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## Appendix: Derivation of Figures

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### *Monthly Data*

The publications of the Bureau of Labor Statistics listed in Table A-1 contain monthly estimates of the number of production workers, the average hours paid for per worker per week, and the average hourly earnings. The general method by which these data are used in conjunction with the listed production data to produce measures of hours per unit and labor cost has previously been described. However, it was necessary to make various special adjustments of the figures.

Before 1939 our data on numbers are for "wage earners," and they are in the form of index numbers, with 1923-25 as 100. We assume that the number of production workers changes in proportion to the number of wage earners. The most obvious way to calculate the number of production workers in, say, July 1934, would be to multiply the average number in 1923-25 by the index for that month. But there are two objections. The first is that even if the number of wage earners and the number of production workers change in the same proportion, the absolute number of the former in 1923-25 was different from the (unknown) absolute number of the latter. The second is that the BLS indexes, which are estimates, gradually lost coverage as they got farther and farther away from the most recent census. Consequently, applying the simple procedure to the indexes for 1939 gives us numbers of workers which are considerably lower than the later BLS direct estimates of numbers from 1939, i.e., those published in the "LS" series of releases. We therefore divided the LS monthly average number of production workers in 1939 by the old index for that year to get a hypothetical base figure. Finally we multiplied the hypothetical base number by, for example, the July 1934 index.

Other statistical problems, pertaining to individual industries, and their solutions are discussed in the following paragraphs.

*Anthracite.* From 1932 through 1938 the only information we have on number of workers is a BLS index of the number of wage earners, 1929 = 100. We multiply the index for each month by the 1929 Census of Mines figure for wage earners, 142,801, to get a first estimate of produc-

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TABLE A-1  
Sources of Monthly Data on Man-Hours, Labor Cost, and Production

Industry	Present SIC Number	Sources		Description of Industry, or Production Measure, in Source
		Labor Data <sup>a</sup>	Production Data <sup>b</sup>	
Anthracite	11	LS 53-2794 <sup>c</sup>	Bureau of Mines <sup>d</sup>	Anthracite coal production, short tons
Bituminous	12	LS 53-2795 <sup>c</sup>	Bureau of Mines <sup>d</sup>	Bituminous coal production, short tons
Meat	2011-12	LS 46-1858 LS 48-1397 LS 50-4264 <sup>f</sup>	Dept. of Agric. <sup>e</sup>	Hundredweight of livestock slaughtered under federal inspection
Confectionery Cigars	2071 212	LS 48-1398 LS 49-90 LS 53-1632 LS 48-1576	Bureau of Internal Revenue <sup>g</sup> SCB <sup>h</sup>	Confectionery Tobacco consumption, large cigars Cotton consumption, running bales
Cotton	2211-14			Cotton except smallwares Cotton smallwares
Wool	2232 2271	LS 48-1575 LS 48-1662 LS 48-1696		Woolen and worsted Wool carpets, rugs, and carpet yarns
Textiles	222 223	LS 53-1627 June, 1954		Cotton and synthetic fabrics Wool textiles
Hosiery	2251-52	LS 48-1665	SCB <sup>h</sup>	Hosiery production, dozen pairs
Suits and coats	231	LS 53-2344		Men's suits and coats
Outerwear Lumber	233 242	June, 1954 Feb., 1953		Women's outerwear Lumber

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Millwork and plywood	243	Feb., 1953	Millwork, plywood, and prefabricated structural wood products	Millwork and plywood
Paper and pulp	261	LS 48-694	Pulp, paper, and paper-board mills	Pulp and paper
Petroleum refining	291	LS 53-2789	Petroleum refining	Petroleum refining
Tires and tubes	301	LS 53-2340	Tires and inner tubes	Tires and tubes
Shoes	314	Feb., 1953	Footwear, except rubber	Shoes and slippers, production in pairs
Cement	324	LS 53-2066	Cement, hydraulic	Portland cement production, barrels
Steel	331	Feb., 1953	Blast furnaces, steel works, and rolling mills	1932-46, iron and steel; 1947-55, pig iron and steel
Foundries, iron and steel	332	Feb., 1953	Iron and steel foundries	Iron and steel castings
Copper and aluminum	335	Feb., 1953	Rolling, drawing and alloying of nonferrous metals	Copper and aluminum mill shapes
Foundries, nonferrous	336	Feb., 1953	Nonferrous foundries	Nonferrous castings
Railroads	4011	ICC <sup>1</sup>	Class I line-haul railways	Revenue ton-miles, revenue passenger miles

<sup>a</sup> BLS mimeographed releases, *Revised Index Numbers of Factory Employment and Payrolls*, September 1938, used to estimate wage earners before 1935, and *Indexes of Factory Employment and Payrolls, January 1935 to February 1940*, May 1940, used for 1935-39 in some industries. Data on hours per week before 1938 in some cases were taken from BLS, *Hours and Earnings in the United States, 1932-40, with Supplement for 1941*, Bulletin No. 697, 1942. The remaining data (cf. note c) were taken from BLS, *Employment, Hours and Earnings*, mimeographed releases. The main releases are identified here by their serial numbers or dates of release. Later data were taken from brief supplementary releases or various issues of the *Monthly Labor Review*.

<sup>b</sup> Except where otherwise noted, production series were taken from various issues of the *Federal Reserve Bulletin*. FRB indexes are on either a 1935-39 or a 1947-49 base.

<sup>c</sup> In addition, BLS, *Employment and Payrolls*, various monthly issues, for data before 1939.

<sup>d</sup> *Minerals Yearbook* and various issues of SCB, monthly, and biennial supplements (in addition, for bituminous, Bureau of Mines, *Weekly Coal Reports*).

<sup>e</sup> *Livestock Market News*.

<sup>f</sup> Number of workers, 1939-46, from correspondence with BLS.

<sup>g</sup> *Tax-Paid Products*, monthly mimeographed release, and SCB.

<sup>h</sup> Department of Commerce, *Survey of Current Business*.

<sup>i</sup> *Wage Statistics* for labor data, *Revenue Traffic Statistics* for production data.

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tion workers. The 1939 average index is 50.6; this would imply only 72,257 production workers in 1939, while the LS figure is 83,600, 15.7 per cent higher. The index was adjusted to the 1935 Census but not to the 1939 Census, which did not come out in time. The LS figure, however, reflects the 1939 Census. We assume that the index missed an increasing percentage of workers during the thirty-seven months from December 1935 to January 1939;  $15.7 \text{ per cent} \div 37 = 0.424 \text{ per cent}$ . For each of these months through December 1938 we have increased our first estimate by 0.424 per cent times the number of months elapsed.

*Bituminous.* This industry has been troubled by widespread strikes. If one of them begins late in the month, the figures on man-hours, based on the middle week, will not reflect the low level of employment during the strike portion of the month; but our production figures will reflect the low level of output during that period. Consequently, the number of man-hours per ton will be improperly high.<sup>1</sup> Sometimes a converse complication presents itself. A strike prevails during the reporting week, but not in all the rest of the month. The figure for man-hours is then too low for division by production, and the two yield a fictitiously low ratio.

Serious disconformities between the labor and production data occur in the bituminous figures for September 1935, May 1939, April 1941, November 1943, April and May 1946, March and April 1948, September 1949, and February 1950. For these months we use a figure for hours per unit which is an average of the figures for the last month before the disturbance and the first month after it. The seasonally adjusted equivalents of these dummy figures enter into the averages for groups of months in which they occur.

*Confectionery.* Since our data on man-hours and cost begin in 1939, we cannot construct index numbers of  $h/p$  or  $c/p$  on a 1935-39 base. We therefore divide the Federal Reserve index, 1935-39 = 100, by its 1939 average level to put it also on a 1939 base.

*Cigars.* Changes in the nature of the underlying figures make it possible to compute variant figures for man-hours per 1,000 cigars in various years: Variant A, man-hours from LS 49-90, cigars based on government sales of revenue stamps; B, man-hours from LS 53-1632, cigars again based on sales of stamps; C, man-hours from LS 53-1632, cigars based on stamps used. The total of the twelve monthly A figures for 1947 equals 95.64 per cent of the total of the twelve B figures for that year. To estimate A figures for 1948-51 we multiply each monthly B figure by 0.9564. The twelve A estimates for 1951 equal 91.98 per cent of the 12 C figures for that year.

<sup>1</sup> For some industries the Christmas holidays cause a similar distortion. Man-hour figures for the week nearest the middle of December do not reflect them, while production figures for the entire month do. But seasonal adjustments cancel out the distortion; it does not appear in the adjusted figures.

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To estimate A figures for 1952-58 we multiply C figures by 0.9198. We finally use only actual or estimated A figures. The procedure makes the figures as nearly comparable in level from year to year as possible, but probably understates man-hours per 1,000 cigars in all but the earliest years. LS 49-90 misses workers as it gets away from the 1939 Census.

*Cotton.* In estimating man-hours from 1932 through 1938, we assume that the index of employment for cotton textiles, excluding cotton smallwares, has the same level as it would have if it included them. In 1939 workers in smallwares were 3 per cent of all cotton workers including those in smallwares. Beginning in 1939, man-hours are computed for smallwares and added to those for the rest of the industry.

In 1934, average hourly earnings were 37.8¢ in cotton, excluding smallwares, and 45.2 cents in the latter. The average, weighted by .97 and .03, is 38.0¢, 0.5 per cent higher than 37.8¢. We increase the monthly cotton figures from 1932 through 1934 by 0.5 per cent. Beginning in January 1935, we weight the average hourly earnings in the two branches by .97 and .03.

*Wool.* The Federal Reserve Board index includes carpets and rugs, but there are no data on hours for that branch of the wool industry before 1934. For 1932 and 1933 we computed an index of man-hours for wool, excluding carpets and rugs. We readjusted the production index on the same base (1935-39) by excluding the component (carpet-wool consumption) that represents production of carpets and rugs, and used the readjusted index to compute hours per unit. For the purpose of comparison we extended these computations through 1937.

Beginning in January 1934 we also computed aggregate man-hours for carpets and rugs. Adding the man-hours for the two branches, we obtained a total for wool, including carpets and rugs, which we used in conjunction with the index of production, also including carpets and rugs. For 1934-37 the *h/p* indexes are on about the same level whether we include or exclude. We therefore treat the index that excludes them before 1934 as continuous with the index that includes them beginning January 1934.

We used payroll indexes to compute labor cost. Both for wool, excluding carpets and rugs, and for them as well, there are two payroll indexes. An older one is based on 1923-25 and extends through 1939. We divided the figures from January 1932 through December 1938 by their 1935-39 average to get them on a 1935-39 base. A newer index is based on 1939 and begins in January of that year. The average of the old index for 1939 exceeds its average for 1935-39 by 3.6 per cent in the case of wool, excluding carpets and rugs, and 5.0 per cent in the case of carpets and rugs. We raised the new figures (beginning January 1939) by these percentages.

Now we had a continuous payroll index on a consistent base for each

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branch of the industry from January 1932 to May 1949. But we still needed to combine them, using weights proportionate to the aggregate payrolls in the two branches in 1935-39. We had to use 1939 as a point of departure. Average aggregate weekly payrolls during that year in wool, excluding carpets and rugs, equaled 157,700, the number of workers, times \$19.21, the average weekly earnings, or \$3,029,417. From this figure and the payroll indexes we computed similar figures for 1935-38. We repeated the process with carpet-and-rug data. The five-year total for wool, excluding carpets and rugs, is 83 per cent of the five-year total that includes them. We therefore combine the payroll indexes for the two branches with weights of 83 and 17. Finally, of course, we divided the combined index by the production index, including carpet-wool consumption, to get an index of  $c/p$ .

*Textiles.* For each of the two BLS industries we computed aggregate middle-week man-hours and payrolls; to obtain the latter we multiplied number of workers by weekly earnings. We then totaled the two man-hour figures and the two payroll figures, and divided the second total by the first to get hourly earnings. We combined the two FRB indexes, using their Federal Reserve Board weights, 3.72 and 0.97.

*Paper.* LS 48-694 reports less man-hours for 1947 than LS 53-1907. Consequently the total of the twelve-month figures for man-hours per index point based on the earlier release is 96.35 per cent of the total based on the later release. All figures based on the latter have been multiplied by 0.9635.

Average production in 1935-39 was 65.1 per cent of the average production in 1947-49. The earlier monthly indexes have been multiplied by 0.651.

*Steel.* For the same reasons as those discussed in connection with bituminous coal, the labor and production figures are not comparable in January, February, and May 1946, October and November 1949, and June and July 1952. In this case, however, we simply omitted the affected months in computing averages for groups of months. Earlier indexes of production on a 1935-39 base are multiplied by 0.518 to get them on a 1947-49 base. The ratio was obtained in the same way as for paper.

*Copper and Aluminum.* We combined the two Federal Reserve Board indexes, using their FRB weights, 0.63 and 0.20.

*Railroads.* Man-hours before 1951 do not include those of workers for whom days, not hours, were reported. We have, however, estimated them for all workers in 1949 and 1950 on the assumption that each man-day of other workers represented eight hours.

Compensation figures include pay of all workers throughout. In the earlier years, therefore, our labor cost figures are somewhat more comprehensive than the man-hour figures.

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### Annual Data

We derive annual figures from the sources described below. Except as noted, the source contains indexes of production, production per man-hour or man-hours per unit of product, and labor cost per unit of product. Where there is an index of production per man-hour but not one of  $h/p$ , we compute the latter by taking the reciprocal of the former. If indexes from two sources overlap in time we splice them, using the more recent index as far back as it goes.

*Mining.* Indexes of production and product per man-hour are from "Output per Man-hour in Selected Nonmanufacturing Industries," *Monthly Labor Review*, February 1956. Earlier data are from Harold Barger and Sam H. Schurr, *The Mining Industries, 1899-1939*, New York (NBER), 1944. To get indexes of  $c/p$  we construct indexes of the annual average hourly earnings from various BLS LS-53 releases and multiply them by the indexes of  $h/p$ .

*Manufacturing.* Indexes for 1919-40 are published in BLS, *Productivity and Unit Labor Cost in Selected Manufacturing Industries, 1919-1940* (mimeographed), February 1942. BLS extended the indexes in Harry Magdoff, Irving H. Siegel, and Milton B. Davis, *Production, Employment, and Productivity in 59 Manufacturing Industries, 1919-36* (mimeographed), Works Progress Administration, May 1939, 3 vols. BLS Bulletin No. 1046, *Productivity Trends in Selected Industries Indexes through 1950*, contains indexes from 1939 through that year.

We have constructed various annual indexes of  $h/p$  and  $c/p$  from 1947 through 1958. Indexes of man-hours and aggregate labor cost were computed from BLS data of the LS-53 type. These were divided by corresponding FRB production indexes.

The data in Table 7 are derived from American Iron and Steel Institute, *Number of Employees, Average Hours Worked per Week and Average Earnings per Hour, Iron and Steel Industry*, various issues. Monthly figures are also given, but the annual data sufficiently illustrate the comparative variability.

The data in Table 14 for production worker payrolls, including the monthly ones, are derived from BLS; those for all wages and salaries, as well as data on supplements are from U.S. Department of Commerce, *National Income Supplement*, 1954; *U.S. Income and Output*, 1958; and *Survey of Current Business*, National Income Number, July 1959.