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THE CYCLICAL BEHAVIOR OF INDIVIDUAL PRODUCTION SERIES, 1889–1984*

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This paper uses simple summary statistics to analyze the volatility, persistence, and comovement of 38 annual individual production series for the period 1889–1984. It seeks to identify the size, source, and correlation of fluctuations in the production of specific commodities within various sample periods and to analyze possible changes in these characteristics over time. The paper also discusses the implications of the behavior of individual production series for the behavior of the aggregate economy within the prewar, interwar, and postwar eras.

INTRODUCTION

Burns and Mitchell's study, *Measuring Business Cycles* [1947], is widely viewed as the pioneering work in the identification and measurement of economic fluctuations. Among the most outstanding and least controversial attributes of this work is its use of disaggregate data in the analysis of short-run movements in economic activity. In their analysis Burns and Mitchell examine the short-run behavior of over 200 production series as well as a plethora of other disaggregate economic indicators. This detailed analysis of individual series allows them both to examine common elements in the behavior of all series and to pinpoint important

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differences in the behavior of series representing different sectors of the economy.

Though widely praised, the use of disaggregate data has been largely abandoned by modern macroeconomists. Aggregate measures such as real GNP or the index of industrial production are typically used in place of individual output series in the analysis of short-run fluctuations. This reliance on aggregate data is especially prevalent in studies of changes in cyclical behavior over time. Of the several studies in recent years that have analyzed changes in the nature of economic fluctuations between the prewar and postwar eras, nearly all of them have relied exclusively on aggregate measures of production (see, for example, Baily [1978], Campbell and Mankiw [1987a], De Long and Summers [1986], Taylor [1986], and Zarnowitz and Moore [1986]).

This paper revives the use of disaggregate production data in historical macroeconomic analysis. It examines the short-run behavior of 38 annual individual production series for 1889–1984. The series all measure the physical production of a particular good and appear to be consistent from the earliest years to the present. The data set covers a wide variety of commodities and is equally divided among manufactured goods, the output of mines and refineries, and agricultural products.

The main focus of the analysis is on possible changes in the cyclical behavior of production over time. Two of the most important characteristics that are compared across time periods are the volatility and persistence of short-run movements in the real output of individual commodities. The disaggregate data are used to analyze whether short-run fluctuations have become less extreme or erratic over time and whether the tendency of shocks to have permanent or transitory effects has changed between the prewar and postwar eras.

Using reliable disaggregate data to analyze possible changes in the size and persistence of cyclical fluctuations is important because traditional aggregate measures of production are not consistent over time. Romer [1986, 1989] shows that conventional prewar estimates of industrial production and gross national product exaggerate the size of short-run fluctuations. Although it is possible to correct the traditional series for the major sources of bias, even the revised series provide uncertain estimates of the volatility and persistence of prewar fluctuations. Comparisons based on consistent disaggregate data, on the other hand, provide reliable estimates of changes in the character of fluctuations at the microeconomic level, and thus provide an additional way of gauging the likely nature of changes in aggregate fluctuations.

A third aspect of cyclical behavior that is examined in the paper is the correlation of short-term changes across sectors. Does the production of various goods move together, as would be the case if aggregate shocks were the dominant source of fluctuations or if sectoral shocks had large and rapid spillovers? Or do the individual series move in vastly different ways, as would be the case if isolated, industry-specific shocks were more important? Have there been changes in the relative importance of various types of shocks over time? These are obviously questions that can only be answered using disaggregate data.

Though the paper focuses on changes in the volatility, persistence, and comovement of short-run fluctuations in the individual production series over time, an important by-product of the analysis is a description of the short-run behavior of these series within various eras. This is useful because there has been inadequate analysis of the behavior of disaggregate production series even within the postwar era.

While the data used in the paper are similar to those used by Burns and Mitchell, the techniques used to identify changes in cyclical behavior are quite different. Burns and Mitchell use such measures as the mean cyclical amplitude and the length of reference cycles to identify changes in the short-run behavior of output. In contrast, I use such simple summary statistics as the standard deviation and the autocorrelations of the growth rates of the individual production series to identify possible changes in short-run fluctuations. The data set and the analytical framework used to examine the short-run behavior of output are discussed in Sections I and II. The findings concerning the volatility, persistence, and comovement of the 38 production series are analyzed in Sections III, IV, and V, respectively. The main results and the implications of the changes identified are summarized in the conclusion.

I. DATA

The data set consists of 38 annual individual production series that span the period 1889–1984. Most of the series reflect the physical production of individual goods such as refined sugar, steel rails, pig iron, coal, corn, and wheat. A few of the series, such as cotton consumed and silk imported, reflect the consumption of raw materials in the production of manufactured goods.[1]

With two exceptions (pig iron and cotton consumed), the individual production data are available through 1970 in *Historical Statistics of the United States* [1975]. My contribution has been to sift through the hundreds of production series given in this volume to determine which ones are reasonably accurate and consistent over time. The series that appeared to be consistent were then checked more thoroughly and revised when necessary. They were then extended through 1984 on the basis of more recent primary and secondary publications.

Three criteria were used to choose the series included in the data set. The first criterion was that the series represent the physical production of a mineral, agricultural, or manufactured good. That is, the series should measure such things as the tons of steel or the bushels of corn produced, rather than the value of that production. This requirement was designed to avoid the errors that might result from trying to convert a nominal series into a real series. The second criterion was that the series exist back to at least 1889 and still be available today from standard reference publications. The desire for long time series was obviously a very restrictive requirement and eliminated at least half of the physical production series in *Historical Statistics.*

The third and most fundamental criterion was that the series be reasonably consistent over time. To establish consistency, I looked for two main characteristics in the data. One was that the production estimates were and still are based on contemporaneous annual censuses or surveys of producers. This requirement was designed to eliminate prewar series that were constructed retrospectively using data that are much less complete than those underlying modern estimates. Another characteristic that I looked for was that the definition of the good being measured was the same over time. This requirement made sure that a series did not, for example, cover shipments in one period and production in another or include some by-products in one period and exclude them in another.

The application of the consistency criterion eliminated many

1. These comprehensive input series should yield good estimates of actual production, provided that swings in materials inventories are not very large. The cotton consumed series is a particularly good proxy for production because it measures the amount of raw cotton genuinely used in production in a given year.

series from *Historical Statistics*. For example, the commonly used wheat flour series was not used because early estimates were simply interpolated by population rather than derived from actual survey data. In some cases it was possible to improve faulty series given in *Historical Statistics* rather than to eliminate them altogether. For example, while the pig iron series given in *Historical Statistics* uses shipments and production data interchangeably, the source publications from the American Iron and Steel Institute contain a series that consistently represents production.

The series included in the data set appear to be based on ample contemporaneous records even in the prewar era. The eleven agricultural series were collected for the prewar era by an extensive network of volunteer farmer correspondents who reported on crop output in their area to the Department of Agriculture. All of the prewar mineral series except pig iron were produced by the U. S. Geological Survey using annual reports filed by mining firms, smelters, and refineries. The pig iron series was derived from an annual survey of nearly all iron and steel producers conducted by the American Iron and Steel Institute. Finally, the thirteen manufacturing series were collected for the prewar era by a variety of trade organizations and commercial newspapers. For example, the series on refined sugar output was the result of a survey of refiners conducted by Willett and Gray, publishers of the *Weekly Statistical Sugar Trade Journal*, and the series on cotton consumed was based on reports from producers of cotton cloth collected by the correspondents of the *Commercial and Financial Chronicle*.

The 38 series included in the data set are shown in the tables presented in later sections of the paper. A detailed data appendix that discusses the sources of the data and any changes that were made to the series given in *Historical Statistics* to improve consistency is available from the author upon request.[2]

II. Framework of Analysis

A. Macroeconomic Issues

There are three important issues in macroeconomics that can be illuminated by an examination of lengthy individual production series. One is the possible role of stabilization policy in damping

2. A diskette containing the actual data is also available upon request.

fluctuations in real output. If monetary and fiscal policy have diminished fluctuations in aggregate demand, one would expect the production of individual goods to have become more stable over time. If the production of individual goods has not stabilized, then any decrease that may have occurred in the volatility of aggregate output would have to be due to changes in the size of the commodity-producing sector or to changes in the correlation between various goods. Neither of these changes, however, could plausibly be the result of stabilization policy.

A second issue that can be illuminated using individual production series is the relative importance of technology shocks and demand shocks in causing short-run fluctuations in various periods. The effects of demand shifts are plausibly less long-lasting than the effects of technology changes. Thus, a finding that movements in the individual series are quite temporary could suggest that demand shocks are driving movements in production. On the other hand, a finding that movements in the individual series are very persistent could suggest that technology shocks predominate. Determining the source of shocks is important for deciding whether traditional sticky-price models or newer real business cycle models of fluctuations are more appropriate.

A final issue in macroeconomics that can only be analyzed using disaggregate data is the relative importance of aggregate and industry-specific shocks. If individual goods tend to behave similarly, this would suggest that aggregate factors are important or that sectoral shocks have strong spillovers to other sectors. If individual goods behave quite differently, this would indicate that isolated industry-specific shocks explain most of the movement in the production of various goods. This aspect of short-run behavior is clearly relevant to the question of whether there is in fact a business cycle, characterized by many individual series moving up and down in concert.

B. Summary Statistics

To analyze the short-run behavior of the individual production series, I look at a variety of simple summary statistics. All of these statistics are calculated on the log differences of the base data. I work with growth rates to deal with the fact that all of the series have been growing over time. This specification is preferable to explicitly detrending the data because it does not presuppose that there is a deterministic trend to which the individual production series revert.

The particular summary statistics that I consider are the following. First, an obvious measure of the volatility of each series is the standard deviation of the log differences. Second, the autocorrelations of the log differences provide a convenient way of assessing the persistence of short-run fluctuations. Cochrane [1988] and Campbell and Mankiw [1987a, 1987b, 1989] show that a weighted average of the first several sample autocorrelations can be used to indicate if movements in production are primarily transitory or permanent. Finally, the use of factor analysis to estimate a simple one-factor model of the log differences provides a way of analyzing the correlations among series and of assessing the relative importance of industry-specific and aggregate factors.

It is important to point out that these summary statistics are most useful in suggesting interpretations of the data and in formulating formal hypotheses to be tested. They do not take the place of such formal tests. Thus, the analysis of summary statistics can provide only suggestive evidence on the characteristics of economic behavior. It is also useful to note that the standard deviations and common factor patterns examined in this paper are the unconditional summary statistics. As a result, they reflect the properties of both the innovations to production and the responses to earlier innovations.[3]

C. Sample Periods

By dividing the 1889–1984 sample period into subperiods and estimating the standard deviations, autocorrelations, and common factor coefficients for each series for each period, one can analyze whether the nature of short-run movements in output has changed

3. An alternative procedure would be to look at the summary statistics of just the innovations to each series. I consider only the unconditional statistics for two reasons. First, in terms of analyzing most of the changes that have occurred over time, changes in overall behavior are often of more interest than changes in the behavior of innovations. In examining volatility, for example, for most purposes the main fact that one would wish to know is simply whether the overall variability of each series has changed over time. Second, given the number of series and the number of observations in each sample period, it is not feasible to run a vector autoregression including lags of each series. The most that one could do is look at the innovations in a simple univariate time series regression for the growth rate of each series. This procedure, however, is unlikely to change the summary statistics substantially because the annual percentage changes are not highly correlated: the R^2 of a regression of the growth rate of a given series on one or two own lags is typically on the order of 0.1 or 0.2.

over time. The particular subperiods chosen for comparison are 1889–1914, 1922–1939, and 1947–1984. In what follows, these periods are referred to as the prewar, interwar, and postwar eras, respectively.

These periods are quite standard (they are, for example, similar to those used in Taylor [1986] and Schultze [1986]) and were chosen for several reasons. First, the prewar sample does not begin until 1889 because several series are not available on a consistent basis until 1889. Second, the two World Wars and the immediate postwar depressions are excluded because it is likely that wartime expansion and subsequent demobilization do not provide useful indications of the typical short-run behavior of the economy.

Finally, the period before World War I is evaluated separately from the period between World War I and World War II because it is not clear whether the interwar period should be grouped with the prewar era or with the postwar era. For example, if one is interested in comparing a period before activist government intervention with one after intervention, the correct break is arguably World War I, when government spending increased drastically and monetary policy was used extensively for the first time.[4] A further reason for evaluating the interwar period separately is to see whether the behavior of the economy in this era was fundamentally different from that in other periods. This analysis may indicate whether the Great Depression was a unique event or merely a more extreme version of earlier or later economic downturns.

III. VOLATILITY

Of all the changes in short-run behavior that may have occurred over time, the one that has received the most attention is the possible decline in the volatility of fluctuations. Therefore, it is useful to see what the sample of 38 consistent production series shows about changes in volatility between the prewar and postwar eras. As discussed in Section II, the standard deviation of log differences, which shows the dispersion of the growth rates of a production series around its mean, provides a simple measure of the volatility of fluctuations in the various time periods.

4. The Federal Reserve System began operations in 1914. Furthermore, Barro finds that "the process for generating deficits in the interwar period, 1920–40, . . . is broadly similar to that in the post-World War II period, 1948–82" [1986, p. 376].

TABLE I
STANDARD DEVIATION OF PERCENTAGE CHANGES

Series	Standard deviations			Ratio of prewar to postwar[b]
	1889–1914[a]	1922–1939	1947–1984	
Corn	0.22	0.28	0.20	1.09
Wheat	0.16	0.17	0.14	1.13
Oats	0.19	0.31	0.15	1.32
Barley	0.17	0.40	0.15	1.09
Flaxseed	0.36	0.54	0.34	1.04
Rye	0.09	0.52	0.25	0.34
Irish potatoes	0.22	0.14	0.10	2.35
Sweet potatoes	0.07	0.19	0.15	0.49
Hay	0.12	0.17	0.05	2.21
Cotton	0.19	0.24	0.25	0.75
Tobacco	0.11	0.21	0.12	0.94
Bituminous coal	0.09	0.15	0.10	0.89
Coke	0.20	0.27	0.14	1.49
Anthracite coal	0.17	0.20	0.10	1.75
Petroleum	0.10	0.10	0.04	2.28
Cement	0.09	0.19	0.07	1.34
Pyrites	0.16	0.22	0.19[d]	0.84
Phosphate rock	0.10	0.20	0.08	1.26
Iron ore	0.22	0.51	0.23	0.97
Pig iron	0.21	0.38	0.16[e]	1.33
Copper	0.08	0.35	0.15	0.51
Lead	0.08	0.20	0.14	0.56
Zinc	0.10	0.19	0.10	1.02
Gold	0.09	0.07	0.11	0.77
Silver	0.07	0.22	0.11	0.68
Coffee imported	0.17	0.09	0.11	1.57
Cotton consumed	0.11	0.16	0.10	1.08
Silk imported	0.32	0.11	0.48	0.67
Refined sugar	0.07	NA[c]	0.06	1.07
Canned corn	0.34	0.41	0.18[e]	1.87
Canned tomatoes	0.30	0.34	0.18[e]	1.65
Beer	0.05	0.46	0.03	1.66
Distilled spirits	0.16	0.25	0.12[d]	1.28
Tobacco	0.05	0.02	0.03	1.74
Cigars	0.06	0.07	0.11	0.55
Cigarettes	0.10	0.07	0.04	2.82
Rails	0.29	0.50	0.25	1.17
Raw steel	0.23	0.35	0.15	1.55

a. Sample periods refer to the raw data used. Actual calculations based on percentage changes start one year later.
b. Columns may not divide due to rounding.
c. Data on refined sugar are not available for the interwar era.
d. Data are only available through 1982.
e. Data are only available through 1983.

A. Results for the Individual Series

Table I reports the standard deviations of each series in each sample period. One obvious finding is that the individual series within each time period have vastly different levels of volatility. For example, within the prewar era, pig iron production has a standard deviation that is twice that of cigarette production, but substantially smaller than that of canned corn production. These large differences in volatility suggest that the various industries are either subject to quite different shocks or respond very differently to common shocks.

A much more important finding is that there has been little change in the standard deviation of the growth rates of various series between the prewar and postwar eras. A convenient way to examine how much volatility has changed over time is to examine the ratio of the prewar standard deviation to the postwar standard deviation of each series. These volatility ratios are given in Table I. Figure I shows a histogram of these ratios for the 38 goods.

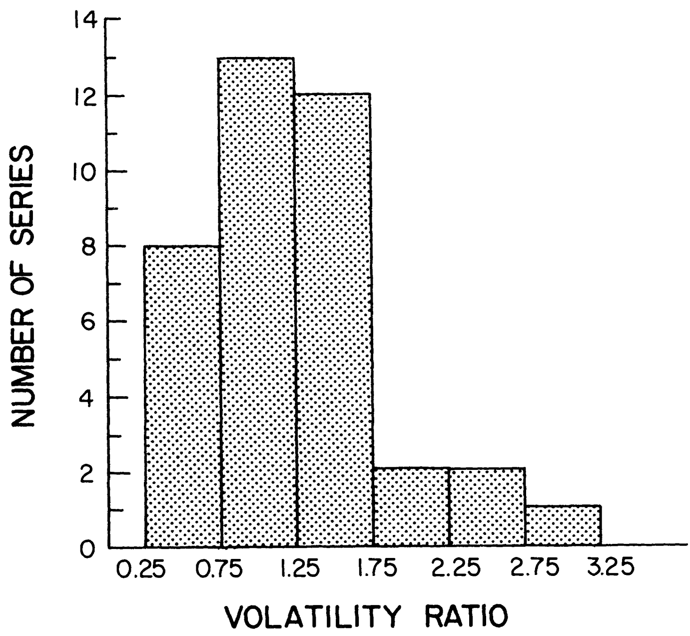

FIGURE I
Distribution of Volatility Ratios

Notes. The volatility ratio is the ratio of the prewar standard deviation of the growth rate of a series to the postwar standard deviation. Ratios on the border are included with the lower group.

The most obvious feature evident from the histogram is that the volatility ratios for nearly all of the goods are close to 1.0. For the total sample over 85 percent of the goods have ratios lower than 1.75, and over half have ratios lower than 1.25. The median volatility ratio is 1.11, and the mean is 1.24.[5] This absence of stabilization is particularly noticeable for six goods that would commonly be considered among the most important goods produced in the United States: corn, wheat, bituminous coal, pig iron, cotton textiles, and raw steel.[6] Of these six goods only pig iron and steel production show more than a trivial stabilization. All of the rest have ratios that are indistinguishable from 1.0.

The volatility ratios for the commodities broken down by sector reveal some differences in the amount of stabilization shown by goods in each sector. Agricultural goods show by far the least stabilization. Over 70 percent of these goods have volatility ratios less than 1.25, and over 30 percent of the goods have ratios substantially below 1.0, indicating destabilization. The volatility ratios for mineral products are distributed fairly evenly over the range 0.25 to 1.75. This indicates that there is a substantial amount of variation in the behavior of the output of mines; indeed, about as many mineral products have become more volatile as have become less volatile over time. Finally, for manufacturing the volatility ratios are clustered in the range 1.25 to 1.75. This indicates that a majority of manufactured goods have shown a modest decline in volatility between the prewar and postwar eras.[7]

5. The mean is a less appropriate summary statistic for the data than the median because it gives more weight to a ratio of 2.0 than to a ratio of 0.5 even though the two are equally far from 1.0 in percentage terms.

6. The relative importance of these goods can be quantified by examining their gross value or value added. In 1899 each of these goods had relative values that placed them at the top of the agriculture, mining, or manufacturing sectors.

7. The absence of a dramatic decline in volatility is not due simply to the fact that the postwar sample period is twelve years longer than the prewar sample period. Theoretically, this difference in sample periods could matter if one believes that the mean growth rate of a series is more likely to change over a longer sample period. In this case, a comparison of standard deviations around constant means could overstate the volatility of the postwar era relative to the prewar era because a larger fraction of the deviations around the mean in the longer postwar era could be due to changes in the drift term rather than to changes in the variance of the disturbance term.

Two pieces of evidence suggest that this possible bias is not important. First, since several of the individual series exist back to 1869, it is possible to compare prewar and postwar eras that are of more equal length. When this is done, the ratios of prewar to postwar standard deviations are very similar to those reported in Table I. For example, the volatility ratio using the extended prewar sample period is 1.02 for corn, 1.21 for wheat, 0.84 for bituminous coal, 1.18 for pig iron, 1.06 for cotton consumed, and 1.65 for steel. Second, one can break the postwar sample into two equal periods and then compute the standard deviation of the growth rate of each series not around the mean growth rate for the full period but around two different

The fact that there has been little decline in the volatility of most individual production series between the prewar and postwar era suggests that there has been no consistent decline in the combined effect of the shocks hitting the 38 industries and the reaction to these shocks. This finding would seem to weigh against the notion that government intervention to stabilize the economy in the postwar era has radically reduced either the size of aggregate shocks or the response to such shocks. If policy has mattered in either of these obvious ways, it is hard to explain why most goods show little change in volatility over time.

While the basic similarity of the standard deviations of each series in the prewar and postwar eras is an obvious feature of the data, an equally obvious characteristic is that the standard deviation of each series is substantially higher in the interwar period than in either of the other eras. Using the data in Table I, the interwar standard deviations are typically one and one half to two and one half times as large as the standard deviations in the prewar or postwar eras. Not surprisingly, nearly all of the increased volatility of the interwar era is due to the depression and recovery of the 1930s. One way to illustrate this is to note that the standard deviations for the period 1889–1928 for essentially all of the series are very close to those for the shorter period 1889–1914.[8]

B. Implications for the Behavior of Aggregate Output

Given that the disaggregate data used in this study are more reliable than the existing aggregate series, it is natural to try to infer the likely behavior of aggregate output from the behavior of these individual series. The fact that the various series show very different levels of volatility within a given sample period suggests that the standard deviations of the individual series will not provide a good indication of the level of volatility of aggregate output. The actual standard deviation of aggregate output will depend on the relationship between the production of various goods and the relative importance of various industries.

The change in the volatility of the individual series over time, however, may provide much more information about the change in

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means corresponding to the two halves of the period. Because changes in mean growth rates between the early and late postwar eras are small relative to the standard deviations of growth rates, this procedure has virtually no effect on the results. Thus, the absence of stabilization in the individual series appears to be a genuine phenomenon.

8. This similarity is well illustrated by the major commodities discussed earlier. For 1889–1928 the standard deviation is 0.19 for corn, 0.17 for wheat, 0.12 for bituminous coal, 0.25 for pig iron, 0.11 for cotton consumed, and 0.26 for steel.

aggregate volatility. To use this information, it is first necessary to ascertain whether there is any bias in the sample of commodities examined. That is, one needs to test whether the goods represented in the sample are more or less likely than the goods on which we do not have data to have shown a stabilization.

The main feature of the disaggregate data set that could make the sample unrepresentative is the fact that it includes many industries whose average growth rates have decreased substantially between the prewar and postwar eras: industries for which we have reliable data dating back to the nineteenth century are often industries that were growing rapidly in the prewar era but are declining today. If such industries tend to become more volatile as they decline, this could cause the series examined to show less stabilization over time than a broader sample would show.

Since the sample of 38 commodities includes a reasonable number of goods that have continued to expand over time as well as many that have declined, it is possible to test for this bias explicitly. In particular, one can examine the correlation between the volatility ratio for each series and the change in its mean growth rate between the prewar and postwar eras. A positive correlation would indicate that those industries that have not stabilized are precisely the industries that have shown a large decline in the rate of expansion.

The relevant correlation coefficients by sector are 0.17 for agriculture, −0.42 for minerals, and −0.06 for manufacturing.[9] As can be seen, only agriculture shows the suspected positive relationship, and the correlation coefficient is very small. Both manufacturing and mining show a negative correlation between the volatility ratio and the change in the mean growth rate of the various commodities. This suggests that for these sectors, goods that move from a phase of high growth in the prewar era to low or negative growth in the postwar era are actually more likely to show stabilization than goods whose growth rates have not declined. Overall, the low and negative correlation coefficients suggest that the goods examined in this paper are not likely to show systematically less stabilization over time than would a sample of goods that included more high-growth industries.

The fact that the 38 goods examined in Table I have shown little stabilization over time and do not appear to be a biased sample makes it unlikely that aggregate output could have stabi-

9. For this calculation the periods compared are 1889–1914 and 1947–1984. The change in the average growth rates is calculated by subtracting the prewar figure from the postwar figure, and hence is negative for declining industries.

lized dramatically. In particular, for aggregate commodity output to have become much less volatile despite the continued volatility of its constituent components, there would have to have been a drastic change in the relationship between commodities over time. For example, fluctuations in the production of individual goods would have to have changed from reinforcing one another to canceling each other out. While this is a theoretical possibility, the simple one-factor model discussed in Section V indicates that no such drastic change in the relationship between goods occurred between the prewar and postwar eras.

For real GNP to have stabilized despite the continued volatility of the commodity sector, one would have to ascribe a very important stabilizing role to the rise of services. Since the output of services tends to fluctuate less than the output of goods, substantial growth of the service sector could tend to damp fluctuations in real GNP. While this effect has no doubt operated to some degree between the prewar and postwar eras, it may have been relatively small because the rise in services has been both gradual and modest. Between 1929 and 1980, for example, the fraction of real GNP accounted for by services (including government) rose from 41 percent to 47 percent.[10]

This discussion of the likely implications of the results from the individual production series for the behavior of aggregate output is consistent with my earlier research on aggregate data. The basic finding of Romer [1986, 1989] is that the most consistent data available on manufacturing production, commodity output, and real GNP show only a modest decline in volatility over time. In particular, estimates of manufacturing production that are based only on primary products and industrial materials in both the prewar and postwar eras have a volatility ratio of 1.37; consistently good estimates of real commodity output have a volatility ratio of 1.09; and revised estimates of real GNP have a volatility ratio of 1.13.[11] The fact that the consistent and reliable disaggregate data also point to a volatility ratio in this range suggests that the volatility ratios of two or three shown by inconsistent aggregate data are very implausible.

10. This calculation is based on estimates of GNP in 1982 dollars by major type of product available from the *National Income and Product Accounts*.

11. All of the ratios compare the standard deviation for 1889–1914 with that for 1947–1984. The data used are described in Romer [1986, 1989].

IV. PERSISTENCE

While a decline in the volatility of production has been the most widely analyzed change in short-run economic activity, there are many other changes that can be analyzed using disaggregate production data. One of these concerns the persistence of short-term fluctuations. Are movements in the output of particular goods mostly permanent or mostly transitory, and has the persistence of real output movements changed over time? This information is useful for determining the nature of shocks and the appropriate model of short-term fluctuations for the prewar and postwar eras.

A. Measure of Persistence

To analyze whether shocks to the production of individual commodities have permanent or transitory effects, it is necessary to derive a measure of persistence. To do this, it is useful to describe the logarithm of each series as following an integrated moving average process with drift. That is,

$$\Delta y_{it} = \beta_i + A_i(L)e_{it}, \tag{1}$$

where β_i is the series-specific mean growth rate, $A_i(L)$ is a polynomial in the lag operator, and e_{it} is white noise.

From this representation it is clear that the sum of the coefficients of $A_i(L)$ (represented by $A_i(1)$) indicates whether a shock to the growth rate is counteracted in subsequent periods. If $A_i(1) = 0$, then a shock to the growth rate is completely undone in later periods. As a result, the level of output returns to its trend growth path and is not permanently changed. On the other hand, if $A_i(1) > 0$, then a shock to the growth rate is not completely undone, and hence the level of output is permanently altered. In the extreme case that the growth rate of output is white noise (which corresponds to the level of output following a random walk), $A_i(1) = 1$.

This description suggests than an estimate of $A_i(1)$ provides an obvious measure of the persistence of short-run movements in the production of individual commodities. In the recent literature on persistence, a way of estimating $A_i(1)$ that does not require specifying and estimating a particular ARMA model for each series has been developed by Cochrane [1988] and Campbell and Mankiw [1987a, 1987b, 1989]. Cochrane suggests that the two-sided infinite sum of the autocorrelations of a series (in log differences) provides one indicator of persistence. If the series reverts to a deterministic trend, this sum (denoted as V_i) is 0; if the series is a random walk, this sum is 1. Cochrane shows that a consistent estimate of this two-sided infinite sum of autocorrelation is

$$\hat{V}_i = 1 + 2\sum_{j=1}^{k}\left(1 - \frac{j}{k+1}\right)\hat{\rho}_{ij}, \tag{2}$$

where $\hat{\rho}_{ij}$ is the jth sample autocorrelation of the first differences of series i, and k must increase with the sample size.

Campbell and Mankiw show that because there is a one-to-one relationship between the coefficients of the moving average representation of a series and the autocorrelations, there is also a unique relationship between Cochrane's V_i and $A_i(1)$. In particular,

$$A_i(1) = \sqrt{\frac{V_i}{(1 - R_i^2)}}, \tag{3}$$

where R_i^2 is the fraction of the variance of a series that is predictable from a knowledge of its past history. Given this relationship, Campbell and Mankiw suggest that a nonparametric estimate of $A_i(1)$ can be calculated as

$$\hat{A}_i(1) = \sqrt{\frac{\hat{V}_i}{(1 - \hat{\rho}_{i1}^2)}}, \tag{4}$$

where the square of the first sample autocorrelation of the series is used as a conservative estimate of R_i^2.

In applying this nonparametric approach, I use $k = 7$ as the number of sample autocorrelations to include in estimating V_i. This level of k relative to the size of the various sample periods is approximately the level that Campbell and Mankiw suggest is necessary to distinguish between a deterministic and a nondeterministic process in Monte Carlo simulations. More intuitively, $k = 7$ should satisfy the requirement that k be fairly large in order to capture any reversion to trend that occurs only after a fairly long lag. At the same time, $k = 7$ is still small relative to the sample size of 25 annual observations in the prewar era and 37 in the postwar era. Hence, it should not introduce the downward bias in $\hat{A}_i(1)$ that results when k is very large relative to the sample size (see Campbell and Mankiw [1987a]).

B. Results for the Individual Series

Changes in Persistence. The nonparametric estimates of $A_i(1)$ are given in Table II. These estimates indicate that for many goods there has been no obvious change in the persistence of short-term fluctuations between the prewar and postwar eras. A simple indicator of this fact is that the median $\hat{A}_i(1)$ is 0.62 in the prewar era and 0.64 in the postwar era. When one examines the goods with the highest gross value or value added, there is somewhat more evidence of a change in persistence over time. For example, the $\hat{A}_i(1)$ for pig iron increased from 0.58 in the prewar era to 0.81 in the postwar era, and that for cotton consumed increased from 0.46 to 0.62. This finding may indicate that movements in the production of major goods became slightly more persistent over time.

The basic similarity in the amount of persistence shown by most individual commodities between the prewar and postwar eras suggests that some combination of the nature of shocks facing these industries and the reaction of the industries to shocks has not changed drastically over time. If shocks had changed, say, from being primarily transitory demand shocks in the prewar era to being permanent productivity shocks in the postwar era, one would certainly expect to see a noticeable change in the persistence of fluctuations in the production of most goods between the two periods. Following this reasoning, the slight increase in persistence shown by major commodities could suggest that for these industries permanent shocks became more important in the postwar era or that the ability of these industries to recover from shocks slowed over time.

Table II also shows that the level of persistence for most commodities was basically the same in the interwar era as in the prewar and postwar periods. The median $\hat{A}_i(1)$ is 0.66 in the 1920s and 1930s.[12] This finding, in combination with the finding that the volatility of production increased dramatically in the interwar era, suggests that the size of shocks (or possibly the response to shocks) rose in the interwar era, but that the source of these shocks and the

12. It is possible that the increase in persistence in the interwar period is larger than that suggested by the estimates of $A_i(1)$ because $k = 7$ may be quite large relative to the sample size of 17. As a result, the interwar estimates of $A_i(1)$ may be biased downward in a way that is not true in the longer prewar and postwar eras. However, it is unlikely that taking this bias into account could undo the basic similarity between the three eras.

TABLE II
MEASURE OF PERSISTENCE

Series	$\hat{A}_t(1)$[a]		
	1889–1914	1922–1939	1947–1984
Corn	0.45	0.49	0.43
Wheat	0.50	0.50	0.62
Oats	0.42	0.44	0.53
Barley	0.54	0.52	0.66
Flaxseed	0.61	0.77	0.50
Rye	0.81	0.55	0.65
Irish potatoes	0.38	0.49	0.42
Sweet potatoes	0.74	0.66	0.51
Hay	0.50	0.46	0.43
Cotton	0.38	0.62	0.40
Tobacco	0.58	0.63	0.46
Bituminous coal	0.80	0.72	0.89
Coke	0.64	0.67	0.77
Anthracite coal	0.43	0.70	0.63
Petroleum	0.91	0.75	1.09
Cement	1.32	1.11	0.96
Pyrites	0.62	0.40	0.50
Phosphate rock	0.80	0.65	0.88
Iron ore	0.68	0.64	0.53
Pig iron	0.58	0.70	0.81
Copper	0.85	1.03	0.54
Lead	0.65	1.26	0.74
Zinc	0.48	0.93	0.88
Gold	1.07	2.12	1.18
Silver	0.71	1.30	0.52
Coffee imported	0.49	0.46	0.53
Cotton consumed	0.46	0.49	0.62
Silk imported	0.42	1.17	0.66
Sugar	0.49	NA	0.75
Canned corn	0.56	0.46	0.40
Canned tomatoes	0.37	0.45	0.49
Beer	0.77	1.26	1.55
Distilled spirits	0.68	0.71	0.61
Tobacco	0.66	0.93	1.21
Cigars	1.04	1.00	0.97
Cigarettes	2.01	1.19	0.89
Rails	0.70	0.66	0.80
Steel	0.58	0.64	0.67

a. $\hat{A}_t(1)$ is a nonparametric estimate of the infinite sum of moving average coefficients.

longevity of the responses were not fundamentally different from those in other areas.

Level of Persistence. In addition to examining possible changes in persistence over time, it is also important to discuss the absolute levels of persistence in the individual series in various periods. Do the estimates of $A_i(1)$ suggest that fluctuations in the production of particular commodities are mainly transitory or mainly permanent?

To answer this question, it is first useful to note that there is a noticeable difference in the level of persistence shown by agricultural and nonagricultural goods. The median $\hat{A}_i(1)$ is roughly 0.50 for agricultural goods in both the prewar and postwar eras and 0.70 for nonagricultural goods. The estimates of $A_i(1)$ for the various agricultural products indicate that a substantial fraction of the effect of a shock to agricultural production is undone in subsequent years. While it is usually natural to presume that such transitory movements in production are caused by demand shocks, this assumption may be unreasonable in the case of agricultural goods. Many of the supply shocks affecting agriculture, such as weather and disease, could plausibly be temporary as well.

For mining and manufactured goods the permanent effect of a shock is typically larger than that for agricultural goods. This is true for most of the goods in these two sectors, and there is no consistent difference in the level of persistence shown by major and minor commodities. The estimates of $A_i(1)$ for these nonagricultural goods indicate that a large fraction of the effects of a shock remains after several years, though fluctuations are less persistent than if the production of these goods actually followed a random walk.[13] The most obvious interpretation of the persistence of fluctuations in mineral and manufacturing production is that shocks to these sectors tend to come at least partially from the supply side. However, it could also indicate that demand shocks have long-lasting effects.[14] The possibility that demand shocks have very persistent effects is particularly likely for industry-specific shocks because they could be related to permanent changes in tastes for individual commodities.

13. It is possible that the nonparametric estimate of $A_i(1)$ overestimates the persistence of short-run movements in production. Including only seven lagged autocorrelations means that the measure will miss any trend reversion that occurs after seven years.

14. See D. Romer [1989] for evidence on this possibility.

C. Implications for the Behavior of Aggregate Output

As was the case with volatility, it is useful to consider what the persistence of individual production series may tell us about the persistence of aggregate output. And again as with volatility, it is risky to infer the level of persistence of aggregate output from the persistence of the individual series. It is possible that the timing of fluctuations in the individual series is such that aggregate fluctuations could be either more or less drawn out than the individual fluctuations. At the same time, however, the fact that most of the series, and especially most of the industrial series, show very similar levels of persistence makes it tempting to assume that the persistence of aggregate output is similar to the persistence of the individual series.

If one makes this assumption, then the results for the individual series suggest that movements in aggregate output are persistent, but not dramatically so. That is, shocks appear to have some permanent effects, but not enough to cause output to follow a random walk. This implication for aggregate output basically confirms the research of Campbell and Mankiw [1987a, 1987b, 1989], which shows that fluctuations in aggregate GNP are quite persistent in the postwar era. However, the individual production series do not lead one to expect the more than one-for-one permanent effect of shocks that Campbell and Mankiw find in the aggregate data.

Because Section V indicates that there has been little change in the relationship between goods, it is likely that the individual results may provide more concrete evidence on the change in aggregate persistence. If the relationship between goods has not changed, it seems unlikely that the changes in the individual series could be undone by aggregation. As discussed above, while many of the individual series show little, if any, increase in persistence over time, major goods such as steel, pig iron, coal, cotton consumed, and wheat show some increase in persistence. Because such major goods will account for a large fraction of total output, this finding may suggest that aggregate output shows a modest increase in persistence over time.

This result is again consistent with the work of Campbell and Mankiw [1987a], which finds that aggregate GNP has become much more persistent between the prewar and postwar eras. However, even the individual goods with large gross value or value added do not show the dramatic increase in persistence that Campbell and Mankiw find in the aggregate data. This could suggest either that the aggregate data for the prewar era are imperfect, or that the change in the fraction of GNP accounted for by commodities has altered the persistence properties of total GNP substantially.

The behavior of the individual production series suggests that there was little change in aggregate persistence between the prewar and interwar eras. Because even major commodities show little increase in persistence between the prewar and interwar eras, it is hard to infer that fluctuations in aggregate production became noticeably more persistent in the 1920s and 1930s. This finding may seem somewhat anomalous given that the Great Depression is conventionally viewed as a period of very prolonged misery. One possible resolution for this seeming inconsistency could be the substantial increase in labor productivity noted by Bernanke and Parkinson [1989]. This rise in productivity is consistent with a more rapid recovery of output than of employment.

V. The Relationship Between Goods

The previous analysis has looked at the volatility and persistence of the individual series. From the differences in these characteristics across series, I have tried to infer whether similar shocks or different shocks were affecting the various industries. In this section I use factor analysis to analyze this question more explicitly.[15] Ascertaining whether the production of individual commodities moves in concert or separately is useful because the two types of behavior are consistent with very different explanations of short-run fluctuations. The predominance of an aggregate factor is consistent with models of fluctuations in which all industries move together because of aggregate demand or aggregate productivity shocks. It is also consistent with models in which sectoral shocks have rapid and extensive spillovers to other sectors.[16] The predominance of industry-specific shocks is consistent with the view that industries are shocked at different times and that linkages between sectors are weak or occur with a substantial lag.[17]

15. For an earlier application of factor analysis to this question, see Long and Plosser [1987].
16. See, for example, Long and Plosser [1983] and Murphy, Shleifer, and Vishny [1989].
17. See Lilien [1982].

A. Factor Analysis

Factor analysis with one common factor is a statistical procedure that decomposes the movement in each member of a set of series into the part that is due to a single unobserved common factor and the part that is due to a disturbance unique to the individual series. In terms of the notation given in Section IV, it seeks to decompose the deviation of the annual growth rate of each series from its mean ($\Delta y_{it} - \beta_i$) into the part that is due to a common disturbance (C_t) and the part that is due to a series-specific disturbance (u_{it}). That is,

$$\Delta y_{it} = \beta_i + \lambda_i C_t + u_{it}, \tag{5}$$

where u_{it} and C_t are uncorrelated and the series-specific disturbances are uncorrelated across commodities. This decomposition is accomplished by first normalizing the variances of the Δy_{it}s and the variance of C_t to one, and then using the comovement between the series to infer the importance of the common factor. That is, the procedure parameterizes the cross-correlation matrix in terms of the λ_is and then chooses the $\hat{\lambda}_i$s to minimize the discrepancy between the actual sample cross-correlations and the estimated cross-correlations.

Because the variances of C_t and the Δy_{it}s are normalized to one, the squares of the $\hat{\lambda}_i$s provide estimates of the fraction of the variance of the growth rate of each series that can be explained by the unobserved common factor. In what follows, I interpret this fraction as showing the relative importance of aggregate shocks in determining the behavior of disaggregate production in various time periods. However, it is important to note that the common movement in the series need not come solely from aggregate shocks such as changes in the money supply or the price of oil. Rather, it could come from sectoral shocks that spread rapidly from one industry to another.

The unsquared estimates of the λ_is (the factor pattern) provide additional information on the signs of the responses of individual production series to the common factor: a series with a negative $\hat{\lambda}_i$ tends to move contrary to the common factor, while a series with a positive $\hat{\lambda}_i$ moves in the same direction. One can examine how these signs have changed over time to infer whether series have changed in their relationship to the common factor and implicitly, therefore, in their relationship to one another.

B. Results for the Individual Series

Importance of the Common Factor. Table III shows the factor patterns for the 38 series in the prewar, interwar, and postwar time periods, respectively.[18] In both the prewar and postwar eras, the fraction of the total variation that is accounted for by the single common factor varies substantially across goods. For some goods the aggregate factor appears to account for at least half of the total variation in both periods; for most other goods the fraction of total variation accounted for by the aggregate factor is very low in both the prewar and postwar eras. The greater prevalence of goods for which the common factor is unimportant is illustrated by the fact that the median $\hat{\lambda}_i^2$ is 0.09 in the prewar era and 0.06 in the postwar era. Since the $\hat{\lambda}_i$s are derived from the sample cross-correlations, the finding that the $\hat{\lambda}_i^2$s of many goods are low is indicative of the fact that the cross-correlation between most goods is very small.

There is a definite pattern in the estimated importance of the aggregate factor. First, agricultural goods typically have a lower fraction of total variation explained by the common factor than do mineral or manufactured goods. This is consistent with the notion that the agricultural sector is subject to its own common shock or that various agricultural goods are subject to product-specific shocks. The unimportance of the aggregate factor for agricultural goods also carries over to some manufactured goods that are very closely tied to agriculture, such as canned corn and canned tomatoes.

Second, the goods for which the aggregate factor is most important are major mineral and manufactured commodities: steel (and its close relatives), cotton textiles, and coal. In keeping with this pattern, the common factor explains much more of the total variance of crude petroleum production in the postwar era when

18. Five of the 38 series are closely related to steel production (coke, pig iron, iron ore, raw steel, and steel rails) and, hence, are highly correlated. One might worry that in this situation the factor analysis would fit the data by setting the common factor equal to the shocks facing the steel industry. To test for this, I ran the analysis on all 38 goods and on a sample that excluded all of the steel-related series except pig iron. Excluding all but one of the steel-related series did not affect the results for the prewar or interwar eras substantially because other series, such as cotton consumed and cement produced, are also highly correlated with pig iron. As a result, even in the restricted sample the factor analysis associates the common factor very closely with fluctuations in pig iron production. In the postwar era excluding the steel-related series mattered somewhat more, but the factor pattern is qualitatively similar to that of the full sample. Because including all 38 series did not yield substantially different results, the estimates reported in this section are based on the full sample of commodities.

TABLE III
FACTOR PATTERN

Series	Coefficient on the common factor[a] 1889–1914	1922–1939	1947–1984
Corn	0.20	−0.19	−0.02
Wheat	0.26	−0.08	−0.26
Oats	0.36	−0.19	−0.30
Barley	0.31	−0.26	−0.16
Flaxseed	0.38	−0.01	−0.19
Rye	0.20	−0.31	0.00
Irish potatoes	0.26	−0.25	−0.01
Sweet potatoes	−0.10	−0.40	0.00
Hay	0.10	−0.32	0.01
Cotton	−0.59	0.33	0.23
Tobacco	0.48	0.56	−0.10
Bituminous coal	0.79	0.92	0.52
Coke	0.95	0.95	0.94
Anthracite coal	−0.07	0.51	0.16
Petroleum	−0.03	0.71	0.50
Cement	0.70	0.75	0.48
Pyrites	0.30	0.67	0.24
Phosphate rock	−0.17	0.80	0.38
Iron ore	0.91	0.96	0.83
Pig iron	0.96	0.96	0.96
Copper	0.32	0.87	0.60
Lead	−0.04	0.90	0.01
Zinc	0.74	0.93	0.35
Gold	−0.25	0.32	0.06
Silver	0.39	0.80	0.25
Coffee imported	0.11	0.12	0.18
Cotton consumed	0.79	0.68	0.62
Silk imported	0.31	0.09	0.38
Sugar	0.05	NA	0.18
Canned corn	−0.18	0.36	−0.09
Canned tomatoes	−0.02	0.17	−0.22
Beer	−0.22	0.39	0.02
Distilled spirits	0.19	0.63	0.27
Tobacco	0.42	0.46	−0.21
Cigars	0.50	0.91	0.21
Cigarettes	−0.07	0.88	0.39
Rails	0.86	0.88	0.70
Steel	0.93	0.92	0.96

a. Factor coefficients are estimated using the principal factors estimation algorithm in SAS. All 38 series are included in the analysis of the prewar and postwar eras; refined sugar is excluded in the interwar era because of missing observations.

petroleum has become an important commodity than in the prewar era. The mineral and manufactured goods that do not appear to be affected by the common factor are typically minor goods with low value added, such as phosphate rock, refined lead, and processed coffee.

It is important to note that the fact that the aggregate factor accounts for more of the variance of major goods than of minor goods is not present by construction: the factor analysis procedure treats all industries symmetrically, regardless of their value added. There are two other hypotheses about disaggregate production, however, that could account for this result. One is that the sensitivity of disaggregate production to aggregate shocks is the same for all commodities but that industry-specific shocks are relatively larger for minor goods than for major commodities. One piece of evidence against the appropriateness of this model is that the standard deviations of the growth rates of minor commodities in the prewar and postwar eras are not consistently larger than those for the major commodities. If aggregate shocks had the same effect on all goods but industry-specific shocks were larger for minor commodities, then the standard deviations should be larger for minor goods.

An alternative model that is more plausible is that producers of major products differ systematically from producers of minor products in a way that increases their sensitivity to aggregate disturbances. For example, major goods producers may tend to be more capital intensive, or they may tend to be more heavily unionized than makers of minor goods. Both of these differences could cause production in larger industries to respond particularly strongly to aggregate shocks such as changes in monetary or fiscal policy.

That much of the variation in minor goods and agricultural products is due to industry-specific shocks is obviously important for understanding fluctuations in particular industries. It is also important if one is interested in inferring the behavior of aggregate output from the behavior of the individual series. The relative unimportance of aggregate disturbances for most goods indicates that the correlation between many goods in the economy is quite low. As discussed in Sections III and IV, this means that the volatility and persistence characteristics of any one individual series or a simple average of these measures for all series will not provide a good indication of aggregate volatility or persistence.

The finding that some goods are much more sensitive than other goods to the common factor could also be useful in revealing the nature of aggregate shocks. If most of the variance of some goods is determined by the common factor, then looking at the persistence characteristics of these goods could suggest whether the effects of aggregate shocks are transitory or long-lasting. The finding from Section IV is that the estimated $A_i(1)$ for major goods is similar to that of other products and consistently in the range of 0.5 to 0.8. That there is noticeable persistence even of the fluctuations of major goods, whose behavior is dominated by aggregate shocks, suggests that aggregate shocks are not the purely transitory demand disturbances they are sometimes assumed to be. Indeed, the finding that the persistence of major goods is similar to that of minor goods, whose behavior appears to be dominated by industry-specific shocks, suggests that the composition of aggregate and disaggregate shocks in terms of transitory and permanent disturbances is roughly the same.

In addition to showing the importance of aggregate shocks within each era, the separate factor analyses for the various sample periods allows one to examine possible changes in the importance of the common factor over time. Table III shows that between the prewar and postwar eras there has been little change in the fraction of a given good's total variance that is explained by the common factor. If one were to push the data very hard, it might be possible to say that the importance of the aggregate factor declined slightly for several goods, but this change is not dramatic. There is also no consistent difference in the change shown by major and minor goods. The fact that there has been at most a slight secular decline in the importance of the common factor for most series may suggest that government policies designed to eliminate aggregate disturbances or to neutralize the reaction to such aggregate shocks have not been obviously successful.

While there has been little change in the importance of aggregate shocks between the prewar and postwar eras, the common factor is definitely more important in the interwar era. For mineral goods the fraction of the variance explained by the common factor is over 0.5 for all but three of the series. For manufactured and agricultural goods the fraction varies more, but is quite high for most series. The median $\hat{\lambda}_i^2$ for all 37 commodities in the interwar era is 0.31. This increased importance of the common factor in the interwar era is consistent with the notion that a large and powerful aggregate shock affected the U. S. economy in the 1930s. In the presence of such a large aggregate shock, even the behavior of minor goods that are not particularly sensitive to aggregate disturbances would be driven by the aggregate shock. As a result, this aggregate effect could dominate the impact of industry-specific shocks.

Factor Pattern. In addition to providing evidence on the relative importance of the common factor, factor analysis also indicates the sign of the sensitivity of the individual series to the common factor. These factor patterns are given in Table III. The estimates of the λ_is show that in all eras mineral and manufactured goods typically respond positively to the common factor. While there are a few exceptions to this pattern, none of the negative coefficients are large.

For agricultural goods the factor pattern shows somewhat more of a change over time. In the prewar era agricultural goods typically have a positive relationship with the common factor. In the interwar era the typical relationship is clearly negative. In the postwar era the relationship of agricultural goods to the common factor continues to be primarily negative, but is noticeably weaker than in the interwar era. While one would not want to place much emphasis on such a minor change, it could indicate that agricultural production changed from being mildly procyclical to mildly countercyclical.

The fact that neither the sign nor the size of the factor pattern has changed substantially over time provides important evidence that the relationship between the various goods has not changed radically between the prewar and postwar eras. As emphasized before, this is crucially important if one wants to make inferences about the behavior of aggregate production from the behavior of the individual series. If the relationship between goods has not changed over time, then the changes in the behavior of individual goods should provide a good indication of the changes in aggregate production. More generally, the absence of a major change in the relationship between goods suggests that the many structural changes that have occurred over time have not altered the basic productive relationships in the economy.

C. Implications for the Behavior of Aggregate Output

The preceding analysis has discussed the relative importance of aggregate and industry-specific disturbances in determining the behavior of the 38 production series. An obvious question is what, if anything, this analysis says about the importance of aggregate shocks in explaining movements in aggregate output. For answering this question, the fact that none of the factor coefficients are large, negative numbers is relevant because it indicates that the responses of individual series to the aggregate shock are not likely to neutralize one another when they are aggregated. More importantly, the fact that major commodities show a much larger role for aggregate disturbances than do minor goods suggests that aggregate output is also likely to show a more important role for aggregate disturbances. This is true because goods with high value added obviously comprise a large fraction of total production.

CONCLUSION

This paper has used annual data on the output of 38 individual commodities to examine the size, source, and comovement of fluctuations in disaggregate production both within various eras and over time. It has also tried to suggest what the behavior of these individual series implies about the behavior of aggregate output and about changes in aggregate behavior between the prewar and postwar eras. This later step is particularly useful because the disaggregate data are more consistent over time than are the available aggregate series.

The main finding is that there has been little change in the short-run behavior of individual production series between the prewar and postwar eras. Fluctuations in the production of the vast majority of the 38 goods are only slightly larger in the period before 1914 than in the period after 1947. Similarly, the persistence of fluctuations and the importance of aggregate disturbances for most goods have, at most, changed only slightly over time.

The results for the individual commodities provide little reason to believe that the volatility of aggregate output has changed dramatically between the prewar and postwar eras. Because there is no obvious bias in the sample of goods considered and because factor analysis shows no change in the relationship between goods over time, it is unlikely that aggregate volatility has decreased by more than the small amount shown by the individual goods. Similarly, since neither major nor minor goods have shown more than a small decrease in the importance of aggregate shocks, it is unlikely that the importance of aggregate shocks in determining aggregate behavior has decreased substantially over time. However, it is possible that the persistence of movements in aggregate output has increased modestly between the prewar and postwar eras. This is true because goods with high value added have shown more of an increase in persistence over time than have minor goods and because movements in major commodities appear to be closely associated with the common factor.

The finding that fluctuations may have become somewhat more persistent over time could suggest that government policy has decreased the importance of temporary aggregate demand shocks in the postwar era. However, the fact that the volatility of production and the importance of common shocks have not declined markedly suggests that the practical impact of this change has been small. This raises the question of why stabilization policy has not had a more obvious effect.

While the analysis shows very little change between the prewar and postwar eras, it does indicate a dramatic increase in both the volatility and the comovement of individual series in the interwar era. These findings are consistent with the notion that a very large aggregate shock hit the U. S. economy in the 1930s. That the fluctuations in individual series were not noticeably more persistent in the interwar era suggests that this large aggregate shock was at least partly temporary.

In addition to indicating possible changes in the behavior of production over time, this study has provided new evidence on disaggregate behavior within various sample periods. For example, estimates of persistence show that fluctuations in the production of individual mineral and manufactured goods are quite long-lasting in all eras, though some of the effects of shocks are undone eventually. The results of a simple factor analysis procedure show that most of the variation in the production of minor goods is due to industry-specific shocks, while much of the variation in major goods is due to a common factor.

These findings on the persistence and comovement of fluctuations in various series obviously have implications for economic modeling. That the effects of shocks are quite persistent in all eras suggests that the notion that most of the fluctuations in the economy are being driven by temporary demand shocks is not appropriate. Similarly, the fact that many minor goods appear to march to their own drummer suggests that the simple view of a business cycle as a time when all goods fluctuate together is naive. A more complete model of the macroeconomy for both the prewar and postwar eras would allow for a variety of temporary and permanent shocks and would include an important role for industry-specific shocks. It would also seek to explain why major goods tend to respond much more forcefully to aggregate disturbances than do minor commodities.

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