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THE ESTIMATION OF PREWAR GNP VOLATILITY, 1869-1938

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ABSTRACT

New evidence is provided to assess the recent controversy regarding the volatility of real economic activity before 1929 relative to the period since World War II. Some recent work claims that the longstanding stylized fact of greater prewar volatility is "spurious". In contrast, this paper reconfirms the greater amplitude of business fluctuations prior to the Great Depression.

The basic technique is the regression method, which estimates equations for real GNP during 1909-38, with one or more explanatory variables for components of GNP, and then uses the estimated coefficients to "backcast" real GNP for the period 1869-1908. The paper contains an extensive examination of the sensitivity of these regression indexes to alternative dependent variables, sample periods, detrending methods, and the inclusion of alternative explanatory variables. Particular attention is paid to the conflicting evidence regarding the amplitude of cycles in construction activity between 1870 and 1890. The resulting prewar/ postwar volatility ratios, for 1869-1928 as compared to 1950-1980, range from 1.43 to 2.16. The paper concludes by suggesting that this range of volatility ratios is more likely to understate than overstate the prewar/ postwar volatility ratio.

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I. INTRODUCTION

Until recently, one of the least controversial stylized facts in macroeconomic history was the reduced volatility of output in the U. S. after World War II. Indeed, Arthur Burns (1960) devoted his entire 1959 American Economic Association Presidential Address to explaining the phenomenon of a more stable postwar economy. More recently, the explanation of postwar output stability has been the subject of a debate between John Taylor (1986), who argues that stability was achieved despite the greater persistence of price movements that tends to make output less stable, and Bradford DeLong and Lawrence Summers (1986), who claim that, on the contrary, greater postwar price persistence has contributed directly to output stability.

The relevance of both Burns' Address and the recent debate between Taylor and DeLong-Summers, as well as the working assumptions of many macroeconomists, have recently been called into question in a series of papers by Christina Romer (1984) (1985) (1986). The three papers compare standard data sources for, respectively, industrial production, GNP, and the unemployment rate, with alternative series that she constructs. In each case her new series display roughly the same volatility before 1919 and after World War II.[1] This leads to the

1. The industrial production paper (1984) does not construct a new prewar series but rather estimates a new "bad" series for the postwar period based on the techniques used to calculate the standard prewar series. The real GNP paper (1985) uses regression techniques to construct a new series for the period before 1919 but does not construct a new "bad" series for the postwar period. The unemployment paper (1986) does both, first developing a "bad" postwar series and then using that as the

conclusion that the stylized fact of improved postwar stability is "spurious."

Contribution of This Paper

This paper is not a detailed critique or examination of Romer's GNP paper (1985).[2] Instead, it contains new research on the same question that she addresses, the volatility of a regression index for real GNP estimated for the period after 1908 and "backcasted" for the period 1869-1908.[3] The aim of the exercise is to compare the volatility of prewar GNP with that of postwar GNP, taking as a point of departure the standard Gallman (1966) "components" series on GNP that indicates that the pre-1909 economy was roughly twice as volatile as the postwar economy.[4]

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basis to construct a new prewar series based on the estimated relationship between the two postwar series.

2. Romer's new unemployment series has already been subjected to a detailed critique by David Weir (1985), who concludes after an examination of detailed sectoral data that "even a very exaggerated procyclical variant of Lebergott's estimates could not render the economy of the early twentieth century as stable as that of its third quarter."

3. The proximate cause of our interest in this topic was our joint authorship of the data appendix in Gordon (1986). Romer's work led us to wonder whether the pre-1909 Gallman GNP series used in that appendix might exhibit excessive volatility.

4. Gallman (1966) does not present annual GNP series, but rather five-year-overlapping decadal averages. The unpublished underlying annual estimates were later published by Milton Friedman and Anna J. Schwartz (1982).

In contrast to Romer, who follows the procedures of Kuznets very closely in developing her new regression index of prewar real GNP, we broaden the investigation by using a superior measure of real GNP in the post-1908 regression estimation, by adding additional explanatory variables, and by carrying out a wide-ranging set of sensitivity tests. Our most important contribution is the use of new information on activity in the economy outside of the commodity-producing sector. Since the regression method is admittedly a second-best procedure designed to estimate the elasticity of unobservable non-commodity GNP to observable commodity GNP, a natural direction by which the procedure can be improved is to find data on non-commodity output that allows the share of the GNP estimate based on observable data to be increased. By introducing railroad freight ton-miles and construction activity as two additional explanatory variables, we shed new light on the behavior of the U. S. economy, particularly in the 1870s and 1880s.

Our work leads us to four important conclusions that go beyond previous work in this field. First, there is not a shred of evidence to support the view that the greater volatility of real GNP before 1929 is "spurious." We produce a range of pre-1929/postwar volatility ratios, defined as the ratio of standard deviations of deviations from trend in a prewar interval in a postwar interval. Of eight different comparisons shown in our final Table 8, the range of prewar/postwar volatility ratios extends from 1.73 to 2.17, with no estimate even close to the 1.0 value needed to confirm the same degree of volatility

prewar as postwar.[5] By contrast, the standard Gallman components index has a volatility ratio of 2.30, so that our results may be characterized as finding that the Gallman index is at the upper end of the range of volatility estimates implied by the regression technique. Our prewar/postwar volatility ratios range from 75 to 95 percent of the Gallman ratio, in contrast to the much lower ratio of 43 percent (1.0/2.3) that would be required to conclude that the prewar economy was no more volatile than the postwar economy.

Second, we reach different conclusions than Romer regarding several issues that arise in developing regression indexes. For instance, we find that inclusion of the Great Depression years in the sample period of the estimated post-1908 regression equation lowers rather than raises the estimated coefficients, the reverse of Romer's finding. Thus the application of her argument that the Great Depression is atypical and that the sample period of the regression should be limited to 1909-28 raises rather than lowers our volatility ratios for the 1869-1908 interval compared with the postwar years.

Our third conclusion is that going beyond Kuznets and Romer to include information on railroad traffic and construction activity not only substantially improves the fit of the estimated post-1908 regression equations, but also implies a "backcast" pre-1909 regression index with a substantially different amplitude and timing of business cycles in the 1880s as compared with the standard Gallman series. In

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5. These ratios are based on the 1954-72 interval of the postwar period, which we choose in Table 8 to exclude the influence of the Korean war and the post-1972 oil shocks.

particular, the enormous boom of an implausible magnitude evident in the Gallman series for the 1880-1884 period disappears in our regression indexes, although the amplitude and timing of the recessions of the 1870s and 1890s in the Gallman series is reconfirmed here.

Fourth, the paper makes an independent contribution to the estimation of construction output in the pre-1889 period. We exhibit the inconsistent time series behavior of existing indexes of construction materials output and of construction activity, and we note that both types of indexes are based on extremely fragmentary data prior to 1889. To deal with this problem we develop an optimal weighting scheme for the available information, based on a regression explaining construction output for the period after 1914.

Differences in Approach

The main task of this paper is the creation of a new regression index for real GNP for the period before 1909. We have discovered that there are at least six basic issues that must be considered in developing a pre-1909 real GNP series, of which Romer addresses only three. Here we briefly summarize the six issues, of which the first three are those addressed by Romer.

1. Components vs. regression. Is it better to build up a real GNP estimate component-by-component or to estimate a regression?
2. Sample period. If the regression is estimated for data between 1909 and 1938 (the later year being the end of the homogenous Shaw commodity output series), should the Great Depression years be excluded?

3. Measurement error. Here we follow Omer by adding an error term to the "backcasted" real GNP series to reflect the variance in GNP not correlated with the commodity output series.

4. Which Post-1908 GNP Series? For the period after 1909, the Kuznets real GNP series used by Romer has been superseded by the Commerce Department's own series that adheres to the standard definitions. There is a strong case supporting the use of this series for the post-1909 regression estimates, and it makes a substantial difference.

5. Detrending Methods. To avoid prejudging whether long slumps and booms occurred in the late nineteenth century, we compare moving averages with the alternative technique of linear detrending through selected benchmarks.

6. Supplementary Data. A common characteristic of the Kuznets-Romer regression technique is its use of a single explanatory variable, Shaw's series on commodity output. However, data series exist for the 1869-1938 period on at least two major elements of non-commodity real GNP, railroad freight ton-miles and construction activity. Inclusion of either or both of these additional indexes in the regressions for 1909-38 substantially improves the fit and changes the properties of the "backcasted" real GNP series for 1869-1908.

Plan of the Paper

We begin in Part II with a scorecard on the available indexes for

real GNP, commodity output, railroad ton-miles, and construction output, identifying the various authors and time intervals. We exhibit tables showing the time periods over which the indexes are available, and the standard deviation of deviations from trend over alternative periods. Part III discusses the three general issues (#4-#6 on the above list) that confront the investigator attempting to develop a new regression index.

Then Part IV presents the regression results in a number of permutations of dependent variables, detrending methods, and sets of explanatory variables. Here we learn that some issues matter only with particular permutations, and we examine plots and measures of volatility for the most plausible alternative regression indexes. Substantial attention is paid to the problems of measuring construction activity, and to the development of a new regression index of construction output. Finally, we review a set of factors that suggest that our regression estimates may <u>understate</u> the volatility of pre-1909 real GNP, and exhibit the sensitivity of the implied volatility ratios to these factors.

II. ALTERNATIVE INDEXES OF REAL ACTIVITY

You Can't Tell the Players without a Scorecard

One element of complexity that may intimidate a novice in this subject is the wide variety of alternative indexes that are discussed, and the different time intervals to which they apply. Figure 1 describes the indexes of real activity that play a role in this paper. Excluded are other indexes of real GNP derived from those included here (e.g.,

Kendrick (1961)), the Federal Reserve Board Index of Industrial Production that is not available prior to 1919, monthly output indexes like that of Persons (1931), and alternative indexes of construction activity.

The first section lists the real GNP indexes, beginning with the "components" series. These share in common a disaggregated approach that develops real GNP by sector, directly in the case of commodity output and indirectly for sectors other than goods production. The original components series is that of Kuznets (1961). Value added in transportation, distribution, and construction is estimated by multiplying a ratio times relevant categories of commodity output (e.g., construction materials). While this ratio is allowed to move between decadal averages to reflect changes in distributive margins and transportation charges, it is not allowed any cyclical variability. In other words, the elasticity of detrended transportation, distribution, and construction output to deviations from trend of the relevant category of commodity output is fixed at unity. In contrast, estimates of services output, inventory change, and the change in foreign claims are based on regressions for 1919-41 of these components on commodity output, establishing a cyclical elasticity can differ from unity and is used to estimate these components before 1919.

Two other components indexes are listed in Table 1. Romer (1985) has extended the Kuznets index for the 1919-28 interval, using similar methods.[6] And Gallman (1966) has made numerous revisions to the

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6. There are two changes. First, actual data on construction output are used rather than a markup over the output of construction materials. Second, since income-side total GNP is available for 1919-28,

Kuznets estimates of sectoral components for the decadal Census years between 1869 and 1909, altering the trend of the Kuznets index but not its deviations from trend in intracensal years.

Income-side estimates of real GNP were constructed by Kuznets (1941) for 1919-38 and were later extended back to 1909. Subsequently the Department of Commerce adapted to its own concepts the Kuznets series beginning in 1909. Among the most important changes is the separation of government expenditures into a separate category rather than their inclusion by Kuznets with consumption and investment spending. The Commerce series, as we shall see, has very different cyclical properties from the Kuznets income series over the 1909-28 interval.

Next listed are the two existing regression series, that developed by Kuznets and that reconstructed recently by Romer. Both share in common an estimated regression of the Kuznets post-1908 income-side GNP estimate on Shaw's commodity output series, and, using the estimated coefficients, both create a fitted value for the period 1869-1918 (with 1909-18 as an overlap period). The main differences are Romer's use of statistical regression vs. Kuznets' "freehand regression curve," her use of seven-year moving average detrending vs. Kuznets linear trends between midpoints of five-year overlapping decadal averages, her use of a two-stage approach to incorporate error terms in the pre-1918 fitted values, and her use of 1909-28 instead of 1909-38 as the sample period

for the regression.

In the bottom section of Figure 1 are listed the alternative series that are used as explanatory variables in the Kuznets-Romer regression estimates and in this paper. First is listed the basic Shaw commodity output series, which was originally constructed by Shaw (1947) for 1869, 1879, and annually for 1889-1938, and which was extended by Kuznets to provide annual estimates for 1869-1888. The Shaw series for total commodity output and the various sectoral breakdowns, e.g., producers durables and construction materials, is the basis for all the annual pre-1909 real GNP estimates that have been made to date.

Next listed are the series that are used in this study for the first time. Total railroad freight ton-miles are available annually on a continuous basis from well before 1869 to the present. They should provide a particularly homogenous measure of cyclical volatility until the 1920s, when trucking began partially to supplant railroad transportation. Gradually from the 1920s until the present, the mix of transportation services shifted, with railroads carrying a relatively larger share of crude and intermediate materials, and trucks carrying an increasing share of final goods. This means that, if crude and intermediate materials exhibit greater volatility in production than final goods, a comparison of prewar and postwar railroad traffic would understate the reduction in the volatility of total real GNP.

Listed last in Figure 1 are the succession of construction activity indexes used in this study. For the period since 1915 an official U. S. government index on real construction expenditures is available. Two

sets of indexes of construction activity, differing mainly in their increased coverage over time, were compiled by Moses Abramovitz (1964) for the periods 1870-1897 and 1889-1918. Abramovitz' work is chosen because it incorporates most prior research on construction activity. Each set contains a nominal, deflated real, and physical volume index for these two periods. The tables and text of this paper are limited to the physical volume index, chosen because it exhibits substantially less volatility during the 1870-1888 period. We also create our own measure of construction activity in order to assess the effect of Abramovitz's construction series on GNP volatility.

Volatility of Alternative Indexes

Historical perspective on the volatility of alternative indexes of real GNP, and of other indexes listed in Figure 1, is provided by Table 1. Here we list the standard deviations of deviations from trend, using the seven-year moving average method of detrending. Our point of departure is the radical reduction in volatility in moving from the Kuznets components method to the Kuznets regression method, to Romer's regression index, as exhibited by Romer (1985, Table 2). Her ratios of standard deviations of deviations from trend for 1872-1914 as compared with 1950-1980 are:

Gallman-Kuznets Components/Commerce GNP	1.98
Kuznets Regression/Commerce GNP	1.57
Romer Regression/Commerce GNP	1.17

Table 1 provides a more comprehensive view of the volatility of alternative indexes. The first six columns list standard deviations of

deviations from trend for five alternative periods covering the interval between 1872 and 1928, and for one postwar period, 1950-80. Column (7) exhibits the ratio of the standard deviations for 1872-1928 to that for 1950-80.

Numerous alternative comparisons could be made between the eras before and after World War II. Since no one disputes the higher volatility of everything in the decade of the 1930s, none of the intervals in Table 1 include that period. The postwar period is 1950-80, chosen to be identical to Romer's comparison table, and includes the Korean War, Vietnam War, and the period surrounding the first 1973-74 oil shock. Yet in her comparisons Romer truncates the prewar interval at 1914, excluding World War I and the 1920-21 depression.[7] We believe that, even if the 1930s are excluded from the comparison, measures of the volatility of prewar real GNP should cover the full 1872-1928 period. If only peacetime periods were to be included, then a fair comparison for the postwar would be the interval between 1954 and 1972, which excludes both the Korean War and the first oil shock episode, although including the effects of the Vietnam war. In fact, there is no systematic increase in volatility caused by extending the termination date of the prewar period from 1908 to 1928, as shown by the comparison of columns (4) and (5) in Table 1.

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7. Here Romer is inconsistent, since her regression equations include the full 1909-28 period, including both World War I and the 1920-21 depression. As we shall see, the 1915-23 period is when the Kuznets and Commerce indexes diverge substantially, accounting for the different implications of our regressions compared to hers. In Table 8 below we compare the alternative intervals 1872-1908 with 1954-72.

Several striking facts emerge from Table 1. First, inspecting the ratios in column (7), one notes the same phenomenon stressed by Romer, the decline in volatility in going from the components indexes in lines 1 and 2, to the Kuznets regression index on line 3, to the Romer regression index on line 4. However, the ratio for the Romer index is 1.35, still indicating that the prewar period was more volatile than the postwar, albeit by a substantially narrower margin than in the conventional Gallman/Commerce measures listed on line 1.

The volatility behavior of the sectoral output measures in lines 5-7 of Table 1 appears to have escaped previous notice in the literature. There is virtually no difference in the prewar/postwar volatility ratio between the Romer regression index, the Shaw commodity output index spliced to GNP goods output, and the homogeneous railroad ton miles index. All show a prewar volatility about one-third higher than postwar, as contrasted with double the volatility exhibited by the Gallman and Kuznets components indexes. Since all the components and regression indexes are based on the lynchpin of the Shaw commodity output index, one wonders why the relatively small decline in the volatility of commodity output shown on line 5 has not received more notice, since this comparison is of raw indexes and requires no econometric wizardry to reveal.

In fact, if the Gallman and Kuznets indexes are blown up from Shaw's commodity output index, using ratios that exhibit only trend and not cyclical movements, one wonders how the difference between the ratios in line 1 and line 5 could have emerged. The two leading

hypotheses are that (1) the higher volatility of goods output than GNP in the postwar supports the Romer hypothesis that line 1 overstates the volatility of GNP relative to goods output in the prewar period or (2) an increasing share of services and declining share of construction has stabilized real GNP in the postwar period relative to the observed volatility of commodity output.

Similarly, the homogenous railroad ton-miles figures have been lying dormant in the Historical Statistics for years, and they reveal (on line 6) roughly the same postwar decline in volatility as does the commodity output comparison on line 5. Quite a different relationship between prewar and postwar volatility is provided by the linked construction indexes, as displayed on line 7. The ratio for 1872-1928/1950-80 is 2.06, as high as for the Gallman components index, and is even higher for the 1872-1908 interval. Clearly construction must be the heart of any new comparison of prewar and postwar GNP volatility, and indeed construction is the centerpiece of our new research on regression-type real GNP measures.

The Case for Excess Volatility in Components Indexes

Kuznets believed that the components index might be too volatile as a measure of annual changes, and this motivated him to construct his regression index.[8] The essential issue is Kuznets' use in the transportation, distribution, and construction sectors of ratios to

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8. To repeat a statement quoted by Romer, Kuznets (1961, p. 546) realized that "the series available as annual interpolators were frequently the more sensitive indexes and . . . yield annual values exaggerating the short-term changes."

commodity output that were allowed to move only with trend changes but not on an annual basis. Hence the annual elasticity of deviations of output from trend in the transportation, distribution, and construction sectors to changes in the relevant component of commodity output was assumed to be unity. But there are good theoretical and empirical reasons to expect that the relevant elasticity would be less than unity.

Theoretical reasons include (1) the flexible accelerator hypothesis of durable goods demand, which creates a relatively high cyclical elasticity of durable goods output to total GNP, and thus a low elasticity of GNP to the durable component of commodity output, and (2) the permanent income hypothesis of consumption demand, which should dampen fluctuations in the consumption of services relative to the output of commodities, which includes not just consumer goods but also producers durables and construction materials. Empirical reasons include the relatively low observed elasticity of services output to commodities output in the postwar NIPA data.[9] Essentially the regression method is designed to estimate the elasticity of non-commodity GNP to commodity GNP. This motivates the subsequent attention to regression estimates as a shortcut to provide estimates of missing data on non-commodity GNP prior to 1919.

III. Issues In Developing Regression Indexes

Kuznets vs. Commerce as Dependent Variable

9. Several regressions are reported by Romer and are not repeated here. Below we compare our basic prewar regression estimates with analogous regression estimates for the postwar period.

Since the basic motivation of this investigation, like that of Romer, is to compare the volatility of prewar and postwar real GNP, a natural presumption would be to use postwar measurement concepts wherever possible. Since the Commerce Department has produced and continues to publish its own index of real GNP beginning in 1909, defined to be consistent with postwar concepts, an attempt to develop a comparable real GNP series for the period before 1909 by the regression methodology should use the Commerce real GNP series as a dependent variable in the post-1908 period.[10] However, Romer chose instead to use the Kuznets real GNP series for her regression estimates, and this makes a substantial difference in the regression coefficients and their sensitivity to changing sample periods and detrending methods.

The Commerce series and the Kuznets indexes used by Romer for her regression estimates exhibit quite different deviations from trend over the 1909-38 period. This contrast is displayed in Figure 2 using the Romer seven-year moving average method, and in Figure 3 using the benchmark method discussed in the next section. Both figures show important differences in the Commerce series that are partly due to its different treatment of government, and partly due to statistical revisions. The main difference in behavior occurs during the 1909-23 subinterval. Noticeable are different trends during 1909-13, quite different behavior during World War I, especially in 1918, and a larger amplitude of the 1920-21 recession in the Commerce series than in Kuznets. The plots in

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10. The Commerce real GNP index for 1909-28 is found in U. S. Department of Commerce (1981, Table 1.22). This series is maintained in the latest NIPA revision, U. S. Department of Commerce (1986).

Figures 2 and 3 reveal quite clearly that the Commerce and Kuznets series differ in cyclical characteristics, denying Romer's undocumented claim that "There is nothing in the [Commerce] corrections that significantly changes the cyclical properties of the underlying Kuznets components series. As a result, they can be ignored for the purpose of deriving new GNP estimates that measure cycles more accurately" (Romer, 1985, p. 55). As we shall see, the low correlation between the Kuznets and Commerce series in the 1909-18 decade accounts largely for the low coefficients of real GNP on commodity output obtained in Romer's regression equation for the 1909-28 sample period.

Prewar Okun's Law Equations

In examining Figures 2 and 3, one bizarre aspect of the Kuznets series is its indication of a decline in detrended real GNP in 1918, the peak year of World War I output. Evidence in support of the cyclical properties of the Commerce index is provided by "Okun's Law" regressions of two different measures of the unemployment rate on the Commerce and Kuznets real GNP measures. The two measures are the Lebergott index and the index that Romer (1986) has recently created and which has been criticized by Weir (1985).

The regressions of the current unemployment rate on current and lagged detrended real GNP are presented in Table 2. The first two columns use Lebergott's unemployment series as the dependent variable, and the second set of columns uses Romer's unemployment series. Alternative explanatory variables are the Commerce and Kuznets real GNP series. The standard error of estimate for both unemployment series is

lower when the Commerce series is used as an explanatory variable, and the improvement in fit is quite substantial when the Lebergott unemployment variable is used, as in column (1).

The Case for Detrending with Benchmarks

Detrending methods may make a difference in assessing the historical volatility of any time series. If business cycles last longer than seven years, then use of a seven-year moving average to detrend a series may artificially dampen the cyclical variance of a series. The most obvious case where this occurs is the Great Depression, when the unemployment rate remained above the 1929 level for twelve straight years.

In previous research we have developed a procedure for detrending through selected benchmark years. For the postwar period, these years are selected as those when the actual unemployment rate is close to a series for the "natural" unemployment rate, which in turn is defined as the rate which is consistent with steady inflation in the absence of supply shocks.[11] For the period between 1900 and 1949, the natural rate is assumed constant for the portion of the labor force that excludes self-employed farmers and proprietors, leading to a natural rate series that rises slowly from 3.5 to 5.0 percent, reflecting the gradual decline in the share of self-employment in the labor force. Benchmark years for this period are also chosen as those which minimize the difference between

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11. Separate sets of benchmarks are selected for annual and quarterly data, using the same criterion of choosing those years or quarters when the actual unemployment rate is close to the natural rate. For details, see Gordon (1984, 1985).

this natural rate series and Lebergott's unemployment rate.

For the period between 1869 and 1890 we lack an unemployment rate series to determine benchmarks. Because of doubts expressed in the literature regarding the reliability of annual data between Census years prior to 1890, we have simply taken each Census year in that period as a benchmark. This leads to our final set of benchmark years, 1869, 1879, 1889, 1901, 1912, 1923, 1929, 1950, 1964, 1972, and 1979. In our previous research on the postwar period 1954 and 1970 are also benchmark years, but in this paper we did not want to smooth the postwar data by choosing intervals between benchmark years substantially shorter than the intervals chosen for the prewar years. Thus on average there are ten years between benchmarks for both the prewar and postwar years in this study.

Two problems are raised by the choice of benchmark years before 1900. First, the choice is arbitrary, since there is no comparable unemployment series for use in selecting benchmark years. Second, while the choice of 1889 creates no problems, since that year appears to be "average" and quite similar for most indexes to surrounding years between 1888 and 1892, the choice of 1879 may have an impact on the results. When 1879 is omitted as a benchmark year and a straight line is run between 1869 and 1889, the detrended commodity output series and Gallman's real GNP series seem remarkably high in 1880-82 (the Gallman series is 19.2 percent above trend in 1880-2, comparable to the ratio of NIPA real GNP to trend at the height of World War II in 1943-44, using our benchmarks). In the opposite direction, several series on construction

activity, examined below, display deviations from trend of -50 percent or more between the mid 1870s and mid 1880s. Our results, by using 1879 as a benchmark year for detrending, tend to "flatten" these episodes of volatility.

Figure 4 displays the Commerce series for 1909-38, detrended by the two alternative methods, seven-year moving average and exponential trends through benchmark years. The effect of the moving average technique in smoothing out economic fluctuations is obvious. This brings us back to the original issue that concerns Romer and ourselves, the extent to which the postwar economy exhibits less cyclical volatility of real GNP than the prewar economy. Surely those who have claimed that the postwar economy was more stable than the prewar economy were thinking of a year like 1936, with a (Lebergott) unemployment rate of 17 percent, as representing abnormal rather than normal conditions. Yet the moving average detrending technique registers a deviation of Commerce GNP from trend in 1936 as +6.6 percent, in contrast to the -21.7 percent deviation indicated by the benchmarking technique. And, while the Depression may represent an extreme case, the moving average technique may prejudge the issue whether decade-long depressions occurred in the 1870s or 1890s.[12]

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12. Here are some examples of the zig-zags of the seven-year moving average trend of real GNP, using the Gallman-Commerce series. There is an average annual growth rate of the trend of +2.83 percent during 1915-27, -2.02 percent during 1927-33, +6.28 percent during 1933-45, -0.23 percent during 1945-49, +3.38 during 1949-75, and +2.33 during 1975-82. In contrast our benchmarking method yields more stable trends of +2.33 percent during 1913-23, +3.41 percent during 1923-29, +2.50 percent during 1929-50, +3.53 percent during 1950-64, +3.48 percent during 1964-74, and +2.89 percent during 1974-84.

Table 3 displays standard deviations of deviations from trend for the same series and time periods as Table 1, but now with the benchmark technique of detrending rather than the seven-year moving average technique. Standard deviations in Table 3 are uniformly higher than in Table 1, as would be expected. However, the four alternative real GNP series have quite similar ratios of prewar to postwar volatility in the two tables. Benchmarking actually diminishes slightly the prewar/postwar ratio of standard deviations for the two components series in lines 1 and 2. As is evident in the last three lines of the two tables, benchmarking reduces slightly the prewar/postwar ratio of standard deviations for commodity output, raises the ratio slightly for railroad ton miles, and raises the ratio substantially for construction output.

Additional Explanatory Variables

Both the Kuznets and Romer regression indexes are based on regression equations in which there is a single explanatory variable, commodity output. This is consistent with the components indexes, which estimate value added in various sectors by applying markups over commodity output, with no other information used to estimate annual values for the components in intracensus years beyond trends in distributive margins and transportation costs.

However, it is worthwhile to ask whether there is informational content in two data series on output outside of manufacturing, railroad freight ton miles and construction output. The two advantages of the railroad freight ton miles series are that it is homogenous for the entire period since before 1870, and that it represents activity in a major sector

outside of manufacturing.

There are also limitations to the usefulness of the railroad series. The first limitation is the changing role of railroads in the transportation sector, which railroads totally dominated before 1920. While the use of autos for passenger transportation became important in the 1920s, it was only in the postwar period that railroads received significant competition from trucking for freight transportation. The second limitation is that railroad freight ton miles do not measure real value added in railroad freight transportation. There may be changes over the business cycle, for instance, in the mix of traffic having high and low value-added per ton. Third, even though railroads are part of the service sector, railroad value added may not be a good indicator of the cyclical volatility of value added in other services, since railroads carry cyclically sensitive crude, intermediate, and final goods, while other services may consist of less-cyclically-sensitive services in such establishments as barbershops and food retailing. Our regression estimates will indicate whether railroad freight ton miles improve the explanation of real GNP during the 1909-38 period, and whether the role of railroad freight ton miles is sensitive to changes in the sample period, method of detrending, or the use of the Kuznets vs. Commerce real GNP series as alternative dependent variables.

The use of direct indexes of construction output, in addition to marked-up indexes of construction materials, has obvious appeal. In any study of real GNP volatility, construction is critical, since it is much more volatile that total GNP as a whole. Further, there are good reasons to believe that the volatility of construction relative to the economy as a

whole was greater in the prewar period than postwar. Our own interpretation of the Great Depression places heavy weight on the unsustainably high level of construction activity during 1924-27 as a source of the severity and duration of the construction slump of the 1930s.[13]

If construction was more volatile in the prewar period, then there is a further reason to pay careful attention to measuring this volatility. Construction represented a more important part of the economy in the late nineteenth century than in the postwar period, and so the sensitivity of GNP estimates to alternative methods of estimating construction output should be greater than would be the case for the postwar. It is useful to review the time series on the share of construction output in GNP, measured in constant prices:[14]

	1869-78	1899-1908	1929	1950	1960	1974	1979
Share (percent)	15.2	12.0	11.4	10.4	10.0	8.4	8.2

Our measure of construction activity after 1914 is the official BLS - Commerce series for real construction expenditures, linked beginning in 1929 to the output of structures in the NIPA. For 1914 and earlier years, the basic

13. See Gordon and Wilcox (1981) and Gordon and Veitch (1986).

14. The first two columns are measured in 1860 prices, from Gallman (1966), Table 3 on p. 11 and Table 4 on p. 15. The other columns are measured in 1929 prices, from the Economic Report of the President, February 1986, Table B-6 and B-7. No adjustment is made for the difference between the share of construction in 1860 and 1929 prices, pending the location of appropriate deflators.

measure used as an explanatory variable in the real GNP regressions, and to backcast real GNP for 1869-1908, is the Abramovitz (1964) series on the physical volume of construction. Abramovitz constructed three aggregate indexes for the period from 1870 to 1918 on the basis of existing series measuring construction activity, including (1) an index of value in current prices, (2) an index of value in constant prices, and (3) an index of volume in physical units. Each of these indexes covers a combination of urban residential, urban nonresidential excluding government, and railroad and public utilities construction; these categories accounted for 75 to 80 percent of total construction in the period covered.

We use Abramovitz' construction series because they incorporate the relevant previous research. Among the sources used for the nominal and real value indexes are Riggleman's index of the value of building permits, as adjusted by Isard, Ulmer's series on gross capital expenditures of railroads, Blank's series on expenditures for new private nonfarm dwelling units, and Long's index of the value of nonresidential building. Used for the physical volume index are Long's index of the number of residential and nonresidential buildings, an index of rail consumption by weight, and Blank's index of new private nonfarm housing starts.

Our choice of the physical volume index, rather than the deflated value index, reflects the lower volatility of the latter in the period between 1870 and 1890. We did not want our results to be heavily dependent on the greater volatility of the deflated value index, which shows a greater amplitude of the construction depression of the 1870s than does the physical volume index. The following illustrates the enormous twenty-year slump in construction that is indicated by both indexes:

Index Numbers, 1870 = 100

Year	Deflated Value	Physical Volume
1870	100.0	100.0
1875	41.7	61.8
1880	56.9	55.0
1885	78.2	76.9
1890	123.0	112.0

The magnitude of the construction depression is obviously disguised by the seven-year moving average method of detrending, but it appears that our choice of 1879 as a benchmark year also implies that our benchmarking method of detrending minimizes the magnitude of the construction cycle. For this reason our regression index is likely to understate the volatility of GNP before 1890.

IV. REGRESSION RESULTS

General Description of Regression Results

The regressions of real GNP on one or more indexes of economic activity are reported in Tables 4 and 5. All regressions in Table 4 use the Kuznets index of real GNP as dependent variable and all in Table 5 use the Commerce measure as dependent variable. Otherwise each table is arranged in the same way, with the top half displaying results that use the seven-year moving average method of detrending (hereafter 7MA), and bottom half displaying results using the trend-through-benchmark-years method of detrending (hereafter TTB). In the left six columns the sample period is 1909-28 and in the right six columns is 1909-38.

Each group of six columns contains six alternative arrangements of the explanatory variables, with commodity output alone in column (1), commodity and railroad in column (2), commodity and construction in column (3), railroad and construction in column (4), all three in column (5), and all three plus the lagged dependent variable in column (6). We note first in Table 4 that in column (1) the coefficient on commodity output alone ranges from 0.61 to 1.00, and that either exclusion of 1929-38 or the use of 7MA contributes to a lower coefficient. Clearly, the lower the coefficient, the lower the estimated volatility of real GNP prior to 1909, when these regression equations are used for statistical backcasting. Romer's choice of the 1909-28 sample period and the use of 7MA is responsible for her relatively low coefficient of 0.61, and thus contributes to her conclusion that the prewar volatility of real GNP is a statistical illusion.

Table 4 also indicates that the statistical significance of the railroad and construction indexes interacts with the choice of sample period and detrending method. With 7MA, neither the railroad or construction index is significant, except when commodity output is excluded. However, with TTB, the addition of these two indexes improves the fit markedly. The coefficient on each of the two indexes is twice or more its standard error in column (5), and the standard error of estimate in column (5) compared to column (1) declines by 15 percent for the 1909-28 sample period and 18 percent for the 1909-38 sample period. In all these results we note the role of the Great Depression in raising the coefficient on commodity output as compared to the 1909-28 period, whether or not the railroad and construction indexes are included, thus confirming Weir's (1985) point that Romer's conclusion of low volatility is heavily dependent on excluding the Great Depression from her regressions.

Effect of Using the Commerce Real GNP Series

Table 5 differs only in using the Commerce rather than Kuznets real GNP series as dependent variable. There are two consistent features of Table 5 as contrasted with Table 4. First, the exclusion of the Great Depression no longer makes an important difference. If anything, the regression coefficients are higher when the Depression is excluded than when it is included, reversing the relationship shown in Table 4. This suggests to us that the real reason for the relatively low coefficients on commodity output in column 1 for the 1909-28 period in Table 4 is an inaccurate cyclical pattern in the Kuznets real GNP series, as contrasted with the Commerce series, prior to 1929.

The second difference in Table 5 is in the coefficients. When commodity output alone is included, the coefficients in Table 5 are higher for the 1909-28 period but not appreciable different for 1909-38. Once the railroad and construction indexes are added, however, the coefficients on commodity output are uniformly and significantly lower in Table 5 than in Table 4. Corresponding to this fact is the higher and more uniform statistical significance of the railroad and construction indexes in Table 5, excepting only construction when detrended by the 7MA method.

Regression Estimates for the Postwar Period

In Table 6 are displayed regression estimates for the postwar period. The format of the table is the same as Tables 4 and 5. Since the dependent variable is the Commerce (NIPA) real GNP series, the relevant comparison of prewar and postwar behavior is between Tables 5 and 6. The first difference evident in Table 6 is that railroad ton miles are never significant, perhaps not surprisingly

in light of the much reduced share of railroads in the transportation sector. Second, while construction is always significant with the 7MA detrending method, it is not significant with the benchmark method except when the lagged dependent variable is included, as in column (6). The significance of the lagged dependent variable, particularly with the TTB method, may reflect the persistence of postwar business cycles, and/or the growing importance of the unmeasured service industry sector.

An interesting comparison can be made between sums of coefficients in column (5) for the prewar and postwar periods, using the two detrending methods:

	Sum of Coefficients on Explanatory Variables in Column 5					
	09-28 7MA	09-38 7MA	54-82 7MA	09-28 TTB	09-38 TTB	54-85 TTB
Sum	0.81	0.69	0.65	0.73	0.60	0.73

These results are starkly at variance with Romer's findings. First, as we noted before there is no systematic tendency for the prewar coefficients to be lower when the Depression years are excluded. Second, the postwar sum of coefficients is not markedly lower than 1909-38 with the 7MA method and is higher than 1909-38 with the TTB method.

Creation of a Regression Estimate of Real GNP, 1869-1908

We follow Romer in using a two-stage procedure to estimate real GNP before 1909. The differences are our use of the Commerce rather than Kuznets real GNP series as dependent variable, the choice of multiple explanatory variables, the method of detrending, and the sample period of the regression.

We begin by positing a "true" relationship between real GNP and a set of extrapolators, with all variables expressed as deviations from their respective trends:

$$GNP_c = \alpha_0 + \alpha_c CO + \beta_c RT + \gamma_c ST + e_c, \qquad (1)$$

where GNP_c is the Commerce estimate of real GNP, CO is Shaw's commodity output series, RT is railroad ton-miles, and ST is the Abramovitz construction series, spliced to the BLS-Commerce series in 1915. By running a regression based on (1), we obtain our basic relationship to be used for backcasting:

$$GNP_c = \alpha_0 + \alpha_c CO + \beta_c RT + \gamma_c ST$$

$$= \underset{(0.79)}{-1.80} + \underset{(0.14)}{0.32}\ CO + \underset{(0.06)}{0.15}\ RT + \underset{(0.03)}{0.14}\ ST, \qquad (2)$$

where the standard errors of the parameter estimates are in parentheses below each estimate. The coefficients in (2) are from Table 5, column (5), in the lower right-hand quadrant (1909-38 sample period, TTB detrending method).

Notice that (2) will understate the true variance of GNP_c, since its true variance is:

$$Var(GNP_c) = Var(\alpha_c CO + \beta_c RT + \gamma_c ST) + Var(e_c). \qquad (3)$$

Using OLS to extrapolate data using (2) understates the true variance of real GNP, which includes not only the first variance term in (3) coming from the extrapolation, but also the second variance term.

To correct this bias, an estimate of the error term e_c is needed. We follow the same two-stage procedure as Romer. The first stage involves regressing another estimate of GNP, in this case the Kuznets series (GNP_k), on

the same set of extrapolators as above. A regression is run over the period 1909-38 to obtain:

$$GNP_k = \alpha_0 + \alpha_k CO + \beta_k RT + \gamma_k ST + e_k \qquad (4)$$

$$= \underset{(0.58)}{-0.68} + \underset{(0.10)}{0.81}\ CO - \underset{(0.05)}{0.06}\ RT + \underset{(0.02)}{0.09}\ ST$$

Taking the residual from (1), $\hat{e}_c$, and regressing it against the residual of (4), $\hat{e}_k$, we obtain the relation

$$\hat{e}_c = \delta \hat{e}_k + u. \qquad (5)$$

The estimated relationship between the error terms $\hat{e}_c$ and $\hat{e}_k$ is:

$$\hat{e}_c = \underset{(0.25)}{0.18}\hat{e}_k. \qquad (6)$$

A second regression using GNP_k is run over the period 1870-1908 to obtain $\hat{e}_k$. The regression results for the period 1870-1908 are:

$$GNP_k = \underset{(0.33)}{-0.15} + \underset{(0.05)}{0.92}\ CO - \underset{(0.04)}{0.07}\ RT + \underset{(0.02)}{0.07}\ ST \qquad (7)$$

The residuals of (7) provide our estimates of the error term $\hat{e}_k$, which are used together with the coefficients in (2) and (6) to calculate the backcasted real GNP series for 1870-1908:

$$GNP_c = \alpha_0 + \alpha_c CO + \beta_c RT + \gamma_c ST + \delta \hat{e}_k \qquad (8)$$

$$= -1.80 + 0.32\ CO + 0.15\ RT + 0.14\ ST + 0.18\ \hat{e}_k.$$

Even with the error correction, the variance of (8) will understate the true variance of real GNP, since from equation (5) $Var(\hat{e}_c) > \delta^2 Var(\hat{e}_k)$.

Furthermore, since the estimates of δ are low and insignificant, we are likely missing much of the effect of e_c on the estimates of GNP_c. Therefore, estimates of variance using the extrapolation technique outlined above must be considered as providing a lower bound of the variance of real GNP, rather than an exact measure of variance.[15]

The Volatility of Alternative Regression Indexes

As indicated in Part III, there are several differences between our regression indexes of real GNP and those of Kuznets and Romer. These are the distinction between the Kuznets and Commerce dependent variable, between a single explanatory variable and multiple explanatory variables, between sample periods ending in 1928 and 1938, and between alternative methods of detrending. Using the method described above in Part IV, alternative regression indexes of real GNP for the years 1869-1908 have been constructed, and their standard deviations of deviations from trend are summarized in Table

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15. We may be able to obtain an idea of the size of $Var(e_c)$ by looking at the standard deviation of the regression residuals. For equation (2), $Var(\hat{e}_c) = (3.02)^2$. It would be unreasonable to apply this standard deviation to the period 1870-1908, but we can obtain an estimate for this period by comparing $Var(\hat{e}_k)$ to $Var(\hat{e}_c)$ and apply this relationship to the $Var(\hat{e}_k)$ during the period 1870-1908. For the period 1909-38, $Var(\hat{e}_c)/Var(\hat{e}_k) = (3.02/2.22)^2 = 1.85$. Thus, an estimate $Var(e_c)$ for the period 1870-1908 would be $Var(\hat{e}_c) = 1.85\ Var(\hat{e}_k)_{1870-1908} = 1.85\ (1.77)^2 = 5.80$. Thus, we can obtain an estimate of the variance of GNP_c over the period 1870-1908 from (3) as:

$$Var(GNP_c) = Var(\alpha_c CO + \beta_c RT + \gamma_c ST) + Var(\hat{e}_c)$$

$$= 21.27 + 5.80 = 27.07.$$

Thus, the standard deviation of deviations from trend over the period 1872-1908 would be 5.20 with this estimate of $STD(\hat{e}_c)$ included, as contrasted with 4.19 that was obtained using the two stage regression method. The drawback of this method is that it provides no information about e_c in each individual year, only about $Var(e_c)$ over the entire sample period. This is an important drawback when trying to form annual estimates of real GNP.

7.

An examination of the first four lines of Table 7 indicates that the addition of the railroad and construction series makes no difference when the Kuznets real GNP series is used as dependent variable. Instead, what matters is the choice between 1928 and 1938 as the termination date of the sample period. But, as we have seen in Tables 4 and 5, the importance of the sample period is heavily dependent on the use of the Kuznets dependent variable. When the Commerce dependent variable is used, the 1928 vs. 1938 issue is reversed in its implications, since coefficients are higher, not lower, when 1928 is the termination date.

The comparison of lines 5 and 6 indicates that the choice of the TTB method of detrending raises the estimated variance of pre-1909 GNP but slightly reduces the ratio of the variance of prewar to postwar GNP. As we shall see in subsequent sections of Table 7, the TTB method seems to raise the variance of postwar GNP relatively more than that of prewar GNP, so that the hypothesis that the variance of real GNP (relative to trend) has declined in the postwar period is (ironically) more strongly supported by the 7MA method chosen by Romer than by the TTB method that we prefer.

Lines 7 and 8 of Table 7 constitute the basic results of this paper, prior to the "fine tuning" that is reported below. We note that with the 7MA method of detrending, a regression estimate that uses the Commerce dependent variable, all three explanatory variables, and the 1909-38 sample period, the volatility index displayed in line 7, column (4), is almost as high as for the basic Gallman series in Table 1, line 1, column (7). Comparing lines 7 and 8 of Table 7, we observe also that the TTB method of detrending raises the variance of the postwar

official NIPA series more than that of the estimated prewar series, implying a reduction in the prewar/postwar variance ratio when the TTB method is used.[16]

Sensitivity of Real GNP Estimates to Alternative Construction Series

The regression indexes that are based on three explanatory variables, commodity output, railroad ton-miles, and construction output, are subject to the possible criticism that there is a break in coverage and method between the Abramovitz construction index and the subsequent post-1914 BLS-Commerce index of construction activity. It is evident from Table 7 that our finding of higher prewar volatility than Romer does not hinge on our treatment of construction, since a comparison of lines 5 and 7 for the 7MA method of detrending shows no change in volatility when just commodity output or three explanatory variables are used, and a comparison of lines 6 and 8 shows that volatility decreases markedly with the addition of the railroad and construction variables. As indicated by Figure 5, this occurs because in some periods within the 1869-1908 interval, either railroad ton-miles or construction or both have deviations from trend going in the opposite direction from commodity output, and this tends to dampen the volatility of the real GNP regression series that results from using commodity output as the only explanatory variable.

The source of the volatility in the Abramovitz physical volume series is evident from just a cursory glance at Figure 6. The components on which the Abramovitz series is based, indexes of nonresidential and residential building

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16. A plot of the official NIPA real GNP series detrended with the 7MA and TTB method over the 1954-72 period indicates that the long boom of the 1960s is much more prominent with TTB detrending, and this helps to explain the much higher postwar standard deviation of the NIPA real GNP series when TTP detrending is used as contrasted with 7MA detrending.

permits and rail consumption, show much more cyclical variability than does the construction materials series on which the Kuznets construction index is based. The collapse of construction implied by the building permit series in the 1870's is striking; the building permits index falls nearly 75 percent from a peak in 1871 to the trough in 1880. Yet, because of the nature of the building permit series, it may not be as accurate an indication of actual construction activity as we would like. The building permit series, constructed by Clarence Long, is based on a gradually increasing coverage of one to twenty-nine cities--one (Philadelphia) in 1856, three (Philadelphia, Manhattan, and the Bronx) in 1863, and finally up to twenty-nine cities in 1912. This incomplete and limited coverage may not provide an accurate picture of construction activity in the late nineteenth century, since construction activity in fast growing cities in the midwest and west are likely to be excluded from the sample. Furthermore, building permits may not be as good an indicator of building activity as they are today for the simple reason that a building permit may not have been required for all types of construction. Also, new building permits neglect maintenance and rehabilitation, components of spending that may be less cyclical than new construction.

However, the construction materials series is not above suspicion. The period 1869-1889 looks implausibly smooth when compared to the same series over the period 1889-1914. The post-1889 series is Shaw's Output of Construction Materials and represents data on construction materials such as lumber, crossties, sand and gravel, crushed stone, cement, brick, rails, structural ironwork, etc. The pre-1889 series is Kuznets' extrapolation of Shaw's series. Kuznets takes Shaw's output of construction materials in the census years 1869,

1879, and 1889 and interpolates between these years using data on the production of nails and rails and of lumber for 1869-79 and adding cement and roofing slate in the period 1879-89. This short list of materials seems to be a slim reed on which to establish a measure of the volatility of construction output. Reconciling some of the conflicting evidence on construction may be an important step in addressing the prewar/postwar volatility issue.

Given the conflicting evidence on construction, we construct our own construction series that is more homogeneous than either the construction materials-based series or the Abramovitz series and incorporates information contained in each of the series. By running a regression of the BLS-Commerce construction series (CST) for 1915-1936 on the output of construction materials (CM), total residential and nonresidential building permits (BP), and rail consumption (RC), we can obtain coefficients for use in "backcasting" construction output for the 1869-1914 period:

$$\begin{array}{l} CST = 4.88 + 0.65CM + 0.32BP + 0.04RC, \quad SEE = 11.87, \quad R^2 = 0.93 \\ \qquad\qquad\quad (0.35) \quad (0.11) \quad (0.17) \qquad\qquad\qquad\quad D.W. = 1.25 \end{array}$$

Because most of the weight is placed on the less volatile construction materials, the resulting backcasted construction is less volatile than the construction series based on Abramovitz (see Figure 7).

When the new construction output series is used in place of the Abramovitz index of real GNP for 1869-1908, we obtain the volatility measures listed on lines 9 and 10 of Table 7. With the 7MA method of detrending the prewar/postwar ration of standard deviations falls from 1.96 with Abramovitz to 1.83 with the backcasted construction series, and with the TTB detrending method the ratio declines from 1.56 to 1.43. However, these volatility measures doubtless are understatements, since no error term has been added to the backcasted

construction series.

Figure 8 shows our two estimates of GNP and the Gallman series. Two observations are readily apparent from the figure. The first is how similar our two series are over most of the sample, and the second is how different our two estimates are from the Gallman series in the 1880s. Either the Gallman series overestimates the boom in the 1880s, or, our estimates underestimate the boom. Because of the opposing direction railroad ton-miles and construction are taking relative to commodity output, the series tend to cancel each other out in the 1880s. We believe that our series may well be superior to Gallman's for the period of the 1870s and 1880s, because Gallman's estimates are entirely based on the assumption that noncommodity output mimicks the behavior of commodity output, whereas our series introduce the railroad traffic and construction activity series as additional information on noncommodity output.

Has the Volatility of real GNP been understated?

Our estimates of GNP in Table 7 are by no means the most volatile that one could develop with the regression technique. We believe that there are at least four reasons to believe that all the estimates shown in Table 7 understate the prewar/postwar volatility ratio.

1. Postwar wars and shocks. In comparing 1872-1928 with 1950-1980, we are including World War I in the first period and Korea, Vietnam, and the oil shocks in the second period. A better comparison of peacetime no-shock intervals would be 1872-1908 with 1954-72. As we shall see in Table 8, such a comparison raises prewar/postwar ratios relative to those shown in Table 7.

4. The Depression Issue. Romer has argued that the Great Depression is atypical, and that regression estimates should be based on the shorter 1909-28

sample period. However, as we learn in Table 8, with the Commerce real GNP series as dependent variable, choice of the shorter sample period raises the volatility estimates above those shown in Table 7.

3. The 1879 Issue. The relatively low volatility ratios that occur with the TTB method of detrending may be sensitive to the choice of 1879 as a benchmark year, because this choice tends to flatten out the long two-decade slump in construction activity during the 1879s and 1880s.

4. Low Residual Error in Regression Index. The two-stage method of backward extrapolation is likely to understate the volatility of the resulting regression index, simply because the coefficient applied to the constructed error term (e_k) is so low. The argument given above in footnote 15 suggests that an extra 20 percent might be added to our prewar/postwar volatility ratios on this account. In the same category is the fact that our backcasted construction index is extrapolated with no error term at all.

By making some quite "reasonable" changes in our procedure to account for some of the issues listed above, we can produce estimates of GNP that are close to the volatility ratio of the original Gallman series. Table 8 displays some alternative estimates of volatility for the no-shock peacetime comparison of 1872-1908 with 1954-72. All comparisons in Table 8 are based on use of the Abramovitz construction series rather than the backcasted construction series, on the ground that no error term has been added to the latter and therefore that its volatility is understated.

Table 8, line 1 displays the same index as Table 7, line 8. Use of the alternative comparison interval raises the volatility ratio by 11 percent, from 1.56 to 1.73. If we had forgotten to include railroad ton-miles, we would have

achieved an increase in volatility of another 9 percent, from 1.73 to 1.88. If the sample period were stopped in 1928 instead of 1938, as recommended by Romer, the volatility ratio would have increased by another 14 percent to 2.15 (with railroads) and by 15 percent to 2.17 without railroads. This brings us to a volatility ratio 95 percent as large as Gallman's 2.30 (shown on line 5).

Table 8 deals only with points 1 and 2 on the above list of four factors that may cause the volatility ratios to be understated in Table 7. Point 3, regarding 1879, is not taken into account in Table 8. When 1879 is excluded as a benchmark year, and a trend line is drawn straight from 1869 to 1879, there is an enormous increase in the volatility of all the indexes developed in previous research. For Gallman the prewar/postwar ratio, using 1872-1908 versus 1954-72 as in Table 8, rises from 2.30 to 2.93, for Kuznets regression from 1.94 to 3.11, and for Romer regression from 1.59 to 2.41. This occurs because the growth of the trend line between 1869 and 1879 is much faster (5.1 percent per annum for Gallman) than between 1879 and 1889 (3.1 percent). Imposition of a trend line growing at a steady 4.1 percent between 1869 and 1889 leads to an enormous positive bulge of the Gallman, Kuznets, and Romer indexes above trend in the period 1879-1884. For instance, the Gallman series is a full 21 percent above trend in 1882, as far above trend as was the U. S. economy in 1944 at the peak of World War II war production. With 1879 used as a benchmark, 1882 for the Gallman series is "only" 11 percent above trend, as shown in Figure 8.

We view the behavior of the detrended series without the 1879 benchmark as implausible and thus do not display in Table 8 the alternative measures based on dropping the 1879 benchmark. Instead, we prefer the interpretation that commodity output in the 1869 census may have been understated, implying that

the "true" trend growth rate between 1869 and 1879 was not 5.1 percent, but perhaps closer to the 4.1 percent observed from 1889 to 1899. By choosing census years as benchmarks, we prevent the uncertainty about the accuracy of the decennial censusses from influencing our measures of volatility based on deviations from trend lines drawn between benchmark years.

Finally, the last of our four points about volatility suggests that all the estimates in the top part of Table 8 may be understated, perhaps by 20 percent. The argument stated in footnote 15 implies that, instead of ranging from 1.73 to 2.17 in Table 8, adjusted prewar/postwar volatility ratios may range from 2.08 to 2.60. This would boost the upper end of our range of estimates above that of the Gallman series.

V. Conclusion

We have examined the sensitivity of regression indexes of real GNP for the 1869-1908 period to alternative dependent variables, sample periods, detrending methods, and inclusion of additional explanatory variables. Starting from the Gallman components series, which exhibits a standard deviation of deviations from trend that is 2.3 times as high during 1872-1908 as during 1954-72, we have shown that it is possible to construct a wide variety of regression indexes, all having prewar/postwar volatility ratios in the range of 1.73 to 2.17. The shift from the Kuznets to the Commerce real GNP series as dependent variable raises the volatility ratio and also indicates that inclusion of the Great Depression in the sample period of the regression reduces rather than raises the volatility ratio. The addition of railroad ton-miles and a measure of construction activity as explanatory variables tends to reduce the volatility ratio, mainly because

railroad output and construction tend to offset the large boom of the early 1880s. Finally, the trends-through-benchmarks method of detrending tends to reduce the prewar/postwar volatility ratio relative to the seven-year moving average method, mainly because the TTB method raises postwar volatility more than prewar volatility.

Thus, we find that there is no case at all that the standard view of higher prewar volatility of real GNP is "spurious." By altering the specification dimensions of the regression technique, including extrapolators, sample periods, dependent GNP series, and detrending methods, we can create a wide range of regression estimates of real GNP during the 1869-1908 period. Depending on the precise combination used, we can obtain estimates of the volatility of prewar real GNP that range from 50 to more than 100 percent higher than the volatility of postwar GNP. However, we do not fully endorse the standard Gallman series, particularly for the 1880s. We show that the use of additional information on noncommodity output (railroad traffic and construction activity) implies that the economy was much less robust in the 1879-1885 period than is suggested by the Gallman series.

This paper does not endorse a single series as the "correct" measure of real GNP for the 1869-1908 period. Instead, it emphasizes the uncertainty implied by the sensitivity of the regression method to minor changes of specification and sample period. By setting out a wide range of estimates, we hope to stimulate discussion and the search for additional data series that may in future research make it possible to narrow the range of estimates of pre-1909 real GNP.

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Prices", in Gordon (1986), pp. 639-77.

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Description of Data Series

GNP

(i) GNP_c - Gallman/Commerce Series

1869-1908: Net National Product from Milton Friedman and Anna J. Schwartz, Monetary Trends in the United States and the United Kingdom. (Chicago: University of Chicago Press), 1982, (based on Gallman) plus Capital Consumption from Simon Kuznets, Capital in the American Economy, Princeton: NBER, 1961.

1909-1928: National Income and Product Accounts, 1929-1976, Table 1.22.

1929-1985: NIPA, Table 1.2.

(ii) GNP_{kc} - Gallman/Kuznets' Components Series

1869-1888: Net National Product (Gallman) plus Capital Consumption (Kuznets).

1889-1918: Real GNP Variant 3, Kuznets' Components, from Capital in the American Economy, Table R 26, unravelled five year moving average.

1919-1949: Real GNP Variant 3, Kuznets, from Capital in the American Economy, Table R 2.

(iii) GNP_{kr} - Kuznets' Regression Series

1869-1888: Replication of Kuznets' unpublished regression series.

1889-1918: Real GNP Variant 3, Kuznets' Regression Series, from Capital in the American Economy, Table R 22.

1919-1949: Kuznets Variant 3 (the same as the components series over

this time period).

(iv) GNP_r - Romer/Kuznets

1872-1918: Romer's Real GNP series.

1919-1949: Kuznets' Variant 3 series.

Extrapolators

(i) Commodity Output

1869-1928: Total commodity output, Shaw's Series, from Capital in the American Economy, Table R 21.

1929-1985: Production of Goods - NIPA Table 1.4.

(ii) Railroad Ton Miles

1870-1889: Burns, Arthur, Production Trends in the United States Since 1870, Princeton: NBER, 1934.

1890-1957: Historical Statistics-Colonial Times to Present.

1958-1983: Statistical Abstract of the United States, various issues.

1984: Transportation in America, November 1984 supplement.

1985: Personal correspondence with Association of American Railroads.

(iii) Construction (C70)

1869-1888: Index of Urban Building and Public Utility Construction, - Physical Volume, series C70, segment 1, from Source Book of Statistics Relating to Construction. eds Robert E. Lipsey and Doris Preston, New York: NBER, 1966.

1889-1914: Index of Urban Building and Public Utility Construction - Physical Volume, series C70, segment II.

1915-1928: Total New Construction, series C22, Lipsey and Preston.

1929-1985: Production of Structures. NIPA, Table 1.4.

(iv) Construction (C69)

1870-1888: Index of Urban Building and Public Utility Construction - Constant Dollars, series C69 segment I, from Source Book of Statistics Relating to Construction. eds Robert E. Lipsey and Doris Preston, New York: NBER, 1966.

1889-1914: Index of Urban Building and Public Utility Construction - Constant Dollars, series C69, segment II.

1915-1928: Total New Construction, series C22, Lipsey and Preston.

1929-1985: Production of Structures. NIPA, Table 1.4.

Other Variables

(i) Capital Consumption

1869-1918: Unravelled five year moving average from Capital in the American Economy. Table R 29.

1919-1929: Capital in the American Economy. Table R 8.

(ii) Construction Materials

1869-1888: Unravelled five year moving average of Kuznets' Gross Total Construction, constant dollars, from Capital in the American Economy. Table R 29. Linked in 1888 to:

1889-1939: Output of Construction Materials Destined for Domestic Consumption, 1913 Dollars, from William H. Shaw, Value of Commodity Output Since 1869.

(iii) Building Permits, Total New Buildings

1869-1936: Index of Number, Total New Buildings, originally compiled by Clarence D. Long. Series B5 in Lipsey and Preston.

(iv) Rail Consumption

1869-1950: Rail Consumption (Tonnage). Series D 16 in Lipsey and Preston.

(v) Unemployment Lebergott

1890-1930: Lebergott's unemployment series, Christina Romer, "Spurious Volatility in Historical Unemployment Data," Journal of Political Economy, Vol. 94, Number 1, February 1986, pp. 1-37.

1931-1941: Series B2, BLS, from Long Term Economic Growth, 1860-1970.

(vi) Unemployment Romer

1890-1930: Romer's unemployment series, Romer.

1931-1941: Series B2, BLS, from Long Term Economic Growth, 1860-1970.

Table 1

Standard Deviations of Deviations from Trend of Alternative Series, 1872-1980, Detrended with Seven-year Moving Averages

Series	1872-1888 (1)	1889-1908 (2)	1909-1928 (3)	1872-1908 (4)	1872-1928 (5)	1950-1980 (6)	Ratio 1872-1928/1950-80 (7)
Alternative Real GNP Series							
1. Gallman (1869-1908)/ Commerce (1909-80)	3.94	4.49	5.22	4.20	4.54	2.10	2.16
2. Gallman (1869-88)/ Kuznets Comp (1889-1918)/ Kuznets Inc (1919-38)	3.98	5.07	3.82	4.55	4.28	-.--	2.04[a]
3. Kuznets Regression (1869-1918)/Kuznets Income (1919-38)	3.33	3.64	3.27	3.46	3.37	-.--	1.60[a]
4. Romer Regression (1869-1918)/Kuznets Income (1919-38)	2.96	2.69	3.09	2.73	2.83	-.--	1.35[a]
Sectoral Real Output Indexes							
5. Shaw Commodity Output (1869-1938)/ Commerce Goods GNP (1939-80)	3.71	4.57	3.87	4.12	4.00	2.92	1.37
6. Railroad Ton Miles (1869-1980)	6.42	5.99	7.70	6.11	6.70	5.03	1.33
7. Abramowitz Construction Output (1869-1914)/ Commerce (1915-1928)/ Structures GNP (1929-80)	13.28	12.14	8.46	12.52	11.24	5.45	2.06

Note: a. Listed Series for 1872-1928 compared with Commerce Real GNP, 1950-80.

Table 2

Regressions of Alternative Unemployment Series
on Alternative Real GNP Series, 1909 - 38
Detrended by Benchmarking

	Lebergott Unemployment		Romer Unemployment	
	(1)	(2)	(3)	(4)
Constant	3.47	4.19	4.16	4.74
	(0.38)	(0.51)	(0.39)	(0.38)
Commerce, GNP Current Year	-0.46	-.--	-0.38	-.--
	(0.02		(0.04)	
Commerce GNP, lagged one year	-0.02	-.--	-0.07	-.--
	(0.04)		(0.04)	
Kuznets GNP, Current Year	-.--	-0.42	-.--	-0.37
		(0.06)		(0.04)
Kuznets GNP, lagged one year	-.--	-0.03	-.--	-0.06
		(0.06)		(0.05)
SEE	1.61	2.29	1.67	1.70
R^2	0.95	0.90	0.94	0.90
D.W.	0.46	0.99	0.60	0.82

Table 3

Standard Deviations of Deviations from Trend of Alternative Series, 1872-1980, Linear Trends through Benchmark Years

Series	1872-1888 (1)	1889-1908 (2)	1909-1928 (3)	1872-1908 (4)	1872-1928 (5)	1950-1980 (6)	Ratio 1872-1928/1950-80 (7)
Alternative Real GNP Series							
1. Gallman (1869-1908)/ Commerce (1909-80)	6.41	5.54	5.96	6.27	6.26	3.28	1.91
2. Gallman (1869-88)/ Kuznets Comp (1889-1918)/ Kuznets Inc (1919-38)	6.41	5.97	4.73	6.47	6.11	-.--	1.86[a]
3. Kuznets Regression (1869-1918)/Kuznets Income (1919-38)	5.45	4.70	4.13	5.30	5.00	-.--	1.52[a]
4. Romer Regression (1869-1918)/Kuznets Income (1919-38)	4.37	3.93	3.97	4.35	4.40	-.--	1.34[a]
Sectoral Real Output Indexes							
5. Shaw Commodity Output (1869-1938)/ Commerce Goods GNP (1939-80)	6.15	5.40	4.13	6.09	5.64	4.44	1.27
6. Railroad Ton Miles (1869-1980)	6.95	9.54	10.10	8.69	9.59	6.35	1.51
7. Abramowitz Construction Output (1869-1914)/ Commerce (1915-1928)/ Structures GNP (1929-80)	14.43	17.73	17.75	16.41	16.75	5.22	3.21

Note: a. Listed Series for 1872-1928 compared with Commerce Real GNP, 1950-80.

Table 4
Regression Results for Kuznets Real GNP Series,
Alternative Sample Periods and Detrending Methods

	Sample Period 1909–1928						Sample Period 1909–1938					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Seven-Year Moving Average												
1. Constant	0.04	0.00.	0.03	-0.06	-0.02	-0.05	0.11	0.11	0.25	0.43	0.26	0.24
	(0.52)	(0.51)	(0.52)	(0.53)	(0.51)	(0.53)	(0.42)	(0.42)	(0.42)	(0.50)	(0.42)	(0.42)
2. Commodity Output	0.61	0.45	0.53	-.--	0.34	0.35	0.88	0.82	0.74	-.--	0.62	0.62
	(0.14)	(0.18)	(0.19)		(0.73)	(0.24)	(0.06)	(0.13)	(0.11)		(0.18)	(0.18)
3. Railroad Ton Miles	-.--	0.12	-.--	0.21	0.13	0.14	-.--	0.04	-.--	0.29	0.07	0.08
		(0.09)		(0.08)	(0.09)	(0.10)		(0.08)		(0.06)	(0.08)	(0.08)
4. Construction Output	-.--	-.--	0.05	0.14	0.07	0.06	-.--	-.--	0.08	0.24	0.09	0.07
			(0.09)	(0.07)	(0.08)	(0.09)			(0.06)	(0.05)	(0.06)	(0.06)
5. Lagged GNP	-.--	-.--	-.--	-.--	-.--	-0.09	-.--	-.--	-.--	-.--	-.--	0.09
						(0.16)						(0.08)
SEE	2.32	2.27	2.36	2.37	2.29	2.35	2.28	2.31	2.23	2.67	2.24	2.23
R^2	0.50	0.52	0.48	0.47	0.51	0.48	0.87	0.87	0.88	0.83	0.88	0.88
D.W.	1.63	1.77	1.74	2.41	1.93	1.94	1.46	1.43	1.58	1.96	1.58	1.67
Benchmarking												
1. Constant	0.39	0.04	0.06	-1.90	-1.05	-1.00	1.07	0.56	0.78	-1.84	0.25	0.37
	(0.86)	(0.99)	(0.82)	(0.58)	(0.91)	(1.07)	(0.65)	(0.72)	(0.56)	(0.75)	(0.61)	(0.63)
2. Commodity Output	0.73	0.65	0.54	-.--	0.25	0.76	1.00	0.86	0.77	-.--	0.62	0.64
	(0.16)	(0.19)	(0.18)		(0.21)	(0.22)	(0.03)	(0.10)	(0.07)		(0.10)	(0.11)
3. Railroad Ton Miles	-.--	0.06	-.--	0.21	0.16	0.15	-.--	0.09	-.--	0.31	0.09	0.08
		(0.08)		(0.06)	(0.07)	(0.08)		(0.06)		(0.05)	(0.05)	(0.05)
4. Construction Miles	-.--	-.--	0.08	0.16	0.12	0.12	-.--	-.--	0.09	0.18	0.09	0.07
			(0.04)	(0.03)	(0.04)	(0.05)			(0.03)	(0.03)	(0.02)	(0.03)
5. Lagged GNP	-.--	-.--	-.--	-.--	-.--	-0.01	-.--	-.--	-.--	-.--	-.--	0.05
						(0.16)						(0.07)
SEE	2.91	2.95	2.70	2.49	2.46	2.54	2.80	2.74	2.39	3.45	2.29	2.31
R^2	0.50	0.49	0.57	0.64	0.65	0.62	0.97	0.97	0.98	0.95	0.98	0.97
D.W.	0.95	0.92	1.24	2.23	1.74	1.74	1.01	1.02	1.27	1.28	1.35	1.32

Table 5
Regression Results for Commerce Real GNP Series,
Alternative Sample Periods and Detrending Methods

	Sample Period 1909-1938						Sample Period 1909-1928					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Seven-Year Moving Average												
1. Constant	0.07	-0.01	0.04	-0.05	0.11	0.01	0.11	0.09	0.22	0.36	0.26	0.27
	(0.85)	(0.82)	(0.86)	(0.83)	(0.82)	(0.82)	(0.58)	(0.56)	(0.60)	(0.59)	(0.57)	(0.57)
2. Commodity Output	0.95	0.64	0.81	-.--	0.44	0.29	0.83	0.60	0.72	-.--	0.39	0.34
	(0.23)	(0.29)	(0.31)		(0.37)	(0.39)	(0.09)	(0.17)	(0.16)		(0.24)	(0.24)
3. Railroad Ton Miles	-.--	0.23	-.--	0.35	0.25	0.25	-.--	0.17	-.--	0.34	0.20	0.22
		(0.15)		(0.12)	(0.15)	(0.15)		(0.11)		(0.07)	(0.11)	(0.11)
4. Construction Output	-.--	-.--	0.10	0.22	0.12	0.17	-.--	-.--	0.07	0.19	0.10	0.09
			(0.14)	(0.11)	(0.14)	(0.14)			(0.08)	(0.06)	(0.08)	(0.08)
5. Lagged GNP	-.--	-.--	-.--	-.--	-.--	-0.19	-.--	-.--	-.--	-.--	-.--	0.12
						(0.17)						(0.10)
SEE	3.80	3.66	3.86	3.72	3.67	3.64	3.14	3.07	3.17	3.12	3.03	3.00
R^2	0.47	0.51	0.46	0.49	0.51	0.52	0.76	0.77	0.76	0.76	0.78	0.78
D.W.	1.83	1.66	1.83	1.63	1.65	1.92	1.76	1.64	1.77	1.67	1.64	1.84
Benchmarking												
1. Constant	0.23	-0.25	-0.31	-2.95	-1.99	-1.52	-0.44	-1.28	-0.93	-2.88	-1.80	-1.66
	(1.30)	(1.50)	(1.20)	(0.82)	(1.32)	(1.38)	(0.94)	(1.03)	(0.76)	(0.70)	(0.79)	(0.87)
2. Commodity Output	1.02	0.93	0.72	-.--	0.29	0.27	0.94	0.70	0.57	-.--	0.32	0.33
	(0.24)	(0.29)	(0.26)	-.--	(0.31)	(0.30)	(0.05)	(0.14)	(0.10)		(0.14)	(0.14)
3. Railroad Ton Miles	-.--	0.08	-.--	0.30	0.24	0.22	-.--	0.14	-.--	0.26	0.15	0.14
		(0.12)		(0.08)	(0.11)	(0.11)		(0.08)		(0.04)	(0.06)	(0.07)
4. Construction Output	-.--	-.--	0.13	0.20	0.20	0.18	-.--	-.--	0.14	0.19	0.14	0.13
			(0.06)	(0.05)	(0.06)	(0.06)			(0.03)	(0.03)	(0.03)	(0.04)
5. Lagged GNP	-.--	-.--	-.--	-.--	-.--	-0.16	-.--	-.--	-.--	-.--	-.--	0.04
						(0.15)						(0.09)
SEE	4.39	4.46	3.98	3.58	3.58	3.56	4.05	3.91	3.23	3.23	2.98	3.03
R^2	0.47	0.45	0.56	0.65	0.64	0.65	0.92	0.93	0.95	0.95	0.96	0.96
D.W.	1.26	1.12	1.53	1.57	1.48	1.71	1.04	0.93	1.55	1.44	1.51	1.55

Table 6
Regression Results for Postwar Period, 1954 - 82 or 1954 - 85,
With Alternative Detrending Methods

	(1)	(2)	(3)	(4)	(5)	(6)
Moving Average, 1954 - 82						
1. Constant	-0.01	0.01	0.04	-1.14	-0.04	-0.05
	(0.08)	(0.05)	(0.14)	(0.05)	(0.05)	-(0.05)
2. Commodity Output	0.69	0.71	0.57	-.--	0.54	0.52
	(0.03)	(0.05)	(0.02)		(0.04)	(0.04)
3. Railroad Ton Miles	-.--	0.01	-.--	0.21	0.02	0.01
		(0.03)		(0.03)	(0.02)	(0.02)
4. Construction Output	-.--	-.--	0.08	0.19	0.09	0.09
			(0.01)	(0.03)	(0.01)	(0.01)
5. Lagged GNP	-.--	-.--	-.--	-.--	-.--	0.05
						(0.03)
SEE	0.44	0.45	0.27	0.74	0.27	0.26
R^2	0.95	0.95	0.98	0.87	0.98	0.98
D.W.	1.34	1.37	1.85	1.01	1.21	1.37
Benchmarking, 1954 - 1985						
1. Constant	0.50	-0.50	-0.44	1.10	-0.38	-0.13
	(0.12)	(0.15)	(0.15)	(0.34)	(0.21)	(0.19)
2. Commodity Output	0.73	0.73	0.72	-.--	0.70	0.54
	(0.02)	(0.05)	(0.03)	-.--	(0.07)	(0.07)
3. Railroad Ton Miles	-.--	0.00	-.--	0.33	0.01	0.03
		(0.03)		(0.04)	(0.03)	(0.03)
4. Construction Output	-.--	-.--	0.02	0.19	0.02	0.06
		-.--	(0.02)	(0.05)	(0.03)	(0.02)
5. Lagged GNP	-.--	-.--	-.--	-.--	-.--	0.05
						(0.02)
SEE	0.67	0.68	0.67	1.51	0.68	0.59
R^2	0.97	0.96	0.97	0.83	0.96	0.97
D.W.	0.81	0.81	0.78	0.89	0.78	0.97

Table 7

Volatility of Alternative Regression Estimates of Real GNP, Prewar Compared to Postwar, Alternative Detrending Methods

	Dependent Variable	Explanatory Variables	Sample Period	Detrending Method	1872-1908 (1)	1872-1928 (2)	1950-1980 (3)	Ratio (2)/(3) (4)
1.	Kuznets	Commodities Only	1909-28	7MA	2.60	2.81	2.10	1.34
2.	Kuznets	All Three[a]	1909-28	7MA	2.59	2.83	2.10	1.35
3.	Kuznets	Commodities Only	1909-38	7MA	3.69	3.52	2.10	1.68
4.	Kuznets	All Three[a]	1909-38	7MA	3.65	3.49	2.10	1.66
5.	Commerce	Commodities Only	1909-38	7MA	3.51	4.11	2.10	1.96
6.	Commerce	Commodities	1909-38	TTB	6.02	6.06	3.28	1.85
7.	Commerce	All Three[a]	1909-38	7MA	3.42	4.11	2.10	1.96
8.	Commerce	All Three[a]	1909-38	TTB	4.70	5.13	3.28	1.56
9.	Commerce	All Three[b]	1909-38	7MA	2.90	3.90	2.10	1.83
10.	Commerce	All Three[b]	1909-38	TTB	3.75	4.69	3.28	1.43

Notes: a. Three included indexes are Shaw's commodity output series, railroad ton-miles, and the Abramovitz construction series.
b. Three included indexes are Shaw's commodity output series, railroad ton-miles, and the backcasted construction series based on three construction indexes.

Table 8

Factors That Increase the Pre-war/Post-war Volatility Ratio, Estimates Based on Benchmark Method of Detrending

Index	Railroads Included?	Sample Period	Standard Deviations 1872-1908	1954-1972	Ratio (1)/(2)
			(1)	(2)	(3)
This Study, Commerce Dependent Variable					
1. Table 7, line 8	Yes	1909-38	4.71	2.73	1.73
2. Exclude Railroads	No	1909-38	5.14	2.73	1.88
3. Exclude Depression	Yes	1909-28	5.87	2.73	2.15
4. Exclude Depression and Railroads	No	1909-28	5.93	2.73	2.17
Previous Studies					
5. Gallman Components	---	-------	6.27	2.73	2.30
6. Kuznets Regression	No	1909-38	5.30	2.73	1.94
7. Rosner Regression	No	1909-28	4.35	2.73	1.59

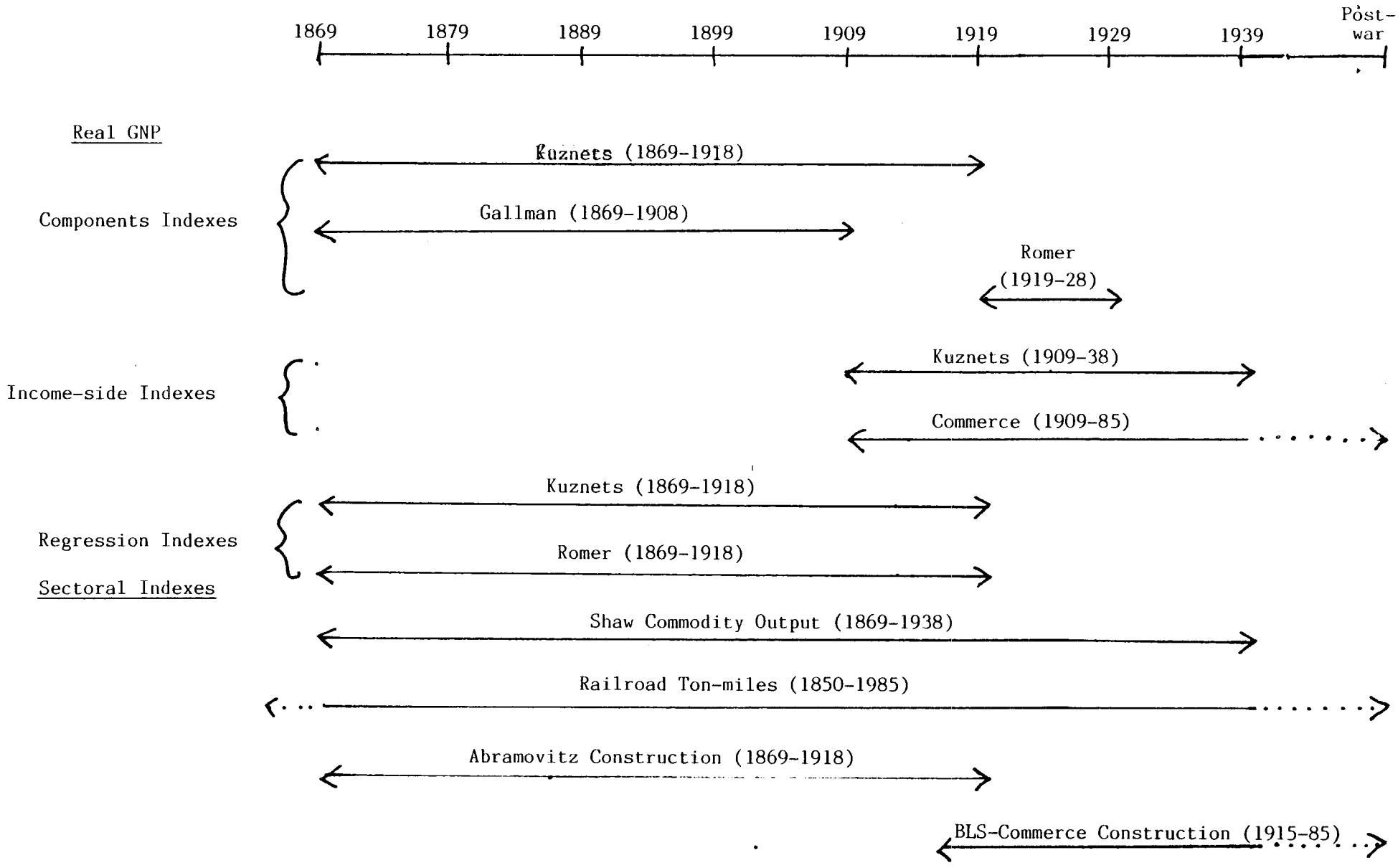

Figure 1

Alternative Indexes and Their Time Coverage

FIGURE 2.
DEVIATIONS FROM TREND GNP, COMMERCE AND KUZNETS. SEVEN YEAR MOVING AVERAGE.
1909–1938.

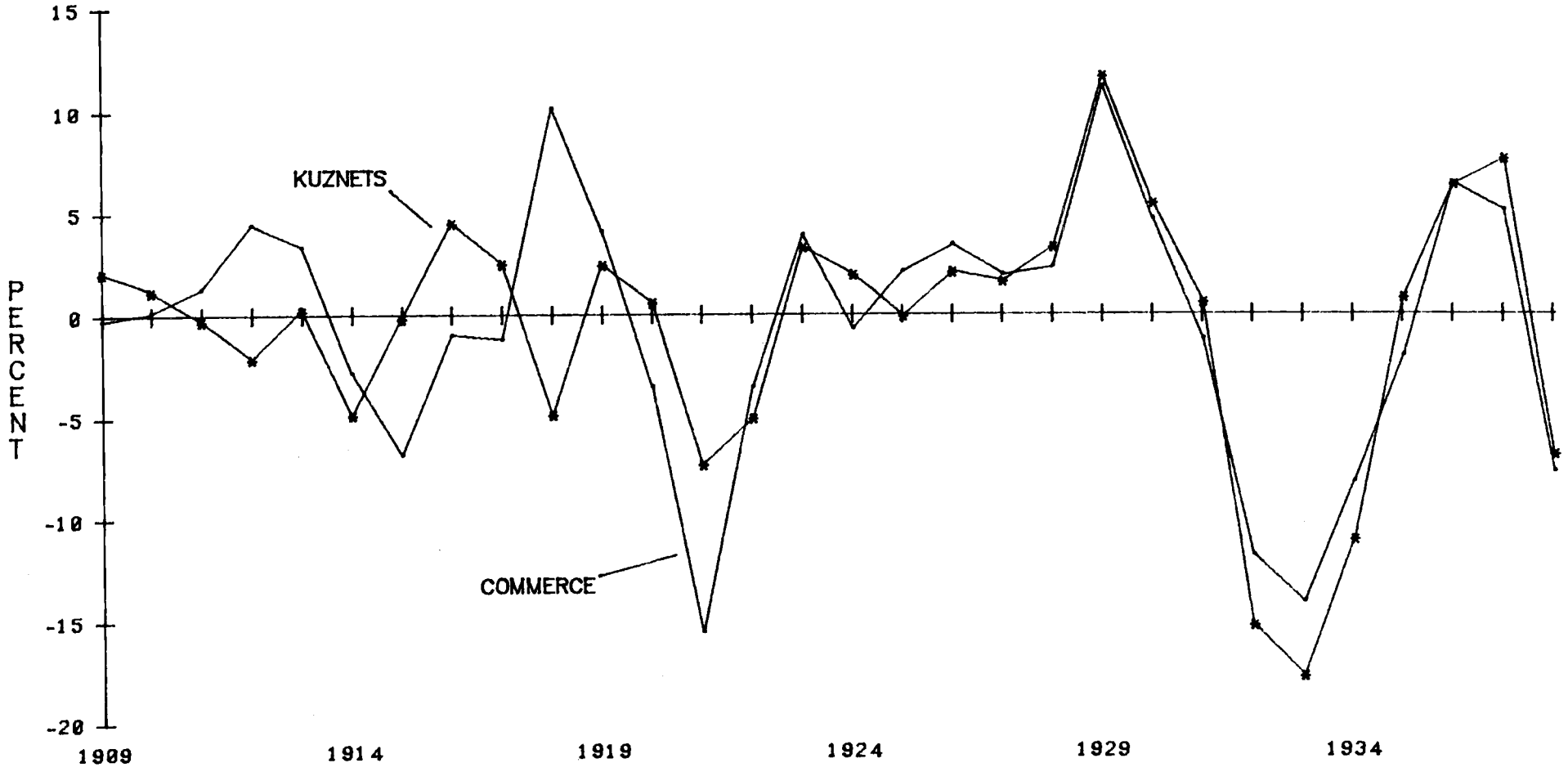

FIGURE 3.
DEVIATIONS FROM TREND GNP, COMMERCE AND KUZNETS, BENCHMARKING.
1909–1938.

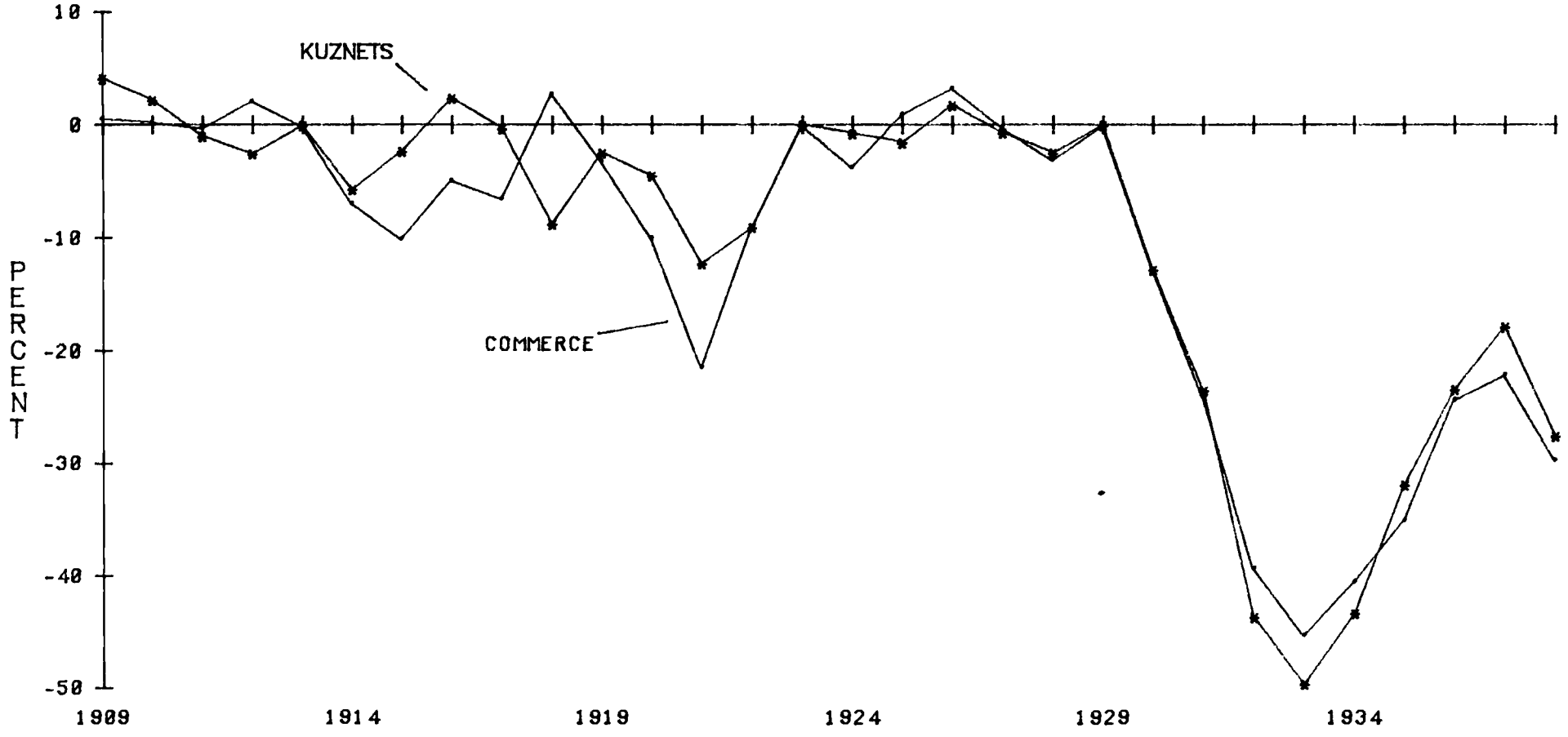

FIGURE 4.
DEVIATIONS FROM TREND GNP, COMMERCE SERIES, BENCHMARKING AND SEVEN YEAR MOVING AVERAGE.
1909–1938.

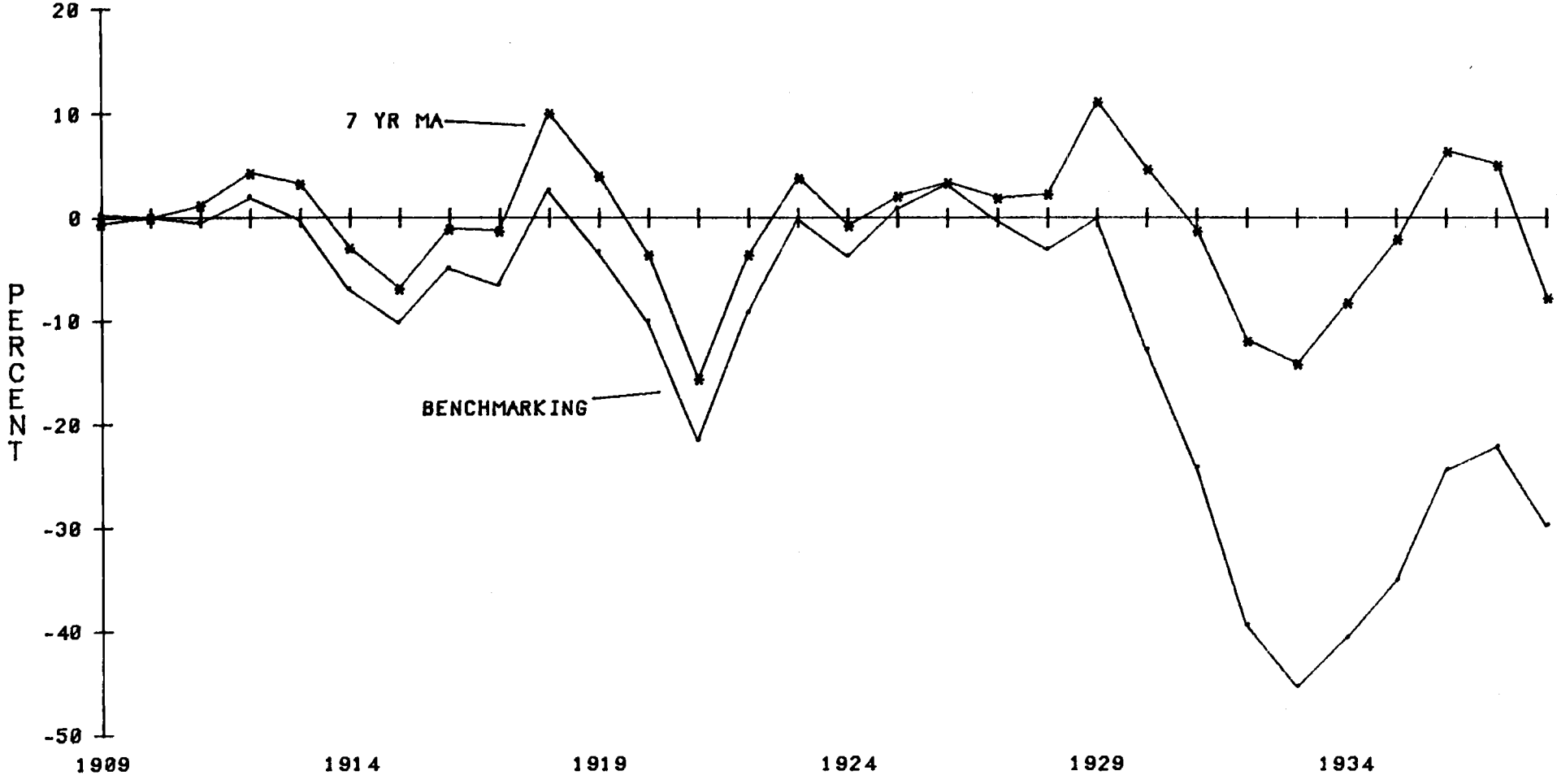

FIGURE 5.
DEVIATIONS FROM TREND OF CONSTRUCTION, COMMODITY OUTPUT, AND RAILROAD TON MILES.
1869–1914.

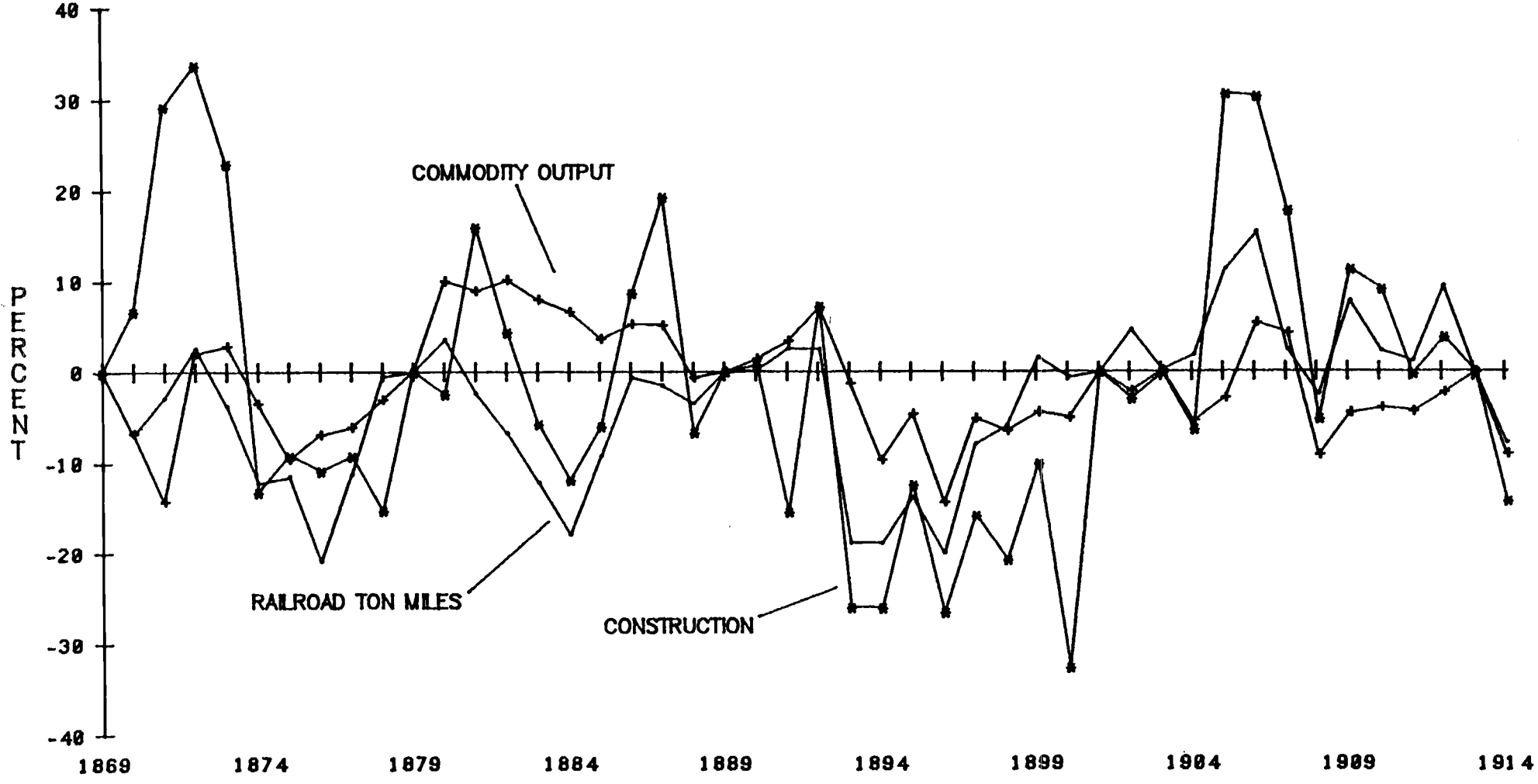

FIGURE 6.
TOTAL NEW BUILDING PERMITS, CONSTRUCTION MATERIALS, AND RAIL CONSUMPTION.
INDEX, 1909=100. 1869–1914.

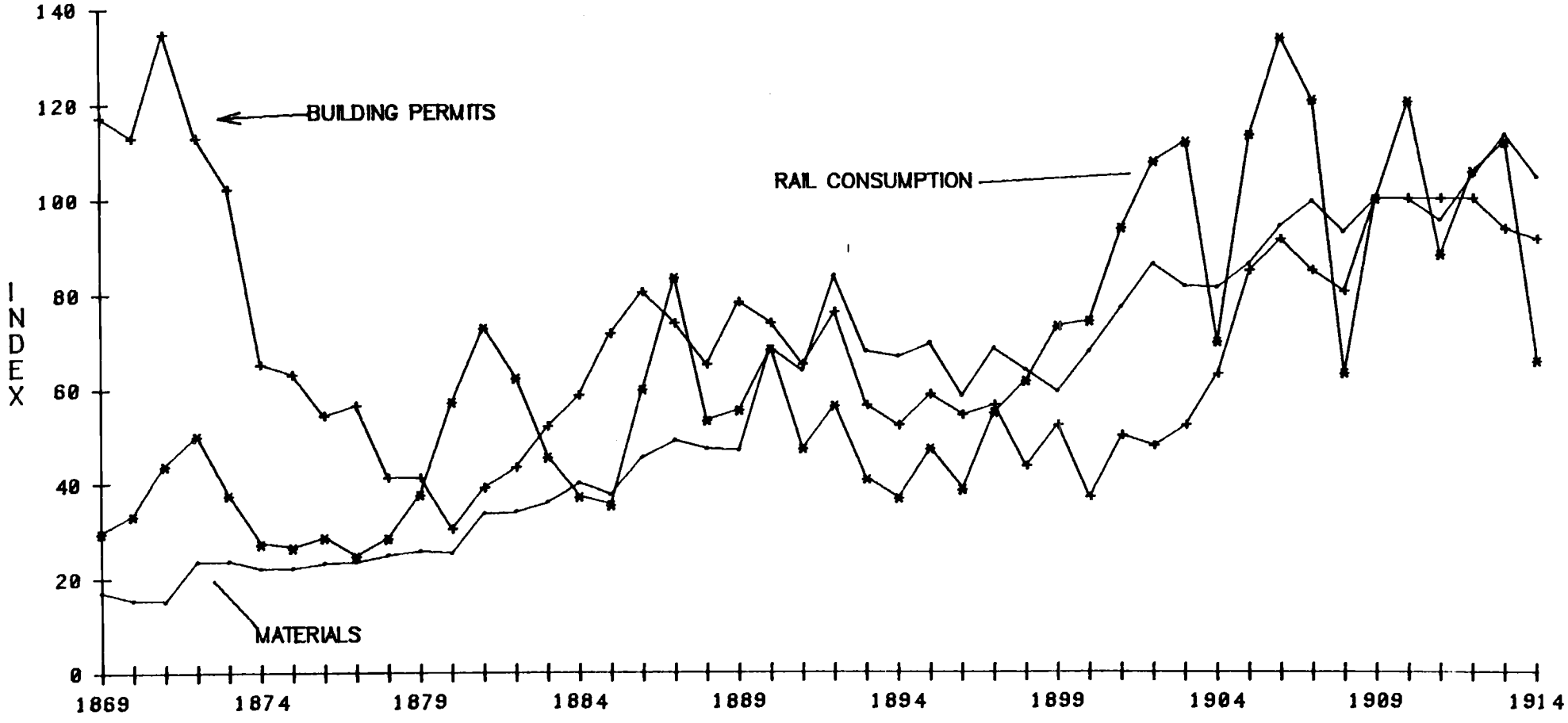

FIGURE 7.
DEVIATIONS FROM TREND OF ABRAMOVITZ CONSTRUCTION, BACKCASTED CONSTRUCTION, AND CONSTRUCTION MATERIALS. 1869–1908.

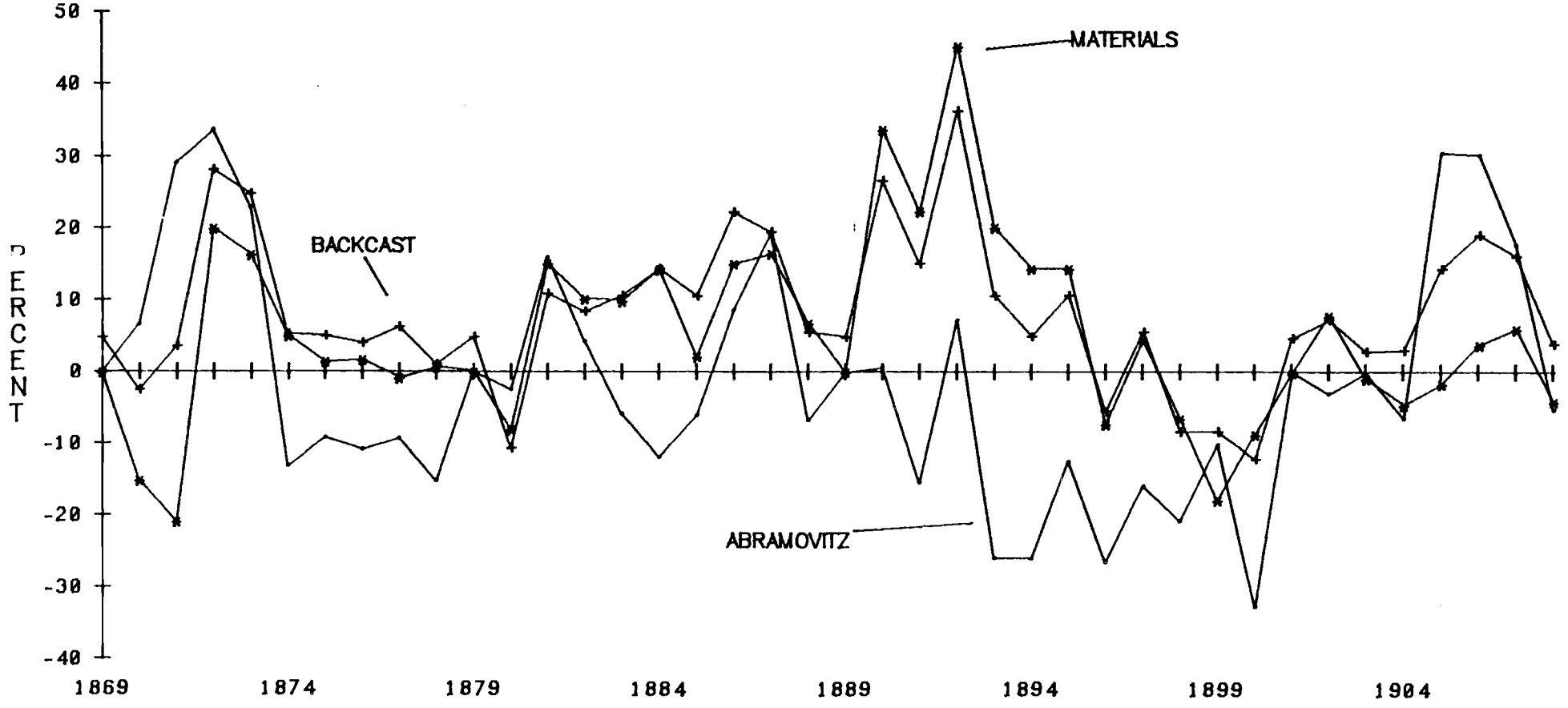

FIGURE 8.
DEVIATION FROM TREND, GALLMAN SERIES, OUR ESTIMATE WITH ABRAMOVITZ CONSTRUCTION, AND OUR ESTIMATE WITH BACKCASTED CONSTRUCTION. 1869–1908.