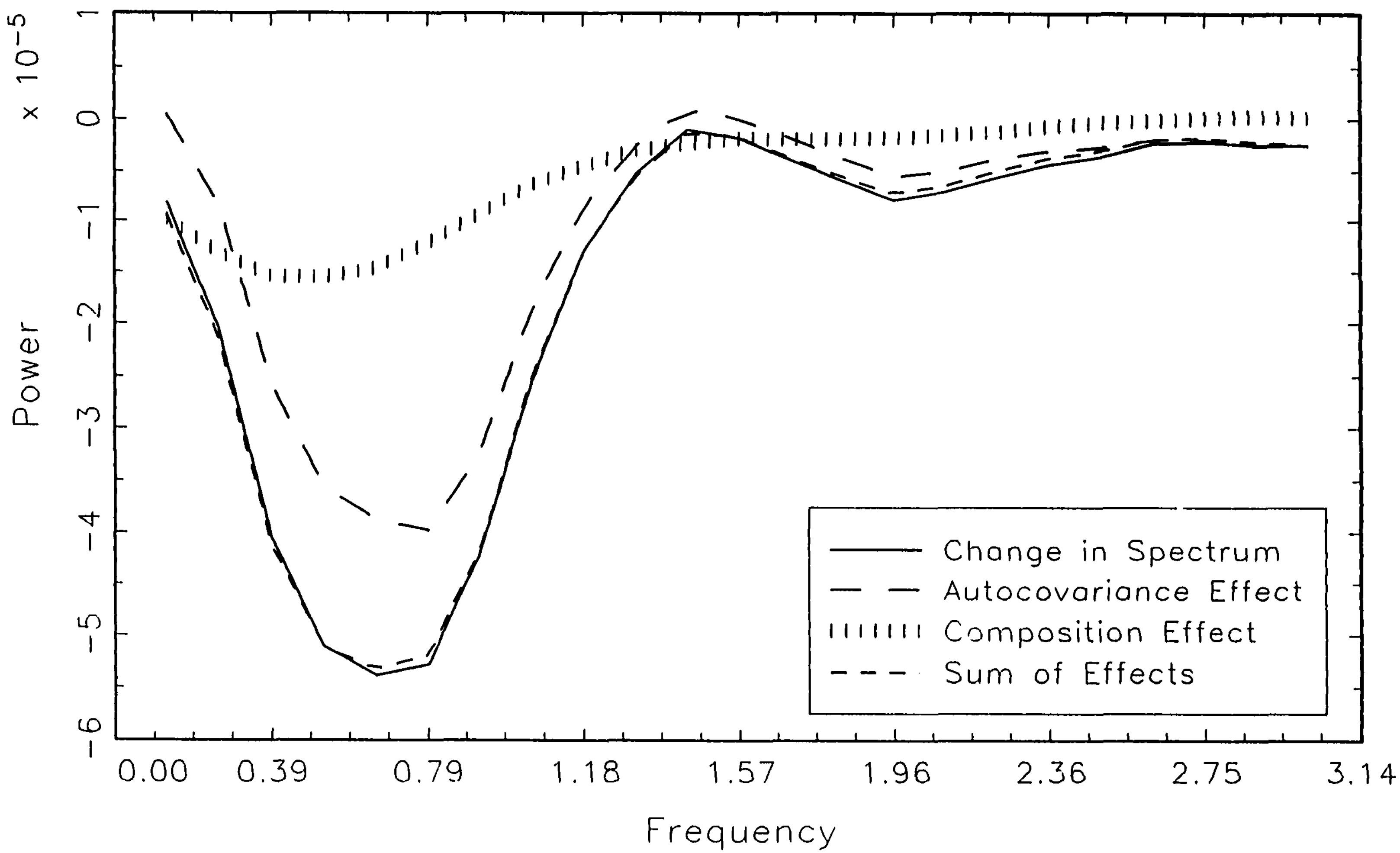


Fig. 13. Estimated Spectrum of Output Growth

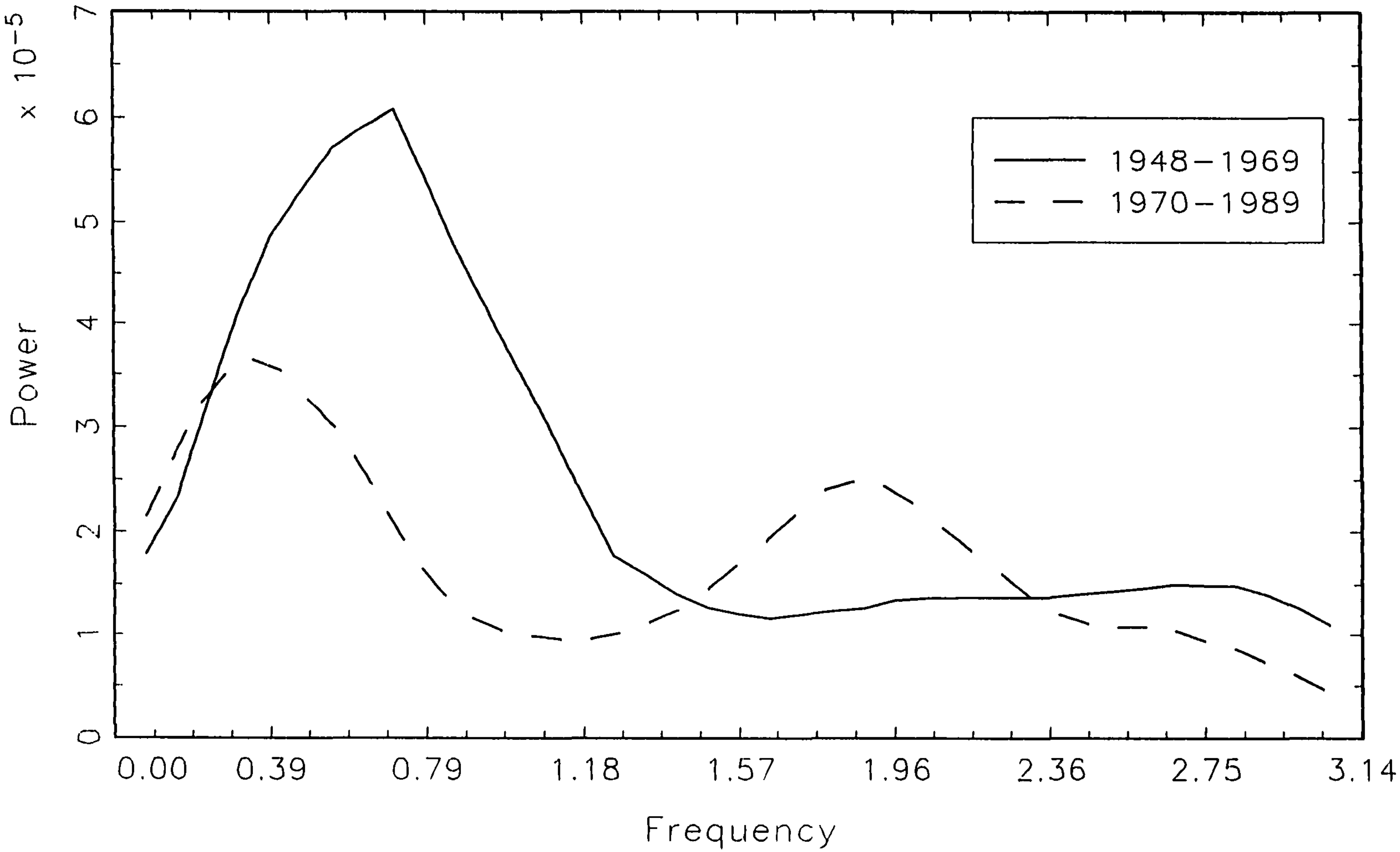


Fig. 14. Estimated Spectrum of Output Growth

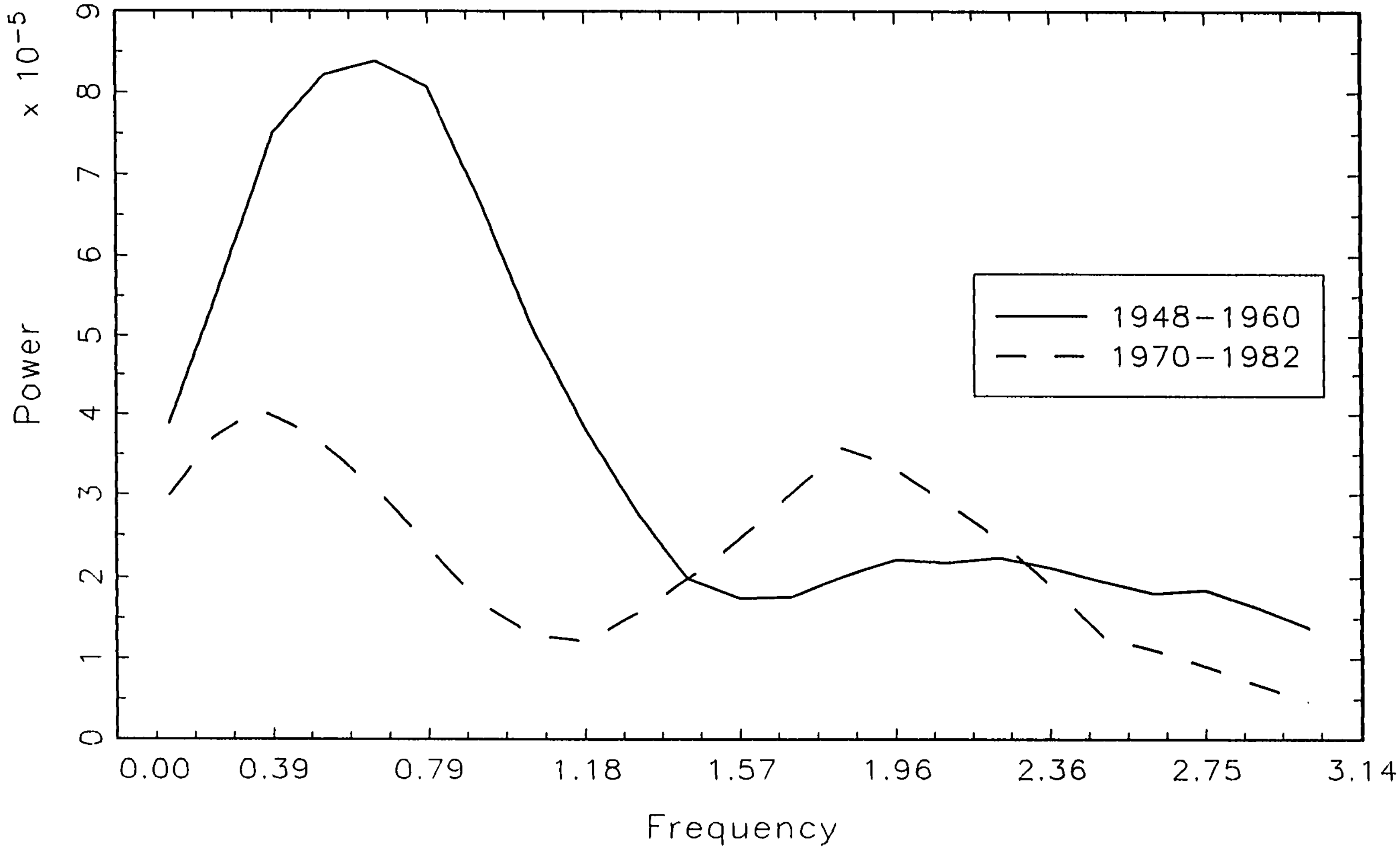


Fig. 15. Effect of Changing Composition on
Estimated Spectrum of Output Growth

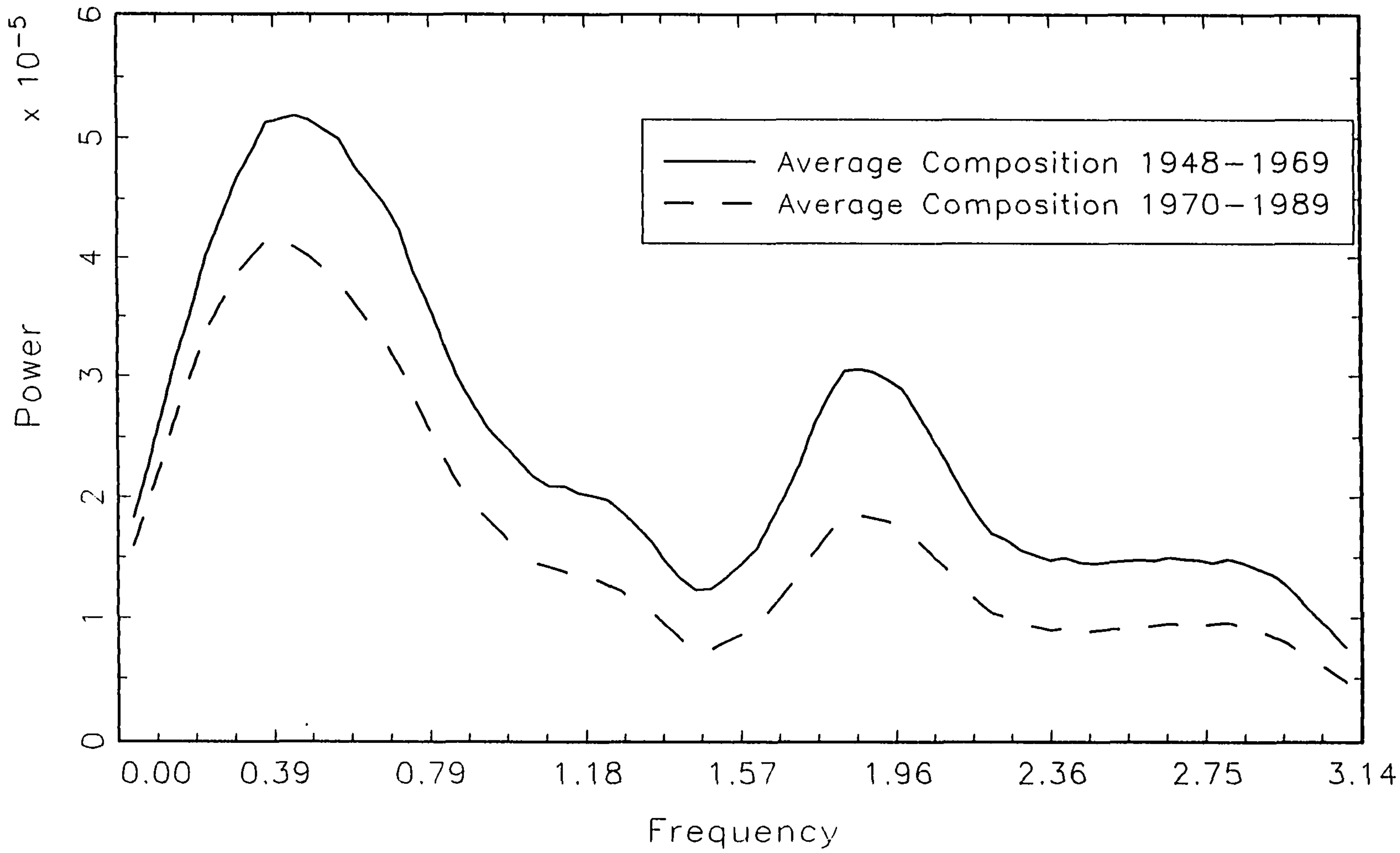


Fig. 16. Effect of Changing Autocovariances on Estimated Spectrum of Output Growth

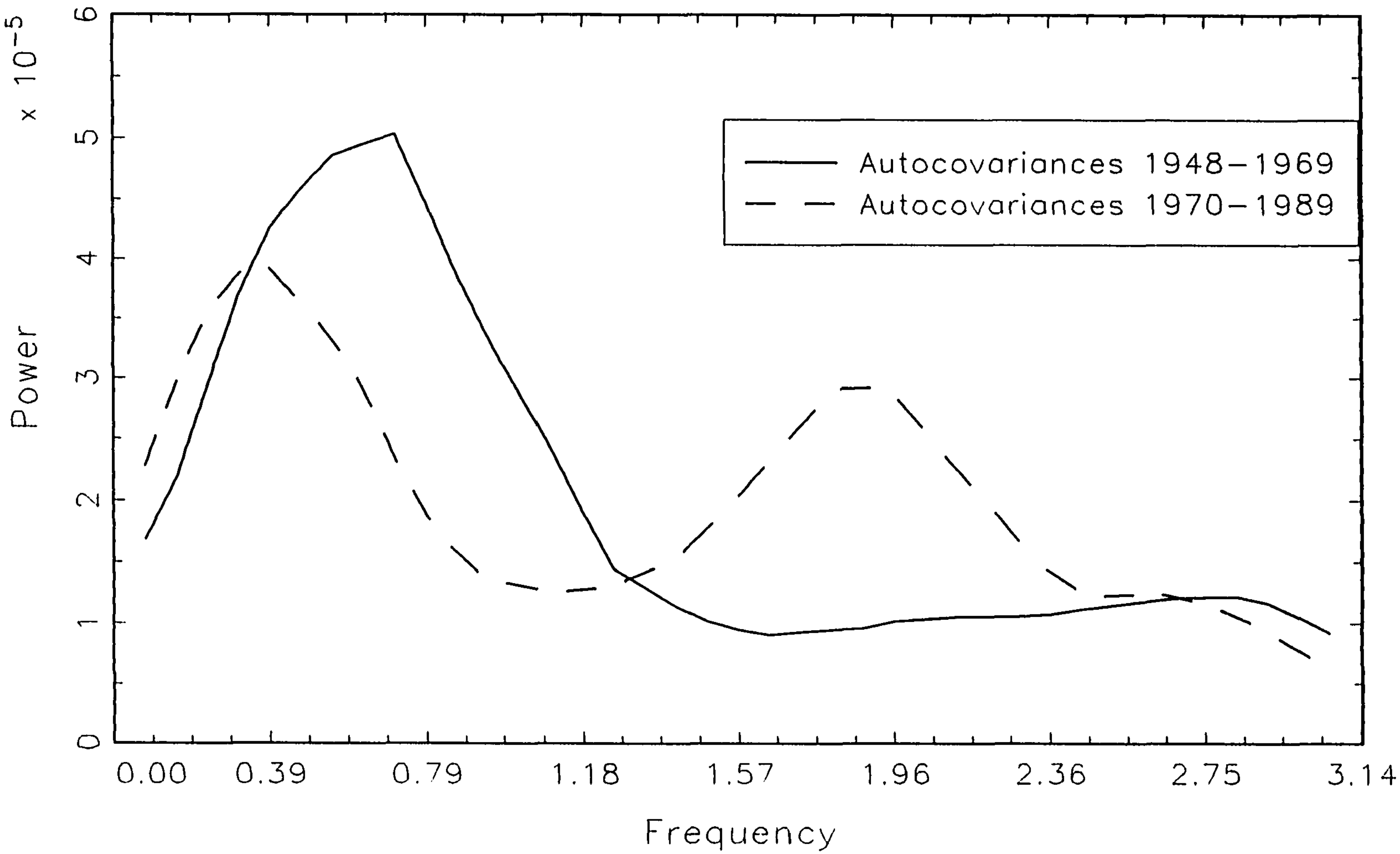


Fig. 17. Decomposition of Change in Estimated Spectrum of Output Growth Between 1948–1969 and 1970–1989

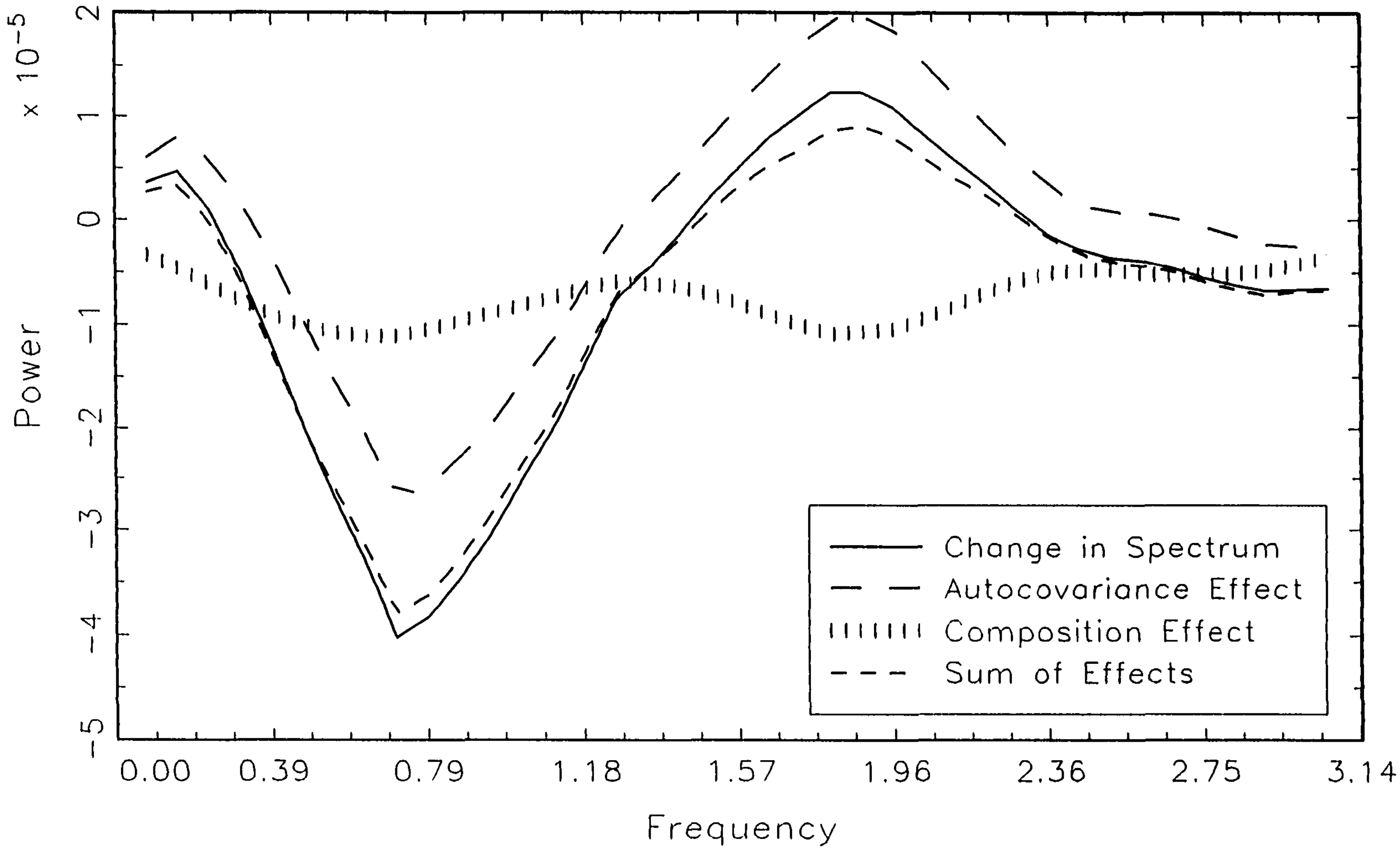
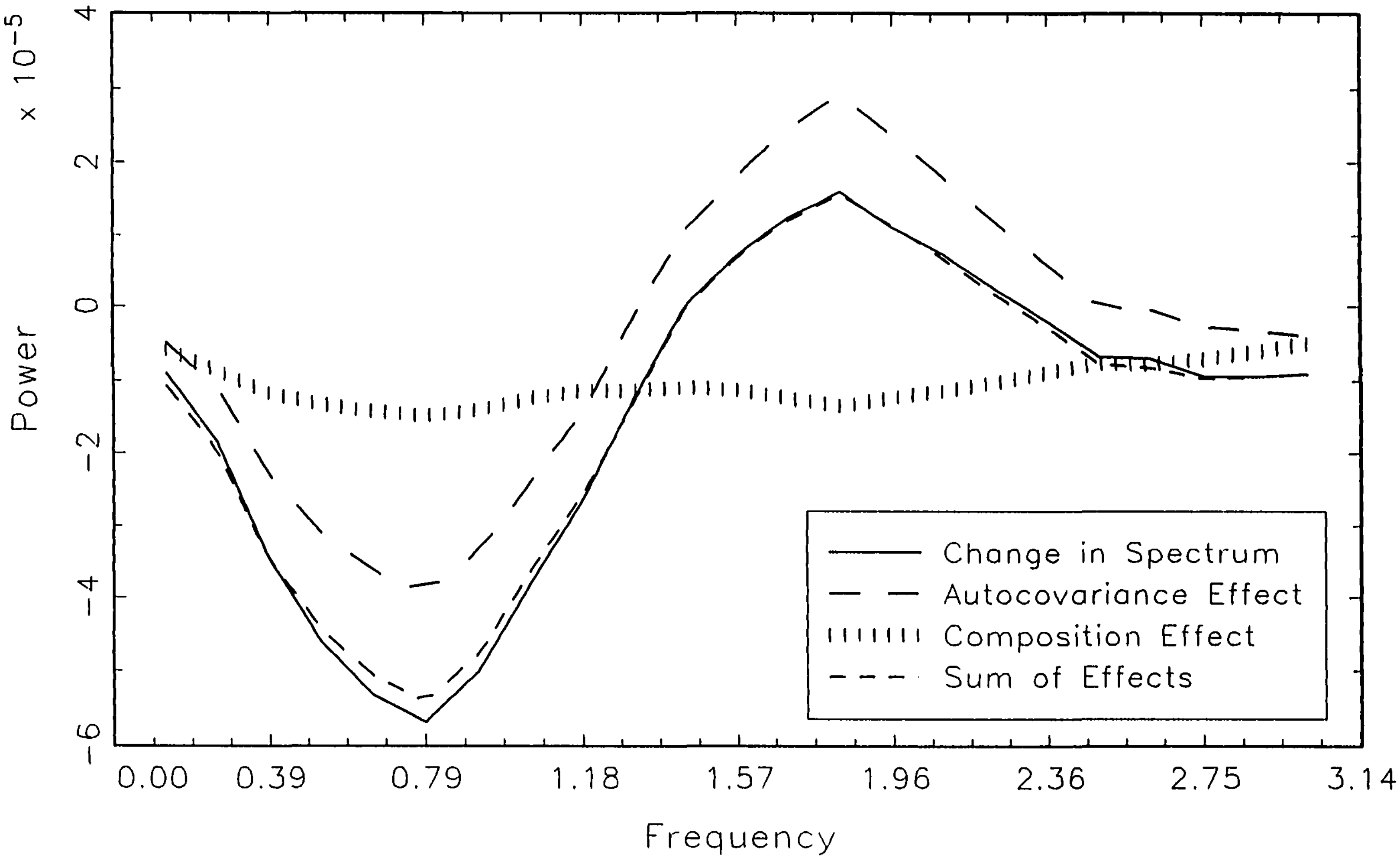


Fig. 18. Decomposition of Change in Estimated Spectrum of Output Growth Between 1948–1960 and 1970–1982



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APPENDIX 1

DATA SOURCES FOR CHAPTER 1

As noted in the text, the data come from The National Income and Product Accounts of the United States and various issues of the Survey of Current Business. The purpose of this section is to indicate the exact sources for each series used in the paper and explain how various revisions in the data were handled.

Gross domestic Product by Industry in Constant Dollars for the period 1948-1977 was taken from The National Income and Product Accounts of the United States 1929-1982. The data for 1977-1990 was taken from the Survey of Current Business, May 1993. The two sources have different numbers for 1977 because of major benchmark revisions of the data. This was handled in the following manner. When calculating the growth rates of real output in each industry between the consecutive years 1948-49, 1949-1950,..., 1975-1976, and 1976-1977, the original numbers were used including the original 1977 figures. For the growth rates between the years 1977-1978, 1978-1979,...., 1989-1990, the revised numbers were used including the revised 1977 figures. This prevents having large false changes in output appear between 1976 and 1977 due to the benchmark revisions. Shares were treated in a similar manner. For the years 1949-1977 time t, time t-1, and the average of time t and t-1 shares were computed from the original data. For the years 1978-1990, the shares were all computed using the revised data. Now in the revised data there is another small problem. The revised data for 1987-1990 are calculated using 1987 SIC classifications while the data from 1977-1987 are calculated using 1972 SIC classifications. The figures are reported using both classifications for 1987. This was treated in the same manner as above in both the calculations of growth rates and of shares. Gross Domestic Product by Industry in Current Dollars had the same problems as the constant dollars version and these were handled in exactly the same way. Only the calculation of shares was necessary however.

Persons Engaged in Production, Full-Time Equivalent Employees, and hours Worked by full-time and part-time Employees were handled in the same way (as each other). The data for 1948-1988 were taken from The National Income and Product Accounts of the United States 1929-1958 and 1959-1988. The data for 1989-1990 were taken from the August 1993 issue of the Survey of Current Business. As with the output data, the change of SIC classifications from 1972 to 1987 classifications occurs at 1987 and figures for both classifications are given in 1987. The same methods for calculating growth rates and shares that were used for output were used for these labor input variables.

APPENDIX 2

AGGREGATION FOR QUARTERLY INDUSTRY GPO DATA

The purpose of this section is to explain how quarterly industry GPO data generated in chapter 3 are aggregated to form a series for aggregate quarterly growth rates. A scheme similar to that used by the BEA for their chain-weighted quarterly GDP measure is employed. The growth rates for each industry in a given quarter are added together using weights equal to the average nominal share of two adjacent years. The growth rates in the first and second quarter of any given year are weighted with the average of the shares from the previous and current year. The growth rates in the third and fourth quarter of any given year are weighted with the average shares from the current year and subsequent year. For example, growth rates from the first and second quarters of 1977 are weighted with the average of the shares in 1976 and 1977. Growth rates from the third and fourth quarters of 1977 are weighted with the average of the shares in 1977 and 1978.