Is the Stabilization of the Postwar Economy a Figment of the Data?

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One of the most recurrent empirical generalizations about the U.S. economy is that the prewar economy was substantially more volatile than the postwar economy. It is widely accepted that the business cycle before World War II (or before World War I for that matter) was decidedly more severe than the cycle after 1947. The source of this belief is simply every conventional indicator of macroeconomic performance; industrial production, unemployment, and Gross National Product all show larger cyclical fluctuations in the late 1800's and early 1900's than after World War II.

This paper challenges part of the stylized fact that the prewar economy was substantially more volatile than the postwar economy. It provides an examination of the conventional industrial production series for the pre-World War I and post-World War II periods and shows that the apparent stabilization of this series is actually a figment of the data. I find that the methods used to construct the historical series exaggerate cyclical fluctuations in industrial production. When this exaggeration is taken into account, there is very little stabilization between the pre-1914 and the post-1947 eras.

By itself, this study of the historical industrial production data challenges some of the existing empirical studies of the stabilization of the postwar economy. For example, a recent paper by J. Bradford DeLong and Lawrence Summers (1984) uses the conventional industrial production series and real Gross National Product series to argue that cycles have become much less severe over time. By showing that the industrial production series has not stabilized over time, the present study undermines part of the empirical regularity DeLong and Summers seek to explain.

This study of the historical industrial production data is also part of a larger project. In two other papers (1985 and 1986), I examine the historical unemployment and Gross National Product data. These two studies yield results very similar to those for industrial production. In all three cases there exist fundamental inconsistencies between the historical and modern series that account for much of the damping of cyclical fluctuations between the prewar and postwar eras.

In conjunction with these other studies of historical macroeconomic data, this study of the prewar industrial production series challenges another strain of the stabilization literature. To many, what is most striking about the twentieth-century business cycle is not that particular indicators have stabilized, but rather that nearly all macroeconomic series show less severe fluctuations in the postwar era (see, for example, Arthur Burns, 1960, and Robert Lucas, 1977). The fact that the present study finds that the historical industrial production data are excessively volatile in the same way that the historical unemployment and *GNP* data are refutes this finding. Errors in the three series rather than genuine economic changes account for the apparent stabilization of these key macroeconomic series.

Historical Industrial Production Data. The historical industrial production series that I examine in this paper is that constructed by Edwin Frickey in his book *Production in the United States, 1860–1914*. Frickey's index is one of the least recognized but most often used macroeconomic series. Frickey's index is traditionally paired with the Federal Reserve Board (FRB) index of industrial

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production in manufacturing which begins in 1919 to form a series on manufacturing production going back to 1860 (see, for example, *Historical Statistics of the United States*, 1975). Frickey's index is also often combined with other historical series on mining and utilities production to form a historical extension of the total FRB index of industrial production (see, for example, G. Warren Nutter, 1962). In addition to being the key historical industrial production series, Frickey's index is also the basis for other conventional output series. For example, John Kendrick's (1961) historical estimates of total output in manufacturing are formed by using Frickey's series to interpolate between census-year benchmarks. Thus, all annual movements in this important output series are derived directly from Frickey's industrial production series.

Frickey's index is also important because it uses essentially the same methodology and includes many of the same commodities as do several other prewar indexes of industrial production. (See, for example, Frederick Mills, 1932, Warren Persons, 1931, and Walter Stewart, 1921.) As a result, Frickey's index is representative of a class of output measures. Hence, any errors found in the Frickey index will almost certainly be present in these other series.

Because of its widespread use, Frickey's index has affected many of our views about the U.S. economy before World War I. When compared to the modern FRB index of industrial production, Frickey's index is substantially more volatile. For example, the average peak-to-trough change in Frickey's index for 1866–1914 is 26 percent greater than that of the modern FRB index of industrial production in manufacturing for 1947–82. Thus, the large cyclical swings in Frickey's industrial production series have helped generate the belief that the prewar economy was much less stable than the economy after 1947.

Although Frickey's series is often used as if it were the prewar extension of the FRB index of industrial production in manufacturing, the prewar and postwar data are not consistent. Frickey's index is based on a much smaller sample of commodities than is the modern FRB manufacturing index. Furthermore, the types of goods included in Frickey's index are qualitatively different from those included in the FRB index. Whereas the FRB manufacturing index includes data on both materials and finished goods, Frickey's index is based almost entirely on materials and very basic manufactured commodities.

Overview. To see if these differences between the prewar and postwar industrial production data can explain the apparent stabilization of the postwar economy, one must separate true economic changes from the tremendous improvements in data collection procedures. To do this, I construct an exact replication of Frickey's prewar index for the post–1947 period. Replicating Frickey's procedures for the modern period yields an industrial production series that is consistent over time. The pre–1914 and the post–1947 series can be compared to see what, if any, changes have occurred in the economy. Furthermore, the modern Frickey replication can be contrasted with the modern FRB manufacturing index to show the effects of changes in data collection and transformation techniques.

In addition to examining the behavior of an exact postwar replication of Frickey's series, I also consider an updated replication of Frickey's series. The FRB index of materials production provides a modern index that is qualitatively similar to Frickey's series, but is less anachronistic than the exact replication. The FRB materials index can again be compared to the prewar Frickey index to see if consistent industrial production data show any stabilization between the prewar and postwar eras. Analysis of the FRB materials index can also be used to suggest the source of errors in the postwar exact replication of Frickey's index.

Once the source of the errors in the postwar replications of Frickey's index has been identified, it is then possible to see if the same source of errors exists in the prewar era. To preview, I find that the characteristics of the economy that cause Frickey's methods to exaggerate cyclical movements in the postwar era have not changed over time.

Thus, it is likely that Frickey's prewar index is excessively volatile.

The various steps in this analysis of the historical industrial production series are organized as follows. Section I describes Frickey's index and discusses the creation of a consistent postwar series. Section II presents a detailed comparison of the pre-1914 Frickey series and both the exact postwar replication of Frickey's series and the postwar FRB materials index. Similar business cycle analytics are used to compare these series to the postwar FRB index of industrial production in manufacturing. Section III examines why the historical methods yield a postwar series that is excessively volatile. Section IV presents evidence that the historical methods generate similar errors in the prewar era. Finally, Section V compares the results of this study of the industrial production data to those of my other studies of the unemployment and *GNP* data. It also discusses the possible implications of the findings for the effectiveness of stabilization policy.

I. Replicating Frickey's Procedures for the Postwar Period

The procedures Frickey uses to construct a prewar index of industrial production are very similar to those the Federal Reserve Board uses today. Both indexes are formed by combining data on the physical quantity of various manufactured goods. Both use value-added weights to combine numerous individual indexes of production into a single index of industrial output. Although there are minor differences in the classification of various products and in benchmarking procedures, the only major difference between the two series is the number and range of commodities included in each index. The FRB manufacturing index includes over 200 commodities; Frickey's index includes 40 commodities.

The series included in Frickey's index are not only fewer in number, but also qualitatively different from those included in the modern FRB manufacturing index. The quantity data available for the turn of the century cover only very basic commodities. Production figures exist primarily for materials and for goods early in the manufacturing process.[1] For example, there exist good data on pig iron production but no estimates of the production of tools and machinery. Similarly, there are figures on the amount of lumber produced but none on the production of flooring or other millwork products. Out of necessity, Frickey uses these available data on the production of materials to proxy for the output of more fabricated products.

Whenever Frickey uses materials to proxy for output, he tries to convert this data on materials produced to an estimate of materials consumed. That is, he attempts to estimate the amount of materials that are actually used in the domestic production of finished goods. In general, to estimate materials consumed, Frickey only corrects the existing materials produced series for fluctuations in foreign trade. In most cases the size of these corrections are so small that the production and consumption series are nearly indistinguishable.

To analyze possible errors in Frickey's prewar index, I examine two postwar replications of Frickey's series. The first is an exact replication of Frickey's methods. I form a postwar series using methods and a sample of commodities that are identical to those Frickey uses. The resulting series is consistent with the prewar Frickey index in the naive sense that the two series are formed in exactly the same way.

The second postwar extension that I consider is an updated replication of Frickey's methods. This replication tries to preserve the essential elements of Frickey's methods while taking into account the many changes that have occurred in the economy. This replication seeks to hold constant the relationship between the index and the underlying economy. That is, this updated replication is designed to preserve the limitations of Frickey's original index, but to remove the additional errors that result from replicating

[1] There are also data on goods that were taxed; specifically alcoholic beverages and tobacco products. While Frickey does include these data in his index of industrial production, these series receive very little weight in the total index.

exactly Frickey's prewar methods and sample of commodities for the larger, more advanced postwar economy.

A. *Exact Replication*

Forming an exact postwar replication of Frickey's index is fairly straightforward. The 40 commodities that Frickey includes in his index represent most of the important, high-growth materials of the prewar era. Among the series included in Frickey's index are wheat flour produced, lumber produced, pig iron consumed, and petroleum produced. Data on nearly all the goods represented in Frickey's index are still collected today. Most of the modern series can be found in either *Historical Statistics of the United States* or *Business Statistics*, the biennial supplement to the *Survey of Current Business*.

I follow Frickey very closely in combining the 40 modern series into an index of industrial production. To combine the various commodity quantity series, Frickey first converts each series into an index based in 1899. These indexes are then combined by taking a weighted average of the individual indexes. For Frickey's original index, these weights are based on the percent of total value-added that each commodity accounted for in 1899. To replicate Frickey's procedures, I choose 1967 as the base year. The weights are derived from data on value-added from the 1967 *Census of Manufactures*.

The actual derivation of the weights is complicated because the allocation of value-added to various commodities is done on the basis of all of the products for which the commodities are proxying. For example, paper consumed is weighted according to the entire value-added in the output of the printing and publishing industry. Similarly, pig iron consumed is allocated the value-added of all iron and steel "end products" except for the few for which output series exist. Fortunately, Frickey is detailed enough that it is possible to assign weights as he does.

The results of applying Frickey's procedures in the postwar era are shown in Table 1. The table shows Frickey's original index for 1866–1914 and my exact replication of his index for 1947–82.

B. *Updated Replication*

In addition to the exact replication, it is also desirable to examine an updated extension of Frickey's index. The FRB index of industrial production of materials is a readily available example of such an updated replication. The FRB materials index preserves the reliance on materials that is obvious in Frickey's index, but greatly expands the sample of materials included in the index. In addition to including most of the goods represented in Frickey's index, the FRB materials index also contains most manufactured materials such as plastics and synthetic rubber. Because the FRB materials index includes most of the important, high-growth materials, it measures the trend of industrial production in the postwar era more accurately than does the anachronistic exact Frickey replication.

The FRB materials index is a good updated replication of Frickey's index because it takes into account the changing degree of fabrication in the economy. The materials included in the FRB materials index are in general somewhat more fabricated than those in Frickey's index. Goods such as engine parts and automobile windshields are classified as materials in the FRB index. This upgrading of the commodities included in the materials index compensates for the increasing fabrication of finished goods in the United States.

While the FRB materials index is a convenient update of Frickey's original index, it is in some sense too good an index. The FRB materials index includes a much larger sample of goods and many more new commodities than does the prewar Frickey index. Thus, it is likely that the FRB materials index does not preserve all the limitations of Frickey's prewar index.[2]

[2] The only way in which the FRB materials index may be a slightly less accurate indicator of total production than is Frickey's original index is that the FRB materials index makes no correction for foreign trade. However, the effect of this particular correction is very small because the volume of trade in the materials included in Frickey's index is minimal.

TABLE 1—INDEX OF INDUSTRIAL PRODUCTION

Year	Frickey (1866–1914)	Year	Frickey Replication (1947–82)	FRB Materials (1947–82)
1866	21	1947	76.78	39.5
1867	22	1948	78.36	41.2
1868	23	1949	70.83	37.6
1869	25	1950	82.19	45.0
1870	25	1951	84.29	49.8
1871	26	1952	78.03	50.5
1872	31	1953	85.42	56.1
1873	30	1954	74.92	51.8
1874	29	1955	88.25	61.3
1875	28	1956	86.47	62.8
1876	28	1957	85.84	62.8
1877	30	1958	74.22	56.5
1878	32	1959	82.10	65.2
1879	36	1960	83.80	66.1
1880	42	1961	82.28	66.2
1881	46	1962	86.01	72.1
1882	49	1963	89.77	76.7
1883	50	1964	97.40	82.9
1884	47	1965	101.91	92.4
1885	47	1966	104.48	100.7
1886	57	1967	100.00	100.0
1887	60	1968	104.47	106.5
1888	62	1969	106.07	112.5
1889	66	1970	102.01	109.2
1890	71	1971	101.78	111.3
1891	73	1972	107.02	122.3
1892	79	1973	113.35	133.9
1893	70	1974	106.72	132.4
1894	68	1975	96.06	115.5
1895	81	1976	105.25	131.7
1896	74	1977	104.86	138.6
1897	80	1978	110.21	148.3
1898	91	1979	109.91	156.4
1899	100	1981	96.86	147.6
1900	100	1981	104.45	151.6
1901	111	1982	82.27	133.7
1902	127			
1903	126			
1904	121			
1905	140			
1906	152			
1907	156			
1908	127			
1909	166			
1910	172			
1911	162			
1912	194			
1913	203			
1914	192			

II. Comparing the Pre-1914 and the Post-1947 Indexes of Industrial Production

Having created two versions of a consistent industrial production series, it is possible to see how much of the apparent stabilization of the postwar economy is due to improvements in the data. By comparing Frickey's prewar index to either its exact or updated postwar replication, it is possible to see what the stylized facts about the economy would have been in the absence of the Federal Reserve Board index of industrial production in manufacturing. It is also useful to contrast both the postwar extensions of Frickey's index with the actual postwar FRB manufacturing index. This will help to identify the magnitude and the direction of the errors caused by using the historical methods to create postwar data.

Given that the postwar series were created using Frickey's methods, the only valid comparisons are between the prewar Frickey data and the postwar series. Since the Frickey series only exists from 1866–1914,[3] the periods of comparison must be the pre-World War I era and the post-World War II era. These are, however, both appropriate and natural eras to consider. The years between the close of the Civil War and the beginning of World War I cover a period that is traditionally thought to be very volatile. If there has indeed been a genuine damping of business cycle fluctuations over time, then the pre-1914 economy should certainly be more volatile than the economy after 1947 when consistent data are compared. Furthermore, the pre-1914 era is a period in which government monetary and fiscal policy is generally considered to have been of reasonably little importance in comparison to the importance of these policies in the postwar era. Hence a comparison of the two periods can be considered a comparison of the prepolicy and postpolicy eras.

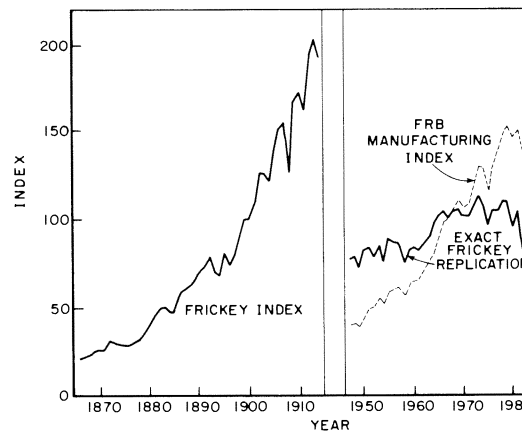

FIGURE 1. INDUSTRIAL PRODUCTION, 1866–1914 AND 1947–82

A. *Trends*

Figure 1 shows Frickey's original series for 1866–1914 and the exact postwar replication for 1947–82. It also shows the Federal Reserve Board index of industrial production in manufacturing for 1947–82.[4]

In Figure 1 the most noticeable difference between the various series is that the trend of the exact postwar replication of Frickey's series is much flatter than the trend of either Frickey's prewar series or the postwar FRB manufacturing index. The average growth rate of Frickey's series for 1866–1914 is 4.6 percent per year and that of the FRB manufacturing index for 1947–82 is 3.6 percent. However, the exact Frickey replication for the postwar period shows almost no growth between 1947 and 1982. The average growth rate of this series is only 0.2 percent per year.

This result is clearly due to the fact that the exact postwar replication is based on a very out-of-date sample of commodities. Though not shown in Figure 1, the updated Frickey replication (the FRB materials index) shows roughly the same growth as the

[3] Frickey actually forms data for 1860–65 as well. However, he suggests that the data before 1866 are of substantially lower quality than the data after 1866 (p. 3).

[4] The FRB index of industrial production in manufacturing comprises 87 percent of the total FRB industrial production index. It excludes production in mining and utilities.

TABLE 2—MEASURES OF VOLATILITY

Measure	Frickey (1866–1914)	Exact Replication (1947–82)	FRB Materials (1947–82)	FRB Manufacturing (1947–82)
Mean Cyclical Amplitude of Detrended Series[a]	.1398	.1319	.1342	.1081
Standard Deviation of Growth Rates	.0884	.0862	.0797	.0643
Standard Deviation of Deviations from Trend	.0830	.0762	.0728	.0636

[a] Trend industrial production is calculated as the fitted value of a regression of the log of industrial production on a constant and a quadratic trend.

FRB manufacturing index. The average growth rate of the materials index for 1947–82 is 3.5 percent per year. The large discrepancy between the trends of the two postwar Frickey replications shows that the accuracy with which the historical methods measure the level of industrial production depends crucially on whether one replicates the historical procedures exactly or modifies them to include modern goods.

B. *Volatility*

A second noticeable difference among the three series shown in Figure 1 is that the exact postwar replication of Frickey's series is much more volatile than the FRB manufacturing index. While the peaks and troughs of the two series are roughly coincident, the severity of cyclical swings is greater in the exact Frickey replication. This same pattern holds for the FRB materials index as well. It too is substantially more volatile than the postwar FRB manufacturing index. The greater cyclical volatility of both the consistent postwar extensions of Frickey's index makes business cycle fluctuations of these series resemble those of the prewar Frickey index quite closely.

1. *Mean Cyclical Amplitude.* The differences in volatility between all four series can be described and quantified in a variety of ways. Table 2 presents three common measures of volatility. The first of these measures is the mean cyclical amplitude of each series. This measure shows the average percentage fall in industrial production between peaks and troughs of the business cycle. For the four series on industrial production under consideration, the measurement of cyclical amplitudes is complicated by the differences in the trends of the various indexes. To account for this, the cyclical amplitude is calculated as the peak-to-trough change in the logarithm of the detrended index of industrial production. The trend values of each index are estimated as the fitted value of a regression of the logarithm of the index on a constant and quadratic trend.[5] For the calculations in Table 2, the peaks and troughs are defined to be the actual turning points in each detrended series.

From the statistics in Table 2 it is clear that the exact postwar Frickey replication and the FRB materials index are both substantially more volatile than the postwar FRB manufacturing index. For example, the mean cyclical amplitude of the FRB materials index is approximately 22 percent greater than that of the FRB manufacturing index. At the same time, both the postwar replications of Frickey's series are less volatile than the prewar Frickey series. However, the implied stabilization is very slight. The exact replication is only 6 percent less volatile than the prewar Frickey index and the FRB materials index is only 4 percent less volatile than Frickey's series. Thus, a comparison of consistent data

[5] The quadratic trend was chosen because it appears to fit all four series substantially better than a linear trend.

TABLE 3—BUSINESS CYCLES

Frickey (1866–1914)		Exact Replication (1947–82)		FRB Materials (1947–82)		FRB Manufacturing (1947–82)	
Peak-Trough	Percent Decline[a]	Peak-Trough	Percent Decline[a]	Peak-Trough	Percent Decline[a]	Peak-Trough	Percent Decline[a]
1869–71	.0556	1947–49	.1237	1947–49	.1581	1947–49	.1219
1872–76	.2917	1951–52	.0963	1951–52	.0376	1951–52	.0093
1882–85	.1845	1953–54	.1488	1953–54	.1297	1953–54	.1177
1887–88	.0149	1955–58	.2199	1955–58	.2240	1955–58	.1597
1890–91	.0199	1960–61	.0311	1959–61	.0740	1959–61	.0664
1892–94	.2454	1966–67	.0524	1966–67	.0463	1966–67	.0184
1895–96	.1382	1969–71	.0536	1969–71	.0836	1969–70	.1001
1899–1900	.0478	1973–75	.1723	1973–75	.2141	1973–75	.1791
1902–04	.1441	1978–82	.2891	1979–82	.2403	1979–82	.2008
1906–08	.2755						
1909–11	.1203						

[a] The percentage decline is measured as the difference between the logarithms of the peaks and troughs of the detrended series.

does not reveal the dramatic damping of business cycle fluctuations apparent in the inconsistent series.

The larger cyclical amplitude of the postwar Frickey replications is important because it shows that Frickey's methods systematically exaggerate cyclical fluctuations in the postwar period. For most cycles both the exact postwar Frickey replication and the FRB materials index show a larger percentage fall in output than does the postwar FRB manufacturing index. This can be seen in Table 3 which shows the peak-to-trough declines in industrial production for each cycle for these three indexes. The historical methods clearly overstate cyclical movements rather than merely add noise to the series.

2. *Standard Deviation of Growth Rates.* The standard deviation of the growth rate of industrial production is another measure of volatility. It measures how much the change in output varies from year to year. The statistics in Table 2 again show that the growth rate of industrial production is much more variable for either of the postwar Frickey replications than for the modern FRB manufacturing series. The growth rate of the exact Frickey replication for 1947–82 is approximately 29 percent more variable than the FRB manufacturing series for the same time period. At the same time, both the postwar extensions of Frickey's series are somewhat less volatile than Frickey's prewar index. Thus, for this measure of volatility, consistent data indicate that industrial production may have stabilized some, but not nearly as much as a comparison of the Frickey and FRB manufacturing data would suggest.

3. *Standard Deviation of Deviations from Trend.* The standard deviation of the deviations of industrial production from trend provides a final measure of the volatility of each series. This measure indicates the variability of yearly cyclical movements. In Table 2, I report estimates using a quadratic trend.[6] The standard deviations indicate that both the postwar Frickey replications are more volatile than the postwar FRB manufacturing series, but slightly less volatile than the pre-1914 Frickey index. For example, the standard deviation of deviations from trend of the exact postwar replication of Frickey's index is 18 percent greater than that of the postwar FRB manufacturing index and 9

[6] When a linear trend is used to detrend industrial production, the standard deviations of deviations from trend are: Frickey (1866–1914) = .0830; Exact Frickey Replication (1947–82) = .0835; and FRB Materials (1947–82) = .0831; FRB Manufacturing (1947–82) = .0714.

percent smaller than that of the prewar Frickey series.

Despite some differences between the various measures of volatility, the results of these three comparisons all point to a similar conclusion: a substantial amount of the apparent stabilization of the postwar index of industrial production is due to improvements in the data. Depending on which series and measure are used, somewhere between half and all of the observed stabilization is the result of comparing inconsistent data. When a consistent series is compared over time, the amplitude of the cycle is roughly similar before World War I and after World War II. Furthermore, while growth rates and the deviations of industrial production from trend have stabilized some, the change over the twentieth century has been mild, not dramatic.

C. *Significance Tests*

One question raised by all the measures of volatility is whether the differences between various indexes are statistically significant. From the perspective of this paper, however, significance is not a major issue. The existence of the stylized fact that the economy has stabilized implies a general consensus that the difference in volatility between the pre- and postwar series is important. If this difference is not statistically significant, then the stylized fact is on shaky ground regardless of inconsistencies in the data. If the difference is significant, then the comparison of the postwar Frickey replications and FRB manufacturing index provides an estimate of how much of the difference arises from changes in data collection procedures.

If one is willing to make distributional assumptions, it is nevertheless possible to test whether various differences in volatility are significantly different from zero. Such significance tests are straightforward in the case of differences in mean cyclical amplitudes. For comparison of the prewar and postwar series, the usual test of the difference between two means can be used. This test assumes that the two samples are independent random samples from populations that are distributed normally with the same variance. For comparison of various postwar series, it is necessary to use a paired t-test because the two samples are clearly not independent.

The test for whether differences in the standard deviations of the growth rates of various series are significant is also straightforward. Under the assumptions of normality and independence, the ratio of the two variances of growth rates is distributed F with degrees of freedom corresponding to the size of the two samples.[7] The same test can be used to compare the standard deviations of deviations from trend.

The test statistics for the various significance tests are shown in Table 4. One result is that using the traditional inconsistent data, the apparent stabilization of the postwar economy is significant. When Frickey's prewar data are compared to the modern FRB index of industrial production in manufacturing, it is generally possible to reject the hypothesis that the volatility of the two series is the same.

A second result is that the slight stabilization shown in the consistent data is not significant. For all three measures of volatility, it is not possible to reject the hypothesis that the prewar Frickey index and both the postwar extensions of Frickey's index are equally volatile. Furthermore, it is also not possible to reject the hypothesis that the exact Exact Replication replication and the postwar FRB materials index are equally volatile. Thus, it is reasonable to conclude that Frickey's prewar index and both the possible consistent postwar extensions have equally severe cyclical movements.

D. *Length and Timing of Cycles*

The fact that Frickey's methods overstate cyclical movements in the postwar period has important implications for the timing and duration of cycles. In several cases this

[7] For growth rates the assumption of independence is probably reasonable. Because the logarithms of various indexes of industrial production are fairly close to random walks, the growth rates are nearly serially uncorrelated. For deviations from trend, the assumption of independence is clearly much less realistic.

TABLE 4—SIGNIFICANCE TESTS

Differences in Mean Cyclical Amplitude[a]	
Mean (Frickey)-Mean (Exact Replication)	.0079
	(.1868)
Mean (Frickey)-Mean (FRB Materials)	.0056
	(.1362)
Mean (Frickey)-Mean (FRB Manufacturing)	.0317[b]
	(.8085)
Mean (Exact Replication)-Mean (RFB Materials)	−.0023
	(−.1783)
Mean (Exact Replication)-Mean (FRB Manufacturing)	.0238[c]
	(1.444)
Mean (FRB Materials)-Mean (FRB Manufacturing)	.0260[c]
	(3.416)
Equality of Standard Deviations of Growth Rates	
SD^2 (Frickey)/SD^2 (Exact Replication)	$F=1.052$
SD^2 (Frickey)/SD^2 (FRB Materials)	$F=1.230$
SD^2 (Frickey)/SD^2 (FRB Manufacturing)	$F=1.890$[d]
Equality of Standard Deviations of Deviations from Trend	
SD^2 (Frickey)/SD^2 (Exact Replication)	$F=1.186$
SD^2 (Frickey)/SD^2 (FRB Materials)	$F=1.300$
SD^2 (Frickey)/SD^2 (FRB Manufacturing)	$F=1.703$[d]

[a] The t-statistics are shown in parentheses.
[b] Significant at the 80 percent confidence level.
[c] Significant at the 90 percent confidence level.
[d] Significant at the 95 percent confidence level.
[e] Significant at the 99 percent confidence level.

exaggeration turns periods of stagnation into what appear to be genuine recessions. Periods of no growth or very slight downturn in the FRB manufacturing index turn into periods of substantial drops in output in the exact or updated postwar Frickey indexes. This fact is easily seen in Table 3, which shows the peaks and troughs of the exact Frickey replication, the FRB materials index, and the FRB manufacturing index. The peaks and troughs are not necessarily NBER reference cycles. Rather, they correspond to actual highs and lows of the particular detrended annual series.

From the peak-to-trough changes in the three detrended series it is possible to see that the postwar Frickey replications have cycles not present in the FRB manufacturing index. The years 1952 and 1967 appear to be years of significant recession in both the exact Frickey replication and the FRB materials index, while they are only the mildest downturns in the postwar FRB manufacturing index. Because the downturns in the FRB manufacturing index are so slight, it is fair to say that the 1951–52 and 1966–67 cycles do not appear in the true data. On the other hand, these same recessions clearly are genuine cycles in the postwar extensions of Frickey's data.[8]

The presence of additional cycles in the Frickey replications alters one's view of the postwar economy. Rather than looking like a period of long, protracted cycles, the post-1947 era looks more like an era of short, choppy cycles. This is seen when one compares the average duration of cycles. In the FRB index of manufacturing production for 1947–82, a cycle lasts on average 5.3 years. Both the postwar extensions of Frickey's index have cycles substantially shorter than those in the postwar FRB manufacturing series. For the exact replication, the average cycle lasts 3.9 years. For the FRB materials index, the average cycle lasts 4.0 years.

[8] This assertion can be codified by saying that cycles with a percent decline of less than 2 percent should not be counted as genuine cycles.

TABLE 5—SAMPLE AUTOCORRELATIONS

Lags	Frickey (1866–1914)	Exact Replication (1947–82)	FRB Materials (1947–82)	FRB Manufacturing (1947–82)
Percentage Changes				
1	−.195	−.382	−.230	−.162
2	−.304	.122	−.044	−.092
3	.220	−.053	−.056	−.038
4	−.011	−.022	.014	.000
5	−.256	.178	.100	.097
6	−.092	−.178	−.146	−.114
Deviations from Trend				
1	.439	.260	.351	.437
2	.112	.260	.125	.173
3	.124	.087	.023	.065
4	−.135	.082	.041	.051
5	−.360	.108	.014	.020
6	−.297	.097	−.143	−.126

If one makes the same calculation for the prewar Frickey index, the average cycle is longer than that for the postwar Frickey replications. Excluding very small cycles (those with a decline in industrial production of less than 2 percent), the average cycle in the prewar Frickey index lasts 5.0 years. This suggests that when consistent data are compared, cycles are approximately one year shorter in the prewar era than in the postwar era.

Very similar results emerge from a consideration of the autocorrelation functions for each index of industrial production. The first six sample autocorrelations of the percentage changes and the deviations from trend of series are given in Table 5. Although the magnitude of the differences in the autocorrelation functions of the four series is reasonably small, the direction of differences is suggestive. Using percentage changes, the first-order sample autocorrelations of the prewar Frickey index and the postwar FRB manufacturing index are smaller negative numbers than are the first-order sample autocorrelaions of either of the postwar replications of Frickey's index. This suggests that the postwar exact Frickey replication and the FRB materials index exhibit choppier movements than do either the prewar Frickey index or the postwar FRB manufacturing index. Using deviations from trend, the first-order sample autocorrelations of the prewar Frickey index and the postwar FRB manufacturing index are larger positive numbers than are the first-order sample autocorrelations of either of the postwar Frickey replications. This finding is consistent with the view that cycles are more protracted in the prewar Frickey index and the postwar FRB manufacturing index than in the exact postwar Frickey replication or the FRB materials index.

The results of both the simple calculation of the length of cycles and the estimation of sample autocorrelations challenge the traditional view that the length and timing of cycles have been stable between the prewar and postwar eras.[9] While this traditional view is evident in a comparison of the prewar Frickey and the postwar FRB indexes of manufacturing production, it is much less apparent when consistent data are compared over time. When consistent data are examined, cycles in the postwar era appear to be somewhat shorter and less protracted than cycles in the period 1866–1914. This result,

[9] The conventional stylized fact is stated most succinctly in Victor Zarnowitz and Geoffrey Moore. Using the conventional NBER business cycle chronology they conclude "With regard to the total cycle durations, neither the means nor the standard deviations indicate any significant trends. Expansions lengthened and contractions shortened drastically but cycle lengths remain about the same" (1984, p. 7).

combined with the earlier results on cyclical amplitude, may suggest that while policy or institutional changes in the economy have not led to a dramatic decline in the severity of cycles over time, they have led to a noticeable shortening of cyclical fluctuations.

III. The Source of Excess Volatility

Considering the significant differences between the postwar FRB manufacturing index and both postwar replications of Frickey's index, it is important to discover what is causing the postwar replications of Frickey's index to have much larger and more frequent cyclical fluctuations than the FRB index of manufacturing production. Specifically, to be able to argue that the prewar Frickey series is excessively volatile, it is necessary to know where the historical methods go wrong. Only by identifying the source of systematic errors in the postwar constructed series is it possible to see if the same sources exist in the historical period.

Since the methods used to construct both the Frickey and the FRB indexes are very similar, the source of the differences in volatility must lie in the vast differences in the sample of commodities included in the two indexes. The three main discrepancies between the two samples are that Frickey's sample is much smaller, much more biased toward materials and primary goods, and comprised of more outdated goods than is the modern FRB manufacturing index.

A. *Reliance on Materials*

From the comparisons of Section II we already have a great deal of evidence concerning which of these differences is most important. The behavior of the exact postwar Frickey replication shows the combined result of all three discrepancies. By using exactly the same sample of commodities that Frickey uses, the exact replication has all the errors stemming from using the production of a small sample of outdated materials to estimate industrial production. The behavior of the FRB materials index, on the other hand, shows the result of only one discrepancy: the reliance on materials. Because the FRB materials index includes a large sample of modern commodities, it should be free of the problems related to using a small sample of anachronistic commodities.

The statistics in Table 2 show that the mean cyclical amplitudes of the exact Frickey replication and the FRB materials index differ by less than 5 percent. A paired t-test shows that the two amplitudes are not significantly different from one another. The standard deviations of percentage changes and deviations from trend are also very similar for the exact Frickey replication and the FRB materials index. This suggests that despite the large differences in the number of commodities and the number of modern products included in the two indexes, the two postwar extensions of Frickey's index appear to accentuate cyclical movements to nearly the same degree. Since the reliance on materials is the one characteristic that the two indexes have in common, it is likely that the reliance on materials is the key source of the exaggeration of cyclical movements in the postwar extensions of Frickey's index.

B. *Cyclical Movements in Materials Inventories*

It is natural to question why materials are more volatile than manufactured goods in general. A partial explanation is that investment in materials inventories is very procyclical. In a recession, inventories of manufactured materials and supplies are run down tremendously, while in a boom they are increased greatly. This implies that, for a given level of demand, the movement in the production of materials is substantially greater than the actual movements in the consumption of these goods. Thus, even if the consumption of materials were proportional to the output of more fabricated products, the production of materials would show larger cyclical fluctuations than manufactures in general.

To see this more clearly it is useful to examine two identities. Suppose that industrial production is directly proportional to materials consumed. Then

$$Y_t = YMC_t \tag{1}$$

where Y_t is total output and YMC_t is materials consumed. By definition,

$$YMC_t = YM_t - \Delta N_t \tag{2}$$

where YM_t is the production of materials and ΔN_t is the change in materials inventories over year t. If materials inventory investment is procyclical, then cyclical movements in materials consumed are always smaller than cyclical movements in materials produced. Empirically, the correlation between changes in materials inventories and the deviations of industrial production from trend is approximately 0.6.[10] Thus, materials inventories movements may explain why a materials index is more volatile than an index of total output.

Given this possible role for inventories, it is useful to see if the size and timing of movements in materials inventories are such that they can explain the observed difference in the cyclical volatility of materials production and the production of all manufactured commodities taken together. One way to see how important inventories are is to see how much correcting the FRB materials index for movements in inventories changes the volatility of the materials index.

To change the materials index from a production to a consumption index, one must first develop a series on the real value of materials inventories. The Bureau of the Census has collected data on materials and supplies inventories since 1954. This is a nominal series that values inventories at the smaller of cost or price. Thus, any form of deflation is inaccurate. Accepting this problem, a reasonable way of deflating is simply to divide the inventory series by the Producer Price Index for intermediate goods. While still inaccurate, this price index does measure many of the relevant price changes.

[10] The change in materials inventories is measured using the Bureau of the Census series on the nominal value of materials and supplies inventories, deflated by the Producer Price Index for intermediate goods. Industrial production is measured using the FRB manufacturing index.

To combine the changes in real inventories with the FRB index of materials production requires a further assumption. The change in real inventories can be represented as

$$\Delta N_t = \sum_i p_{i,1967} \Delta Q_{i,t} \tag{3}$$

where ΔN_t is the change in the level of real materials inventories in year t, $p_{i,1967}$ is the price of material i in 1967, and $\Delta Q_{i,t}$ is the change in the quantity of inventories of material i in year t. The index of the industrial production of materials can be represented as

$$IPM_t = \sum_i \frac{v_{i,1967}}{V_{1967}} \frac{Q_{i,t}}{Q_{i,1967}} \tag{4}$$

where IPM_t is the index of materials production in year t, $v_{i,1967}$ is the value-added by material i in 1967, V_{1967} is the total value-added in 1967, $Q_{i,t}$ is the physical quantity of material i produced in year t, and $Q_{i,1967}$ is the physical quantity of material i produced in 1967.

If one multiplies IPM_t by V_{1967}, this leaves

$$IPM_t V_{1967} = \sum_i \frac{v_{i,1967}}{Q_{i,1967}} Q_{i,t}. \tag{5}$$

In this form it is clear that to combine ΔN_t and $IPM_t V_{1967}$, one must assume that price per unit of material i in 1967 is proportional to value-added per unit of material i in 1967. That is, for all commodities, one must be able to write

$$p_{i,1967} = \alpha(v_{i,1967}/Q_{i,1967}). \tag{6}$$

A comparison of the value-added in production and the value of shipments for the various materials indicates that this is not an altogether unreasonable approximation. On the aggregate level, and more roughly on the disaggregate level, price is approximately twice as large as value-added per unit. In the 1971 edition of *Industrial Production*, the Federal Reserve Board calculates both the total value of shipments and the total value-added of the commodities included in their

TABLE 6—EFFECTS OF INCLUDING INVENTORIES, 1954–82

Measure of Volatility	FRB Manufacturing	FRB Materials	Index of Materials Consumed[a]
Mean Cyclical Amplitude of Detrended Series	.1237	.1498	.1389
Standard Deviation of Growth Rates	.0620	.0761	.0690
Standard Deviation of Deviations from Trend	.0610	.0714	.0677

[a] FRB materials index corrected for changes in inventories.

materials classification in 1963. The ratio of the two is 1.97. This ratio can be taken to summarize the relation between price and value-added.

To form the corrected materials index is now straightforward. The materials index is multiplied by 1.97 times the value-added in the production of materials in 1967. The change in real inventories is then subtracted from this figure. This leaves a series on the real value of materials consumed. To return this series to index form, it is normalized by dividing each observation by the value of the series in 1967. Because the inventory data are only available after 1954, an index of materials consumed can only be created for the period 1954–82.

The results of correcting the FRB materials index for movements in inventories are shown in Table 6. The table shows various measures of volatility for both the original materials index and the new materials consumed index. The results are quite strong: the index of materials consumed is substantially smoother than the original FRB materials index. For the mean cyclical amplitude, it is possible to reject the hypothesis that the average amplitudes of the materials consumed and the materials produced indexes are the same at the 95 percent confidence level ($t = 2.66$). Indeed, correcting for inventory movements reduces the discrepancy between the volatility of the materials index and the total FRB manufacturing index by approximately half. This suggests that inventory movements are important and an accurate index of materials consumed is much less volatile than an index of materials produced. For this reason, total output, which is more closely proportional to materials consumed, is less variable than materials produced.

Inventory movements may, in fact, explain more of the difference in volatility between the FRB materials index and the total FRB manufacturing index than the calculations in Table 6 suggest. The crude index of materials consumed presented in Table 6 only corrects for investment in materials inventories. Investment in finished goods inventories may also be important. Goods such as pig iron or lumber are held both as materials inventories by ultimate fabricators and as finished goods inventories by the original pig iron or lumber producers. Since investment in these types of finished goods inventories is also very procyclical, a true index of the materials consumed is probably even less cyclically responsive than one that only takes into account materials inventory investment.

IV. Is the Prewar Index of Industrial Production Excessively Volatile?

Section II shows that both the postwar extensions of Frickey's index are systematically more volatile than the true total index of postwar industrial production. This section extends the analysis to see if the Frickey index is also more volatile than a true index of industrial production would be if it were available for the prewar era. It examines

whether the methods used to form the Frickey index have the same effects in the pre-1914 era as they have in the post-1947 period.

A. *The Relative Importance of Materials in the Prewar and Postwar Eras*

The first issue involved in determining whether the prewar Frickey index is excessively volatile concerns the role of materials in the prewar economy. While it is obvious that the goods included in Frickey's index are for the most part manufactured materials, it is possible that such materials represented a larger fraction of the prewar economy than such materials represent today. If this were true, then Frickey's series might not be as poor an indicator of total industrial production in the prewar era as it is in the postwar era.

To test whether or not this supposition is correct involves devising a measure of how representative a materials index is for both the prewar and postwar economies. One simple measure that can be calculated for both periods is the ratio of the cost of materials to the total value-added in manufacture, where both values are in nominal terms. This ratio provides a rough estimate of the importance of materials in the prewar and postwar eras.

Data on the necessary quantities are available from the *Census of Manufactures* for 1904 and 1967. For both time periods, the cost of materials includes both raw and partially manufactured materials. The resulting ratios of the cost of materials to total value-added in manufacture are 1.26 for 1904 and 1.14 for 1967.[11] The similarity in the ratios suggests that materials are only a slightly larger fraction of the economy in 1904 than in 1967. This implies that the prewar Frickey index and the postwar FRB materials index are approximately equally representative of the underlying economies.

There are, however, some severe limitations to the calculations. While the basic definitions and methods appear to be comparable over time, the data from the two censuses are probably not consistent. Most importantly, because the cost of materials number includes both raw and manufactured materials, this figure involves a substantial amount of double counting. If the degree of vertical integration has changed over time, then there could be different degrees of double counting in the two benchmark years which could affect the calculation. Similarly, because the available data are in nominal terms, relative price changes over time could have affected the ratios.

Nevertheless, this calculation is instructive. It suggests that the importance of materials has not decreased significantly over time. Part of the explanation of this finding is that our definition of materials has changed over time. The manufactured materials classification has come to include increasingly fabricated goods as the economy has become more sophisticated. However, the FRB materials index also includes goods much further along in the production process than does the prewar Frickey index. Thus, the comparison of the cost of materials to total value-added, where the definition of materials changes over time, does provide a legitimate way to assess how representative the prewar and postwar materials indexes are of total industrial production.

B. *The Behavior of Materials Inventories in the Prewar Era*

While the previous comparisons suggest that a materials index is no more representative of total industrial production in the pre-1914 era than in the postwar era, this is still not proof that the prewar Frickey index is excessively volatile. A second issue concerns the behavior of prewar materials inventories. It is possible that materials inventory investment was not procyclical in the prewar era as it is in the postwar era. If this were true, then Frickey's prewar index of materials produced

[11] The data for the calculations for 1904 are from Part 1 of the *Census of Manufactures* (1905, Table 57, p. 109). The data for 1967 are from Vol. 1 of the *Census of Manufactures* (1967, Table 5, p. 45). The results are essentially the same using gross value in the denominator: the ratio of the cost of materials to gross value is .57 for 1904 and .54 for 1967.

might be an adequate proxy for materials consumed and hence for total industrial production.

Historical evidence on the behavior of materials inventories is, unfortunately, very limited. Data on manufactured materials inventories are essentially nonexistent for the pre-1914 period. However, there are a few fragments of inventory data from the interwar period that can be used to test whether the cyclical behavior of inventories is similar in the interwar and postwar eras. It is likely that data from this later, but contiguous, period may reflect prewar inventory movements fairly well. It is difficult to imagine what structural shift could have caused inventory behavior to change dramatically between the early 1900's and the 1920's.

One such fragment comes from Moses Abramovitz's early study of inventories. His study includes data on raw materials inventories for the period 1918–38 (1950, chs. 9 and 10). On the basis of these data, Abramovitz finds that investment in raw materials inventories is decidedly procyclical. Using monthly data and the then fashionable business cycle techniques, Abramovitz concludes that "investment in raw materials inventories tends to conform to cycles in the rate of change in manufacturing activity" (p. 397). While Abramovitz's findings only apply to raw materials inventories rather than to manufactured materials inventories, they are nevertheless suggestive. It seems plausible that the same considerations that govern a firm's choice of raw materials inventories also apply to manufactured materials inventories. Hence, if raw materials inventory investment is procyclical in the prewar era, it is likely that manufactured materials inventory investment is procyclical as well.

A second fragment of data on interwar inventories comes from early issues of the *Survey of Current Business*. Available data on inventories of newsprint at publishers from 1920 to 1937 provide a more direct look at the behavior of an example of manufactured materials inventories. The estimated coefficient of the regression of the change in inventories of newsprint at publishers on the deviations of industrial production from trend is .336 ($s.e = .339$).[12] Because of the very limited sample the standard error is large, but the results are still suggestive of a procyclical relationship.

Finally, a third fragment of evidence concerns the behavior of materials held as finished goods inventories. As mentioned earlier, if investment in materials held as finished goods inventories is procyclical, then cyclical movements in materials produced will be larger than cyclical movements in materials consumed. There is a substantial amount of data on such finished goods inventories of materials for the interwar period. Again, from early issues of the *Survey of Current Business* it is possible to put together a sample of real finished goods inventories from the 1920's and 1930's. The sample includes a variety of materials and intermediate goods, among them lumber, wheat flour, crude petroleum, and steel sheets.[13]

The percentage changes in these series can be pooled and the composite series used to test whether investment in finished goods inventories of materials is procyclical in the interwar period. When the pooled changes in finished goods inventories are regressed on pooled deviations of industrial production from trend, the coefficient is .40 ($s.e. = .15$). This suggests that movements in finished goods inventories are procyclical. It is important to note, however, that the actual correlation between inventory movements and the cycle in this regression is small ($R^2 = .06$). This fact, however, is probably due to the fact that the inventory data are very disaggregated so that industry specific shocks may be dominating the overall influence of the cycle.

[12] The industrial production series used is the conventional FRB index of manufacturing production for 1919–47.

[13] The sample includes 118 observations. The inventory series included in the sample are: Wheat flour (1921–37); Crude petroleum (1923–37); Southern pine lumber (1920–29); Cotton cloth (1926–31); Cotton yarn (1928–31); Refined sugar (1923–37); Steel sheets (1919–35); Paper (1920–31); Woolen cloth (1934–47); Newsprint at mills (1920–37); and Petroleum coke (1923–37).

Taken together, these findings suggest that investment in materials inventories and finished goods inventories of materials are procyclical in the prewar era as they are in the postwar era. As a result, it is likely that Frickey's prewar index of industrial production overstates the volatility of the prewar economy in the same way that the replications of his index overstate the volatility of the postwar economy. Because his methods do not take into account the procyclical movements in the stock of materials, Frickey's original index exaggerates cyclical movements in total manufacturing output in the prewar era.

C. *Volatility of the Shaw-Kuznets Series*

A final, important piece of evidence on the excess volatility of the prewar Frickey index is the behavior of what appears to be a better measure of prewar industrial production. While many prewar indexes of industrial production suffer from the same excess volatility evident in Frickey's series, an annual series created by William H. Shaw (1947) appears to represent cyclical movements more accurately. The Shaw series covers the period 1889–1919. It has been extended back to 1869 by Simon Kuznets (1961).[14]

The Shaw-Kuznets series differs from other historical indexes of industrial production in that it is based on the value of commodity output rather than on the physical quantity of goods produced. To form a real measure of commodity output, the Shaw-Kuznets estimates are deflated by a series of price indexes derived from the Bureau of Labor Statistics Wholesale Price Index. The resulting estimates of real commodity output also differ conceptually from a total index of industrial production in that they include only finished goods.

Because these estimates are not based on quantity data, Shaw and Kuznets have a much larger sample of data with which to work. For a variety of reasons there are far more records on the value of goods produced in the prewar era than on the physical quantity of goods produced. Shaw and Kuznets are able to amass an impressive array of annual data on the value of finished goods produced. Most of these data are from annual state reports and special industry and government publications. These annual state data are used to interpolate between the more comprehensive data on the value of commodity output available in years in which the *Census of Manufactures* was conducted.

The fact that the Shaw-Kuznets series contains a great deal of annual data on the value of finished goods produced suggests that it should be a more accurate measure of prewar industrial production than is the Frickey index which contains only data on materials produced. Because the Shaw-Kuznets series includes data on the value of finished goods such as machines and clothing, it should be free of the excess volatility that comes from using the production of pig iron and cotton to proxy for the output of these finished goods.[15]

Given this reason for believing that the commodity output data represent cycles accurately, it is instructive to examine the volatility characteristics of the prewar Shaw-Kuznets series. It is also useful to consider the volatility characteristics of a postwar continuation of the commodity output series. Fortunately, there exists a postwar series that appears to be very similar to the Shaw-Kuznets series, both conceptually and in its actual calculation. This series is the Federal Reserve Board series on the gross value of finished goods.[16] Like the prewar series, the

[14] For a concise and consistent presentation of the Shaw-Kuznets series, see Kuznets (Table R-21, pp. 553–54).

[15] While the commodity series is free of the excess volatility due to a reliance on materials, Kendrick believes that it may still be systematically flawed because of the deflating process. He states that "the price indexes are usually based on quoted prices and do not take full account of changes in subsidiary terms of sale. 'Net realized' prices tend to fluctuate more than quoted prices over the business cycle and thus the real-product estimates have a downward bias in depressed periods and an upward bias in recoveries" (p. 41).

[16] This series is described in detail in the FRB publication *Industrial Production* (1971, pp. 9–11, and 1976, pp. 29–30).

TABLE 7—VOLATILITY OF COMMODITY OUTPUT

Measure	Shaw-Kuznets (1869–1914)	FRB Gross Value (1954–82)	FRB Final Products (1947–82)
Mean Cyclical Amplitude of Detrended Series[a]	.0937	.0894	.1063
Standard Deviation of Growth Rates	.0567	.0469	.0497
Standard Deviations of Deviations from Trend	.0678	.0345	.0527

[a] Trend commodity output is calculated as the fitted values of a regression of the log of industrial production on a constant and a quadratic trend.

postwar FRB series is a gross value rather than a value-added index. Furthermore, like the Shaw-Kuznets series, this series measures the constant dollar value of only final finished goods.

While the FRB gross value series is a good postwar continuation of the Shaw-Kuznets series, it suffers from two limitations. The most serious of these is that the gross value series is only available after 1954. Since this means that the very volatile late 1940's and early 1950's are excluded, this series will underrepresent the true volatility of commodity output in the postwar era. A second limitation is that the gross value series changes base years in 1967. As a result, in calculating trend commodity output one must estimate the trend over a very short period. As a result the standard deviation of deviations from trend is likely to be artificially low. To deal with these two limitations, I also examine the more common FRB final products index which is available without break from 1947 to 1982. While this is a value-added index, a comparison of this series with the gross value series over the period where they both exist shows that the cyclical properties of the two series are essentially identical.

The various measures of volatility for the prewar and postwar commodity output data are given in Table 7. From these statistics, two characteristics of the commodity output series are obvious. The first is that commodity output has stabilized very little between the pre-1914 and the post-1947 periods. The second is that the Shaw-Kuznets series for 1869–1914 is substantially less volatile than the Frickey index for the same period. The Shaw-Kuznets series is, on average, approximately 35 percent less volatile than the Frickey index. On the other hand, for the postwar era, the two commodity output series are not noticeably less volatile than the FRB index of industrial production in manufacturing.

The fact that the prewar Shaw-Kuznets series is substantially less volatile than the Frickey index provides evidence that the prewar Frickey index is excessively volatile. Since there is reason to believe that the Shaw-Kuznets series is a more accurate measure of the cyclical behavior of prewar industrial production than is the Frickey index, the difference in volatility between the two series suggests that the Frickey series is incorrect.

The fact that the Shaw-Kuznets series shows no stabilization over time also provides support for the view that consistent industrial production data do not show a damping of business cycles between the pre-1914 and the post-1947 eras. When Frickey's index is compared with either its exact postwar replication or the FRB materials index, there appears to be only a slight stabilization. When Shaw's series is compared to a similar postwar series, there appears to be little stabilization of the production of finished goods. In both cases, the dramatic stabilization of the postwar economy apparent in inconsistent data disappears.

V. Conclusions

The preceding analysis yields several conclusions about the historical industrial production series. Section I discussed the possible inconsistencies between the prewar Frickey index and the postwar FRB index of industrial production and described the construction of a postwar index that is consistent with the prewar index. Section II showed that when consistent industrial production data are compared, there is very little damping of business cycle fluctuations between the pre-1914 and the post-1947 period.

The last two sections sought to explain the source of this result. Section III showed that the postwar replications of Frickey's index are more volatile than the true index of industrial production because the Frickey-like series are based very heavily on the production of materials. Because materials inventories are strongly procyclical, an index of materials produced is much more volatile than an index of total industrial production. Section IV showed that the prewar Frickey index is excessively volatile. Data on the relative importance of materials and the behavior of materials inventories in the prewar and postwar eras suggest that the Frickey index is as bad a proxy for total industrial production in the prewar era as a replication of his index is for total industrial production in the postwar era.

It is useful to compare these conclusions on the industrial production series to those I have drawn elsewhere on the historical unemployment and Gross National Product series. The results of the three studies are essentially identical. All three suggest that the prewar macroeconomic data are excessively volatile.

It may seem puzzling that all three studies show similar results. To some degree, the source of the excess volatility in each series is very different. For the unemployment series, the source of exaggerated cyclical fluctuations is the fact that the relationship between unemployment and output is misspecified. The Lebergott unemployment series for 1890–1930 is derived by assuming that the labor force does not move with the cycle and that employment in some sectors moves one-for-one with output in that sector. (See Stanley Lebergott, 1964.) A variety of evidence suggests that these assumptions are false for the prewar era and using them yields a prewar series that is excessively volatile.

The source of exaggerated cyclical fluctuations in the Kuznets *GNP* series involves the specification of the relationship between the available data on commodity output valued at producer prices and total Gross National Product. Kuznets derives estimates of total *GNP* by assuming that *GNP* by sector moves one-for-one with commodity output. However, this assumption, which is certainly false for the postwar era, appears to also be false for the prewar era. *GNP* includes several components that move much less over the cycle than does commodity output. Therefore, using the assumption that the two move together one-for-one yields a series that accentuates cyclical movements.

While the sources of errors in the unemployment and *GNP* data may seem quite different from that in the industrial production data, the problems in each series are, in fact, quite similar. In all three cases the cyclical exaggeration stems from using a series that is too volatile to proxy for the aggregate series being created. In the derivation of the Frickey index, materials production is used to proxy for total industrial production. In the creation of the unemployment series, output is used to proxy for employment. In the construction of the prewar *GNP* data, commodity output is used to proxy for total *GNP*. In all three cases, the aggregate series is assumed to move one-for-one with the series being used as a proxy, rather than substantially less than one-for-one as is almost certainly true. Because all three historical series have essentially the same mistake, it is not surprising that all three are excessively volatile.

While the errors in each series are similar, it is important to note that they are nevertheless independent. That is, the errors identified in one of the series do not cause further errors in the other two series. The reason for this is that none of the three series considered are actually used in the construction of one of the other series. For example, the

output series used to derive the unemployment series is neither the Frickey nor the Kuznets series. Rather, Shaw's series on commodity output is used to construct the unemployment series. Similarly, Kuznets's *GNP* series is based on the Shaw data rather than the Frickey data. Because of this independence, one can identify errors in each series separately.

The fact that the prewar industrial production, unemployment, and *GNP* data are all excessively volatile casts serious doubt on the usual belief that the prewar economy was substantially more volatile than the postwar economy. Indeed, it does appear that the relative stabilization of the postwar economy is a figment of the data. It is important to be very precise about the extent of this conclusion. All three of these studies only examine the data before the Great Depression. As a result, this work in no way challenges the severity of the economic decline of the 1930's. Rather, what this study and its two companions suggest is that the severity of economic fluctuations on both sides of the Great Depression are roughly equal. In fact, one implication of this work may be to emphasize the degree to which the Great Depression is an anomaly in the history of American business cycles.

The conclusion that cycles before and after the Great Depression are equally severe is itself very important. As mentioned in the introduction, this finding contradicts the empirical studies that find a dramatic stabilization between the prewar and postwar economies. On the other hand, this finding may confirm some of the more theoretical analyses of prewar and postwar business cycles. For example, a variety of studies of the prewar economy stress the presence of relatively flexible wages and prices. (See, for example, Jeffrey Sachs, 1980, and Phillip Cagan, 1975.) It is certainly possible that such flexible prices could have enabled the prewar economy to adjust rapidly to various shocks.

The decline in wage and price flexibility between the prewar and postwar eras may explain why the use of both discretionary and automatic stabilizers in the postwar has not yielded a dramatically more stable economy. These stabilizing forces may have served primarily to counteract the possibly destabilizing effects of wage and price rigidity. While this is clearly only a conjecture in need of careful testing, it does suggest an interpretation of the results in this paper that are in accord with relatively Keynesian models of the business cycle.

Thus, the finding that pre-World War I and post-World War II cycles are of equal magnitude need not imply that stabilization policy is ineffective. However, without clear evidence of stabilization, we can no longer simply assert that government stabilization policy is obviously effective. If we wish to argue that policy does matter, then we must posit and test possible explanations for the similarity of the prewar and postwar business cycle.

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