Tab A

A

Proposed Project: Determination of Labor Input requirements for (1) industries comprising the 80-order classification and (2) specific products included in these industries, by both physical and value units

Introduction

After exploratory investigation and discussions with technicians in the manpower field, it has been ascertained that the basic data required to conduct a project of this nature are available from the 1947 Census of Manufactures and individual studies conducted in the Bureau of Labor Statistics, particularly the Divisions of Interindustry Economics, Productivity and Technological Developments, and Manpower and Employment Statistics. It has been suggested that a thorough review of the individual BLS studies in the productivity and employment field be made to establish to what degree of detail it is possible to extend unit man-hour requirements on a product detail basis which would be consistent with the overall primary product industry approach. For labor input requirements based on the 80-order classification, procedures can be developed from 1947 Census data which will yield consistent results. As outlined below, the basic problem, apart from the choice of proper standards of measurement, relates to the transformation of Census data on employment and output from the establishment basis to the primary product wherever produced one. The recently established output control totals for the I-O (450-sector) industries, defined on a primary product wherever produced basis, will enable properly weighted labor inputs to be obtained. Before proceeding to a discussion of the procedures proposed to obtain measures of labor input requirements on an 80-order industry primary product basis, it is worthwhile to discuss the three possible measures which can be employed to describe labor input requirements and the advantages and disadvantages of each.

I. General Discussion of Labor Input Coefficients

Labor input measurements relate to the amount of labor required, in dollar or physical terms, to produce a unit of output; they likewise may be expressed in dollar or physical terms. The labor component included in the labor input per unit of output may refer to "production and related workers" or to "all employees," which includes production and related workers" and "all other employees." 1/ With the exception of the unit

1/ 1947 Census of Manufactures, Vol. II, pp. 12-14.

man-hour requirement approach, labor input per unit of output can be readily expressed in terms of "all employees" or "production and related workers."

A. Labor Coefficients Based on Payrolls

The labor input coefficient which most closely approximates the usual interindustry flow coefficient relates to the ratio of total annual wages and salaries of an industry--i.e., payrolls or money cost of labor--to the annual monetary output value of the industry. The resultant relationship is described as the labor input in monetary terms per designated monetary unit of output. This measure is inapplicable when the objective is to compare relative labor input requirements for the same industries over time or for different industries or economics. Payroll data used in this particular index reflect not only the industrial techniques, economic activity levels, and labor force composition--i.e., full time, part time employees--but also the accompanying institutional factors associated with the industry. Thus payroll data include payments for such items as vacation, sick and dismissal pay, and nonproduction bonuses.

B. Labor Coefficients Based on Number of Employees

A second index which can be employed is the ratio of either the average yearly number of "all employees" or "production and related workers in an industry" to the total yearly monetary output of the industry; this may be described as the labor input in physical terms per designated monetary unit of output. This particular labor input is beset with definite limitations which can give rise to serious instability in the coefficients. Although the total number of workers in an industry may not change significantly, yearly hours worked per worker may register wide variations from year to year in an industry due to changing economic conditions. Thus, if the total number of workers in an industry remains constant for two periods of time and productivity does not change for the two time periods, labor input coefficients for the industry may register a decline for the latter period because of increased output over the base year due to an increase in yearly hours worked per worker. 2/ Notwithstanding these aforementioned limitations, this particular index of labor input requirements per unit of output may, as indicated below, serve a useful analytic purpose and should not be summarily discarded.

2/ This situation may result from changing proportions between full and part time employees and by extending the work week of full and part time employees.

C. Labor Coefficients Based on Man-hours

The unit man-hours criterion used to measure labor inputs is defined as the ratio of the total number of man-hours worked per year by "production and related workers" in an industry to the total yearly output of the industry in value terms. While the physical labor input coefficient per designated unit of monetary output is seriously hampered by changing conditions, other than technological, over time, the unit man-hours requirement index appears to imply straight-line proportionality in relation to the scale of production and thus may be inadequate, in itself, to indicate the degree of increased output per worker per year, or conversely, the physical labor input requirements per year associated with a stipulated increase in output. The industry unit man-hour requirements which can be computed from Census data represent an average for the whole year. However, if unit man-hour requirements are not constant over the entire range of the working year, the ratios obtained may have built-in biases which limit the validity of the proportionality assumption. 3/

D. Observations

For individual industries or for the more basic operating units, the problem of unit man-hour requirements may be a more important consideration than the physical labor input employed in producing the annual output. The former has impact upon the financial status of the operating units, while the latter, being conditioned by increased average hours worked yearly by full or part time employees, may continue to fall and result in rising unit man-hour requirements and, consequently, higher cost per unit of output, assuming wage rates to be constant. However, when mandatory increases in output, irrespective of labor cost, are part of a national program, physical labor input coefficients may assume considerable importance, the underlying assumption being that the labor supply is more inelastic over a period of time for all industries as a whole (i.e., the national economy) than for specific industries. On an overall national scale, increasing man-hour requirements may serve as indicators and regulators of the limiting conditions imposed in the reduction of the labor input coefficients for a given labor force. Thus national considerations might demand that certain production be carried to the point where marginal unit man-hour requirements approach infinity, and, therefore, physical labor input coefficients become irreducible.

3/ The industry man-hour statistics reported in the Census of Manufactures and the Annual Surveys of Manufactures refer only to production and related works and do not include the category of "all other employees." For certain industries this understatement of man-hours for "all employees" may be considerable.

E. General Conclusions

Clearly, both unit man-hour requirements and physical labor input coefficients ("production and related workers") per unit of output are desirable indices to have available for analytic purposes where labor requirements are an essential part of an overall national economic study. In utilizing unit man-hour requirements for inter-year comparisons in order to project manpower requirements, changes in average hours worked or stipulated per year may be worthy of separate examination independent of the study of change in unit man-hour requirements resulting from the application of advances in technology. Productivity studies which are not based on the division of total man-hours by annual output but on individual performance studies may prove useful in discerning productivity changes which do not contain the elements of a yearly average. In respect to yearly hours worked per worker, if significant increases are postulated, it may be appropriate to examine the implications in terms of changing unit man-hour requirements and physical labor input requirements. An estimate of the hours worked per year per worker in an industry can be obtained by dividing the total number of man-hours worked in the industry by the total number of workers employed in the industry. Estimates of average hours worked per year are in themselves rather crude tools when used to appraise the possibilities and extent of expanding output by utilizing the labor force more intensively. Further useful information would include composition of labor force (i.e., full or part time employees, sex, age) to determine relevant factors tending to restrict expansion of average hours worked per year (i.e., family responsibilities, physical limitations, etc.). Always lurking in the background in this type of analysis is the assumption of sufficient plant capacity and the maintenance of the necessary synchronized flow of materials. Thus, depending upon an analysis of these various factors which affect labor requirements, different assumptions may be made as to limitations imposed on marginal unit man-hour requirements and physical labor input coefficients.

Summarizing, it would appear that estimates for both unit man-hour requirements and physical labor input coefficients per designated monetary unit of output should be attempted. I have not as yet had the opportunity to conduct a careful analysis of labor input requirements for specific products, in physical and value units, included in the 80 order industries and therefore have refrained from making any substantive comments on this subject. I expect to prepare a report on this tentative phase of the project at a later date.

As a final note to the general discussion, it should be underscored that any interindustry and inter-economy inferences to be drawn from any set of labor input coefficients computed according to the indices outlined

above merit the closest examination to ascertain their validity or, at least, their appropriateness. Labor input coefficients should not be used for value judgments among industry groups within an economy; for example, one should not infer comparative efficiency or inefficiency as to the use of labor among industries. Labor and plant and equipment may all be equal, but a variance in labor input coefficients may occur among industries simply because of differences in cost of materials in relation to output resulting from the particular stages of production with which particular industries are concerned. Even if labor and plant and equipment are not the same, variance in labor input coefficients among industries might occur because of differing degrees of industrial integration among industries. It is conceivable that labor inputs, when compared to value added for the industries in question, might yield similar ratios but would show extreme variations when compared to their respective outputs. More appropriate inferences, and perhaps significant as indicative of policy decisions, might be drawn from the relative dispersion of labor input coefficients among industries and grouped by annual time periods. This could be shown in graphical form by plotting labor input coefficients along the ordinate and industries (i.e., from 1 to 80) along the abscissa.

If any attempt were made to estimate labor input coefficients for similar industries located in different economies from information obtained for industries in the United States economy, it would be necessary to proceed with extreme caution and buttress the estimates with additional information, particularly as to the relative industry capital structures in both economies. 4/ What would appear to be required is information concerning the scope of the manufacturing processes (degree of integration) encompassed for comparable industries located in the domestic and foreign economies and the capital associated with each manufacturing step in the integrated industries. Comparable capital structure bases could be obtained by subtracting from the relevant industries the capital associated with the integrated process tending to create the incomparability. In addition to examining the degree of integration for similar industries located in two different economies in order to neutralize these differences, the amount of capital plant and equipment per worker would undoubtedly be an index of the utmost significance for attempts at estimating labor input coefficients for other economies based on estimates derived from the United States economy. If extremely questionable estimates are to be avoided, it would appear that efforts should be directed to ascertaining, at a minimum, the varying effects on the relevant labor input coefficients of differing capital structures for comparable industries located in different economies.

4/ Perhaps, as a general summary expression, it may be stated that Labor Input Coefficients for similar industries located in different economies may vary due to differences in capital structure, degree of integration, composition of labor force, hours worked, institutional factors, etc.

II. Operational Procedure to Derive Labor Input Coefficients for Primary Product Industries

In order to derive "production and related workers" requirements for primary product industries based on physical labor input coefficients and unit man-hours per monetary unit of output, it is necessary to have yearly primary product industry data relating to the number of "production and related workers," total man-hours worked by "production and related workers," and value of output. These data are either already available, as in the case of primary product industry output control totals, or can be derived from the statistical compilations included in the 1947 Census or Annual Surveys of Manufactures (1949, 1950, 1951, 1952). Census industry data for "production and related workers," are based on the establishment concept and hence require adjustment to accord with the concept of primary product wherever produced before they can be employed in the present project. Below is an adjustment procedure intended to transform the relevant Census data to the proper base and thus enable the computation of the desired labor input requirements for primary product industries.

A. Census Heterogeniety in Respect to Labor Input Coefficients

In the Census of Manufactures industry statistics, the data compiled refer to both primary and secondary products produced in an industry. Consequently, the relationships between the labor employed in an industry and the output of that industry which can be derived from Census data are inapplicable for this project. Schematically, the labor input coefficients (and unit man-hours) which can be derived from Census data may be presented as follows:

1. Labor input coefficient for Census industry i 5/ =
   a. labor input coefficient for primary products of Census industry i (output of primary product of Census industry I) +
   b. labor input coefficient for secondary products of Census industry i (output of secondary product of Census industry I).
   c. Both (a) and (b) are divided by total output of Census industry i.
2. A similar presentation may be made for unit man-hours.

5/ 1) $LIC(i) = \frac{P(i)}{O(i)} = \left[\frac{P(i)pp \cdot O(i)pp}{O(i)pp} + \frac{P(i)sp \cdot O(i)sp}{O(i)sp}\right] / O(i)$.

or alternatively

2) $LIC(i)pp = \frac{P(i)pp}{O(i)pp}$; $LIC(i)sp = \frac{P(i)sp}{O(i)sp}$

5/--Continued

therefore

2.1) $LIC(1) = LIC(i)_{pp} \cdot O(i)_{pp} + LIC(i)_{sp} \quad /O(i)$,

where: LIC(i) = labor input coefficient for Census industry i;
P = "production and related workers" for Census industry i;
O(i) = output of Census industry i; and subscripts pp and sp refer to primary products and secondary products, respectively.

B. Objectives of the Adjustment Procedure

Given primary product industry output control totals, which were derived in order to compute primary product input coefficients, the problem in this project is reduced to determining for each Census industry 6/ the distribution of the number of "production and related workers" and their total man-hours between primary and secondary production and then transferring the estimates relating to secondary production to the proper primary producing industries. The rationale for this transfer procedure is outlined below:

1. Total number of "production and related workers" in Census industry i,

   less: number of "production and related workers" attributable to secondary production of Census industry i,

   plus: number of "production and related workers" of other Census industries attributable to the production outside of Census industry i of its primary product,

   equals: total number of Census "production and related workers" attributable to the production of products classified as primary to Census industry i. 7/

2. A similar presentation is required for man-hours. 8/

6/ Technically, many Census industries were combined to form I-O industries and thus the operation described in the text can be performed on a more aggregative basis than indicated.

7/ For the purpose of this project, estimates have to be made of the number of production and related workers (also man-hours) that would be required to produce competitive imports and inventory depletions for the industry.

8/ Ibid.

C. The Proposed Adjustment Procedure

A preliminary operation in the adjustment procedure is the aggregation, where necessary, of Census industry data for production and related workers and their total man-hours to the I-O industry definition. For ease of operation, the next step is to determine the number of production workers and their total man-hours attributable to primary products of Census industries produced in Census industries other than the producing one (the so-called "transfers-in"). 9/ If the assumption is made that the man-hours required to produce a designated unit value of primary product in industries other than the primary producing one are the same as the man-hours required to produce a designated unit of output in the primary producing industry, total man-hour estimates attributable to "transfers-in" can be derived. The total value of "transfers-in" multiplied by unit man-hour requirements of the industry receiving the "transfers-in" can be utilized as an estimate of the total number of man-hours attributable to the production of primary products outside of the primary producing industry. The concomitant estimate for the number of "production and related workers" attributable to "transfers-in" can be secured as follows:

For each industry transferring out secondary products, it is possible to estimate the hours worked per year per worker by dividing the total man-hours worked by "production and related workers" by the total number of production workers. Assuming that for the transferring-out industry the hours worked per year per worker is the same for both primary and secondary production, an estimate of the number of workers attributable to each "transfer-in" can be obtained by dividing the man-hour requirements for each "transfer-in" by the hours worked per year per worker in the transferring-out industry. The increments for the "number of production and related workers" and their total man-hours resulting from industries receiving "transfers-in" need to be offset, of course, by appropriate decrements to the transferring-out industries.

Since Census industries usually include secondary products in their outputs, unit man-hour requirements for industries which are computed from Census data, in order to estimate total man-hours for "transfers-in," contain a bias. It is believed that where secondary products (transfers-out) are not significant, the resultant bias in the labor input measurements will not be significant. However, for industries in which the production of secondary products is important (e.g., more than 10 percent of direct inputs), the bias may be substantial. It is proposed,

9/ The required information for secondary products is available from the work done for the current primary product industry project.

therefore, that the "transfer-in" adjustments be performed first for industries where the impact of secondary products is not considered to be significant. Then intermediate estimates can be made to include all relevant revisions resulting from recording "transfers-in" for the relatively homogeneous industries and from partial revisions on the "transfers-out" side for both the relatively homogeneous and heterogeneous industries. The objective of this intermediate computational stage is to reduce as much as possible for heterogeneous industries the number of "production and related workers," their total man-hours, and the industry output attributable to secondary products. After completion of this stage, "transfer-in" revisions for the heterogeneous industries are to be undertaken following the procedure outlined above.

After all relevant data are available in terms of primary product industries (i.e., number of "production and related workers," their total man-hours, and monetary output), the data must be aggregated to the 80-order industry classification before the desired physical labor input coefficients and unit man-hour requirements are computed.

D. Computing Labor Input Coefficients for Years Later than 1947

It is proposed that the data in the 1947 Census of Manufactures be employed to obtain the basic estimates. If desirable, labor input requirementsestimates for the years 1949, 1950, 1951 and 1952 can now be constructed. A series such as indicated would require several adjustments to the data in order to achieve comparability with the base year, 1947. The "number of production and related workers," their total man-hours, and Census industry output appearing in the Annual Census Survey of Manufactures would have to be adjusted for industry definition (i.e., from Census industry to I-O industry and from the I-O industry establishment basis to a primary product one) and for changes in price level of output in relation to the base year.

The Bureau of Labor Statistics has developed interindustry wholesale price indices (1947 = 100) for I-O industries for each subsequent year through the first half of 1953. These price indices can be applied to appropriately aggregated annual Census output data to achieve comparability with the base year. Scalar factors (coefficients) employed in the primary product industry project to achieve a transformation of output control totals from an establishment to a primary product industry basis can be employed to adjust the annual price corrected industry output estimates derived from Census data.

In order to achieve labor input relationships which are consistent with the primary product industry definition, the following adjustment should be made:

1. The statistic, total industry man-hours for "production and related workers" (on an I-O industry basis), can be adjusted by applying a coefficient which will transform man-hours from an establishment to a primary product industry base. This coefficient may be defined as the ratio of the 1947 primary product total man-hours estimate for "production and related workers" to the 1947 total man-hours for "production and related workers" on an establishment basis.

2. Total number of Census "production and related workers" (adjusted to an I-O industry basis) can be transformed to the primary product industry concept by applying a factor representing the ratio of the 1947 primary product industry number of "production and related workers" to the 1947 number of I-O industry production and related workers on an establishment basis.

It it were desired to adjust the physical labor input coefficients to the 1947 base, an average hours worked per year per worker series (properly weighted with 1947 = 100) would be required. Unadjusted estimates of physical labor input coefficients for years other than 1947 may prove useful, along with information available at the same time concerning the relative change of average hours worked per year per worker, in analyzing the potential maximum utilization of a given labor force. The difference between a stipulated potential maximum utilization of labor and the utilization of the labor force for any given period may indicate the possibilities of intensifying labor force utilization, assuming the availability of necessary plant capacity and materials.