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Christina Romer

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New Estimates of Prewar Gross National Product and Unemployment

CHRISTINA ROMER

The paper examines in detail revised estimates of unemployment and gross national product for the United States before 1929. It first discusses the nature of the revisions to each series and contrasts the assumptions underlying the new data with those underlying the Kuznets GNP series and the Lebergott unemployment rate series. It then examines the business cycle properties of the new prewar estimates. It analyzes the volatility and serial correlation properties of the new macroeconomic series and investigates the Okun's Law relationship between unemployment and GNP, concluding with an evaluation of the assumptions underlying the old and new data.

PIONEERS in national income accounting and labor market analysis created a wealth of data. Simon Kuznets and William Shaw put together data on commodity output and gross national product for the late 1800s and early 1900s. Edwin Frickey, Frederick Mills, and many others created indexes of industrial production. Stanley Lebergott created data on the labor force, employment, and unemployment for the first half of the twentieth century. Through frequent use, and respect for the creators, many of the prewar aggregate series have achieved a status almost equal to that of modern data. The historical data are used to answer questions never contemplated by their original creators and economists rarely challenge the accuracy of the series.

In two recent papers, I have suggested that such an unquestioning acceptance of the historical data is unwise.¹ The papers examine the methods used to construct the historical GNP and unemployment series and find that the existing historical series are not adequate for certain purposes. The series accentuate cyclical movements, and are therefore not adequate for detailed cyclical analyses. I have created new series that I believe represent prewar cyclical movements more accurately.

This paper analyzes the business cycle properties of the new estimates of prewar GNP and unemployment in detail. It compares the severity and timing of cycles in the new data to those in the original prewar series and the official postwar series. It also examines the

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The author is Assistant Professor of Economics and Public Affairs, Woodrow Wilson School, Princeton University, Princeton, New Jersey 08544. She wishes to thank David Romer and Peter Temin for extremely helpful comments and suggestions.

¹ Christina Romer, "Spurious Volatility in Historical Unemployment Data," *Journal of Political Economy* 94 (Feb. 1986), pp. 1-37, and "The Prewar Business Cycle Reconsidered: New Estimates of Gross National Product, 1872-1918" (unpublished manuscript, Princeton University, 1985).

assumptions underlying the old and new prewar estimates in an attempt to explain the observed differences in the cyclical properties.

REVIEW OF METHODS UNDERLYING THE OLD AND NEW ESTIMATES

Gross National Product

For GNP the standard prewar series is the Kuznets components series presented in *Capital in the American Economy*.² The widely used Kendrick and Gallman estimates derive nearly all of their cyclical movements directly from the Kuznets components series.³

The Kuznets components series on GNP for the period 1869–1919 is derived directly from Shaw's data on commodity output valued at producer prices.⁴ Working at a fairly disaggregate level, Kuznets first estimates the trend of real gross national product for each sector. He then estimates annual GNP by assuming that the percentage deviations of GNP from trend in a particular sector are equal to the percentage deviations from trend of commodity output at producer prices in the same sector.

The problem with this procedure is that it is likely to accentuate the size of cyclical fluctuations. In the postwar era commodity output valued at producer prices is far more cyclically volatile than is GNP, even at a sectoral level. The reason for this is that the value added to a good not reflected in producer prices includes the less cyclically sensitive components such as distribution and transportation. If these components behave similarly in the prewar era, then assuming that these components move one-for-one with basic manufacturing output yields a total GNP series that is excessively volatile.

To derive new GNP data I examine the aggregate relationship between GNP and commodity output in a period with good data on both quantities. I regress the percentage deviations from trend of aggregate gross national product on the percentage deviations from trend of aggregate commodity output. I then use the estimated coefficient to form new estimates of aggregate GNP for the period 1872–1918.

The period over which I estimate the relationship between GNP and commodity output is 1909–1928. I test the validity of the coefficient from this short sample period by examining the relationship between GNP and commodity output over the combined period 1909–1928 and 1947–1982. The coefficient from the combined prewar and postwar sample is nearly identical to the coefficient for 1909–1928. Thus the key

² Simon Kuznets, *Capital in the American Economy: Its Formation and Financing* (Princeton, 1961).

³ John Kendrick, *Productivity Trends in the United States* (Princeton, 1961); Robert Gallman, "Gross National Product in the United States, 1834–1909," in *Output, Employment, and Productivity in the United States after 1800*, Studies in Income and Wealth (New York, 1966), vol. 30, pp. 3–76.

⁴ William Shaw, *Value of Commodity Output since 1869* (New York, 1947).

assumption underlying the new estimates is that the relationship between GNP and commodity output has been stable between the prewar and interwar eras.

The Unemployment Rate

For the unemployment rate, the standard prewar series is that constructed by Stanley Lebergott and presented in its final form in his book, *Manpower in Economic Growth*.⁵ I concentrate on Lebergott's estimates of the unemployment rate for 1900–1930 because the methods he uses to construct data are roughly unchanged over the period. I also consider to a lesser extent Lebergott's data for the 1890s. Lebergott's basic procedure is to estimate the labor force and total employment, and then calculate unemployment as a residual.

To estimate the labor force Lebergott calculates the labor force participation rates of various demographic groups in census years. He then derives annual labor force participation rates by interpolating linearly between census observations. Actual estimates of the labor force are calculated by multiplying the participation rate series by annual population estimates. This procedure provides one possible source of excess volatility. In the postwar era the labor force is significantly procyclical. If this is also true in the prewar era then Lebergott's estimates of the labor force are too high in recessions and too low in booms. The unemployment rate, therefore, would also be too high in recessions and too low in booms.

To estimate total employment Lebergott uses a more complicated procedure. He estimates total employment as the sum of several individual employment series for various sectors and types of workers. In general, Lebergott's procedure is to derive benchmark estimates of employment in a sector from census records or industry reports. He then calculates annual employment by interpolating between benchmark estimates by some annual series that is likely to be correlated with employment in that sector.

Excess volatility in his series may occur because in several key sectors (among them construction, manufacturing, and trade) Lebergott uses a measure of output as the interpolating variable. Lebergott's interpolation procedures assume that the deviations of employment from trend move one-for-one with the deviations of output from trend. In the postwar era, however, employment actually moves much less over the cycle than does output. Because Lebergott's estimates of total employment are likely to overstate volatility, the derived estimates of unemployment are also likely to overstate cyclical movements.

To deal with the likely cyclical exaggeration I create a new prewar

⁵ Stanley Lebergott, *Manpower in Economic Growth: The American Record since 1800*, Economics Handbook Series (New York, 1964).

unemployment series. I first replicate some of Lebergott's procedures in the postwar era. Specifically, I create an unemployment series for the postwar period using Lebergott's methods for estimating the labor force and for estimating employment in those sectors where an output series is used as the interpolating variable. I then derive the statistical relationship between this constructed postwar unemployment rate series and the actual postwar unemployment rate data. This estimated relationship is then applied to the prewar constructed unemployment series to yield a new historical unemployment series. For the procedure to work, the cyclical behavior of the labor force and the relationship between employment and output in certain sectors must have been stable between 1900–1930 and the postwar era.

BUSINESS CYCLE PROPERTIES

Volatility of the Prewar Economy

The new estimates of prewar gross national product and unemployment certainly alter one's perception of the volatility of the pre-Depression economy. Using the original Kuznets and Lebergott series, the traditional view is that the prewar economy was dramatically more volatile than the postwar economy.⁶ This stylized fact holds regardless of how one defines the prewar era. Even if one excludes the Great Depression, most measures of volatility are at least twice as large for the pre-Depression economy as they are for the postwar economy.

The stabilization of the postwar economy is much less apparent in the new estimates of historical GNP and unemployment. Table 1 shows several measures of volatility for both the old and new historical series and for the corresponding postwar series. In these calculations the time periods considered are 1893–1927 and 1951–1980.⁷ The two new prewar series are substantially less volatile than the original series. In fact, the new estimates of unemployment and GNP are only slightly more volatile than the corresponding postwar series.

The fact that the new estimates of GNP and unemployment show little stabilization between the periods 1893–1927 and 1951–1980 is quite important. While the results obviously do not challenge the severity of the Great Depression, they do challenge the common belief that cycles in the forty years before the Great Depression were decidedly more

⁶ See, for example, J. Bradford DeLong and Lawrence Summers, "The Changing Cyclical Variability of Economic Activity in the United States," National Bureau of Economic Research, no. 1450 (Sept. 1984); and Martin Neil Baily, "Stabilization Policy and Private Economic Behavior," *Brookings Papers on Economic Activity*, 1 (1978), pp. 11–50.

⁷ These periods are chosen primarily on the basis of data availability. The new GNP data I construct are available for 1872–1918. The new unemployment data are available for 1890–1930. To get the longest period of overlap, I consider 1893–1927. Three years are lost on either end because I calculate trends using a seven-year moving average. For GNP for 1919–1930 I use Kuznets's real GNP series in both the old and new series.

TABLE 1
VOLATILITY CHARACTERISTICS

Series	Time Period	Mean Cyclical Amplitude of Detrended Series ^a	Standard Deviation of Deviations from Trend ^b	Standard Deviation of Percentage Changes ^c
GNP—Kuznets	1893–1927	.080	.040	.059
GNP—Romer	1893–1927	.048	.028	.040
GNP—Commerce Department	1951–1980	.044	.021	.025
Unemployment Rate—Lebergott	1893–1927	4.968	2.493	3.374
Unemployment Rate—Romer	1893–1927	2.767	1.396	1.819
Unemployment Rate—Bureau of Labor Statistics	1951–1980	1.934	.922	1.181
Commodity Output—Shaw	1893–1927	.084	.039	.055
Commodity Output—Federal Reserve Board	1957–1980	.081	.037	.046

^a Cycles are defined by actual turning points in the detrended series. Cycles in GNP and commodity output with less than a 1.5 percent decline and cycles in unemployment with less than a 1 percentage point rise are excluded from the calculation of the mean.

^b Series are detrended using a seven-year moving average trend.

^c For GNP and commodity output percentage changes are used. For the unemployment rate the change in levels is used.

Note and sources: Kuznets, Romer, Lebergott, and Shaw data, see text. The Romer GNP series is a preliminary series that may be revised slightly before final publication. Commerce Department, Bureau of Labor Statistics, and Federal Reserve Board data, see *Economic Report of the President* for 1985.

severe than those in the postwar era. Indeed, by showing that business cycles before and after the Great Depression were approximately equally severe, the data focus attention on the Great Depression as an unprecedented collapse of a reasonably stable economy.

A second characteristic of the new prewar GNP and unemployment series is that the relationship between the volatility of the prewar and postwar series is roughly similar for the two series. Using the new GNP data the measures of volatility for 1893–1927 are on average 30 percent larger than those for the postwar GNP series. Using the new unemployment series the measures of volatility for 1893–1927 are on average 40 percent larger than those for the postwar unemployment data. Thus both series show the same, albeit reasonably small, degree of stabilization between the pre-Depression and post-1950 eras.

That the two new series show the same small amount of stabilization between the prewar and postwar eras is not surprising. To some extent, both the GNP series and the unemployment series are derived from the same output series. Both use Shaw's series on commodity output as a key interpolating variable. In deriving the new GNP series I use the aggregate Shaw series directly. In deriving the new estimates of unemployment I use the original Lebergott unemployment estimates

which in turn use various pieces of the Shaw series to interpolate employment in some sectors.

An important characteristic of the commodity output data is that they are roughly equally volatile in the prewar and postwar eras. The Federal Reserve Board (FRB) series on the gross value of final goods production is a modern series that is conceptually identical to the prewar Shaw series.⁸ Like Shaw's series, the FRB series measures the real value of final commodity output. The volatility characteristics of the Shaw series for 1893–1927 and the FRB series for 1957–1980 are also given in Table 1.⁹ From these estimates it is clear that commodity output has not stabilized over time. For all three measures of volatility the Shaw series is only very slightly more volatile than the FRB series.

The absence of stabilization in the Shaw-FRB series on commodity output provides a key insight into the source of the apparent stabilization of the Kuznets and Lebergott series. Both are derived from the Shaw series using the implicit assumption that the relationship between commodity output and the series being created is different in the prewar and postwar eras. The assumptions chosen are such that the Kuznets GNP and the Lebergott unemployment series are more volatile in the prewar era than in the postwar era, even though the underlying Shaw data are equally volatile in both periods. My new series are derived on the assumption that the relationships between the underlying commodity output data and GNP and unemployment have not changed over time. Since the underlying Shaw series shows little stabilization, neither do the new GNP and unemployment series.

Time Series Properties

It is interesting to see if the new estimates of prewar gross national product and unemployment possess autocorrelation properties that are noticeably different from those of the original estimates or the corresponding postwar series. These comparisons can provide information on whether cycles have become more protracted over time.

The first five autocorrelations of the various prewar and postwar series are given in Table 2. Since gross national product has a very strong trend, an examination of the autocorrelations of this series in levels provides very little information about cyclical behavior. To see what the new estimates reveal about the cycle, it is necessary to consider the autocorrelations of the first differences and the deviations

⁸ For a description of the gross value series see U.S. Board of Governors of the Federal Reserve System, *Industrial Production*, for 1971 (Washington, D.C., 1972).

⁹ The version of the Shaw series that I use is that presented in Kuznets, *Capital in the American Economy*, Table R-21, pp. 553–54. This version includes Kuznets's changes in the Shaw series to include net exports and to transform the series from a 1913 to a 1929 base. The FRB series can only be considered over this shorter period because it is only available after 1954.

TABLE 2
SAMPLE AUTOCORRELATIONS

Series	Time Periods	Lags (in years)				
		1	2	3	4	5
Deviations from Trend^a						
GNP—Kuznets	1893–1927	-.041	-.386	-.098	.222	-.228
GNP—Romer	1893–1927	.077	-.410	-.019	.124	-.285
Unemployment Rate—Lebergott	1893–1927	.306	-.266	-.220	-.070	-.073
Unemployment Rate—Romer	1893–1927	.400	-.198	-.272	-.128	-.027
GNP—Commerce Department	1951–1980	.314	-.295	-.390	.076	.190
Unemployment Rate—Bureau of Labor Statistics	1951–1980	.203	-.363	-.312	.118	.154
First Differences^b						
GNP—Kuznets	1893–1927	-.245	-.313	.155	.256	-.462
GNP—Romer	1893–1927	-.132	-.400	.274	.178	-.462
Unemployment Rate—Lebergott	1893–1927	.087	-.340	.064	.025	-.271
Unemployment Rate—Romer	1893–1927	.249	-.211	.015	-.044	-.201
GNP—Commerce Department	1951–1980	.008	-.200	-.264	.220	.040
Unemployment Rate—Bureau of Labor Statistics	1951–1980	-.115	-.233	-.166	.205	.061

^a Trends are measured as seven-year moving averages.

^b First differences are percentage changes for GNP and absolute changes for unemployment.

Source: See text.

from trend of each series. The calculations of deviations from trend use a seven-year moving average trend.

One main result is that for both GNP and unemployment, and using both first differences and deviations from trend, the original prewar series and my new estimates have very similar autocorrelation properties. This result should not be surprising. The methods used to form the new estimates serve mainly to remove excess volatility from the original prewar series. There is little in the methods that could change the timing of cyclical movements. As a result, one would expect the old and new prewar series to have similar serial correlation properties.

A second result apparent from Table 2 is that using either the old or new data there is very little change in the serial correlation properties of GNP and unemployment over time. For unemployment, both deviations from trend and first differences show no increase in first-order serial correlation over time. For GNP, first differences show no change in first-order serial correlation and deviations from trend show only a slight increase in persistence between the prewar and postwar eras. The results suggest that the common belief that the cycle has become more protracted over time is simply not borne out by either the old or the new prewar estimates of GNP and unemployment.

The Relationship Between GNP and Unemployment

A final issue to examine is the relationship between GNP and the unemployment rate. Before any comparisons are made it is important to stress the limitations of the analysis. Both the old and new prewar estimates of unemployment and GNP are to a large degree derived from the Shaw series on commodity output. Therefore neither the old nor the new estimates of GNP and unemployment provide much independent evidence on the structural relationship between unemployment and GNP.

Nevertheless, estimating Okun's Law coefficients on the new and old GNP and unemployment series can provide some information. Most importantly, it can provide a check on the derivation of the new prewar series. The new prewar unemployment and GNP series are derived using aggregate relationships from the postwar era. Therefore one would expect to find the Okun's Law coefficient for the pre-1930 period using the new data to be similar to that of the postwar era.

The Okun's Law relationship can be specified in three ways. The standard static specification measures the sensitivity of the percentage deviations of GNP from trend to the deviations of the unemployment rate from trend. The usual way that this relationship is specified is

$$gnp_t = \alpha + \gamma TREND_t + \beta U_t + e_t \quad (1)$$

where *TREND* is a simple linear trend and small letters denote logarithms. In this form the estimate of β should be negative and in the range of 2 to 3, for the postwar era.

Rather than detrend the data by including a linear trend in the regression, it is better to detrend the data using seven-year moving averages as estimates of the trend. This method allows the trend rate of growth of GNP and unemployment to vary over time. One can then estimate the equation

$$gnp_t - \overline{gnp}_t = \alpha + \beta(U_t - \overline{U}_t) + e_t \quad (2)$$

where bars over variables denote trend values.

A third specification is the dynamic version, which measures the sensitivity of the percentage change in GNP to the change in the unemployment rate. The specification posits that the two series should be related in changes as well as in levels. One can estimate the equation

$$gnp_t - gnp_{t-1} = \alpha + \beta(U_t - U_{t-1}) + e_t \quad (3)$$

The parameter estimates for the various series and time periods are given in Table 3. Two prewar periods are used because there is evidence that the parameter estimates are somewhat sensitive to whether the main years of American involvement in World War I are included in the

TABLE 3
OKUN'S LAW COEFFICIENTS

Time Periods	Combination of Series				
	(1) GNP—Kuznets Unemployment— Lebergott	(2) GNP—Romer Unemployment— Lebergott	(3) GNP—Kuznets Unemployment— Romer	(4) GNP—Romer Unemployment— Romer	(5) GNP—Commerce Department Unemployment— Bureau of Labor Statistics
<i>Linear Trend—Equation (1)</i>					
1893—1927	-1.3	-1.1	-1.9	-1.7	—
1893—1917, 1920—1927	-1.5	-1.3	-2.1	-1.8	—
1951—1980	—	—	—	—	-2.3
<i>Moving Average Trend—Equation (2)</i>					
1893—1927	-1.1	-0.9	-1.9	-1.5	—
1893—1917, 1920—1927	-1.4	-1.0	-2.3	-1.7	—
1951—1980	—	—	—	—	-2.1
<i>First Differences^a—Equation (3)</i>					
1893—1927	-1.3	-0.9	-2.2	-1.6	—
1893—1917, 1920—1927	-1.4	-1.0	-2.3	-1.7	—
1951—1980	—	—	—	—	-1.9

^a First differences are percentage changes for GNP and absolute changes for unemployment.
Source: See text.

regression.¹⁰ In general the fit of the regressions is good, though the R^2 's of the prewar equations are consistently lower than those for the postwar era. The Durbin-Watson statistics show no evidence of autocorrelation in the residuals for the specifications using a moving-average trend or first differences, but do indicate severe autocorrelation for the specifications using a linear trend. The standard errors of the parameter estimates are consistently quite small.

The estimates of the Okun's Law coefficients for the various data sets are quite plausible. Column 1 shows the prewar Okun's Law coefficients for the original Kuznets and Lebergott series. For the two prewar sample periods and for all three specifications the estimated coefficient is much lower than the postwar value. It is in the vicinity of 1.4. Because both the unemployment and GNP series are excessively volatile, it would have been possible for this coefficient to be either higher, lower, or the same as the postwar coefficient, depending on which series was more exaggerated. That the coefficient is low may suggest that the Lebergott unemployment series is slightly more excessively volatile than the Kuznets GNP series.

The second and third columns show the estimated Okun's Law coefficients using one new prewar series and one of the original series. The results are exactly what one would expect. Using the new, smoother prewar GNP series and the original unemployment data yields a very low Okun's Law coefficient. Using the new, smoother prewar unemployment series and the original GNP data yields an unreasonably large coefficient.

The last two columns show the estimated Okun's Law coefficient using both new prewar series and using the official postwar unemployment and GNP data. For various prewar samples the coefficient is quite similar to that for the postwar era. If there is any general relationship between the prewar and postwar coefficients, it is that the prewar coefficient is slightly lower. That the new prewar estimates of unemployment and GNP bear roughly the same relationship to one another as do the corresponding postwar series suggests that even though the new series have been derived separately and using different procedures, the methods yield new prewar data that preserve the postwar Okun's Law relationship.

EVALUATING THE ASSUMPTIONS

The analysis of the business cycle properties of the old and new estimates of GNP and unemployment shows that the differences in the volatility of the old and new prewar series is due to the assumptions used to derive the series, not to the base data. Thus it is important to

¹⁰ This may be because military expenditures are not fully included in the Kuznets components series.

evaluate the accuracy of the assumptions underlying the old and new estimates of GNP and unemployment.

Considering the care and knowledge that Kuznets and Lebergott brought to data creation, there is a tendency to remain loyal to their assumptions. But there are several reasons for believing that we should alter the assumptions. The first is that we have learned a great deal about the economy since the original series were created. It is only since we have had good aggregate data in the postwar era that economists have discovered relationships such as Okun's Law. Now that we know more about the cyclical behavior of unemployment and GNP, it is only natural to consider including that knowledge in our prewar estimates.

A second reason for changing the assumptions is that the technology of data creation has improved drastically. One of the most important determinants of the choice of assumptions for the original prewar series was computational feasibility. Both the Kuznets and the Lebergott series were constructed before the use of computers had become widespread. As a result they had to choose assumptions that could be implemented by hand or by simple calculators.

Lebergott's assumption that the percentage deviations of employment from trend in some sectors move one-for-one with the deviations of output from trend is an example of an assumption that needed to be chosen for computational ease. The obvious alternative procedure involves using an estimate of the actual correlation between the series to be estimated and the interpolating series in the interpolation procedure. The advent of easy computing makes estimating such correlations from fragments of prewar data very simple.

A third reason for changing the original assumptions is that the prewar macroeconomic data are being used to answer new questions. Both Kuznets and Lebergott were primarily interested in long-term growth. Each created macroeconomic data to analyze the importance of various factors in the long-run performance of the American economy. It is not surprising that the methods chosen may not have yielded a series that represents cycles accurately. Today the historical data are being used primarily for cyclical analyses. Given this change in emphasis, it is important to consider revising the assumptions underlying the historical series.

While it is reasonable to consider altering the assumptions underlying the original GNP and unemployment estimates, the validity of the assumptions I choose is open to debate. In my papers on unemployment and GNP I use fragments of data from the prewar and interwar eras to suggest that the assumptions I choose on the basis of postwar relationships may also be true in the prewar era.

The similarities in the business cycle properties of the new prewar GNP and unemployment series also provide indirect support for the assumptions underlying the new data. First, both new series, when

compared to their postwar continuations, show the same amount of stabilization over time. The fact that two independent sets of assumptions yield new estimates of GNP and unemployment that are consistent with one another provides some evidence that the assumptions may be accurate. Second, consistency of the Okun's Law coefficients over time using the new data is another piece of evidence in favor of the new prewar estimates of GNP and unemployment. The original prewar estimates yield a very low Okun's Law coefficient. If one believes that the true relationship between GNP and unemployment has indeed been stable over time, then the implausibly low coefficient implicit in the original prewar data is evidence that these estimates are flawed. By similar reasoning, the stability of the coefficient using the new prewar data is supportive of the new assumptions.

While this evidence is not conclusive, it suggests that the assumptions underlying the new estimates of prewar GNP and unemployment may be more accurate than those underlying the original Kuznets and Lebergott estimates. If this is true, then economists may need to revise their views of the prewar business cycle and especially of the change in the cycle over time.