Chapter 13. Employment Projections

For more than 35 years, the Bureau of Labor Statistics has developed medium- to long-term (10 years ahead) projections of likely employment patterns in the U.S. economy. Since the early 1970s, projections have been prepared on a 2-year cycle. The projections cover the future size and composition of the labor force, aggregate economic growth, detailed estimates of industrial production, and industrial and occupational employment. The resulting data serve the many users who need information on likely patterns of economic growth and their effects on employment. The information on future employment opportunities by occupation, for example, is used by counselors, educators, and others helping young persons choose a career, and by officials who plan education and training programs.

IN THIS CHAPTER

Projection Procedures

Over the years, the procedures used to develop the projections have undergone many changes as new data series became available and economic and statistical tools improved. Since the late 1970s, however, the basic methodology has been relatively unchanged. The procedures have centered around projections of an interindustry or input-output model, which determines the chain of indirect job requirements associated with the production needs issuing from several possible scenarios.

Projecting employment in industry and occupational detail requires an integrated projection of the total economy and its various sectors. The BLS projections are developed in a series of six steps, each of which is based on separate projection procedures and models, and various related assumptions. These six steps, or system components, deal with:

- The size and demographic composition of the labor force.
- The growth of the aggregate economy
- Final demand or gross domestic product (GDP) subdivided by consuming sector and product
- Interindustry relationships (input-output)
- Industry output and employment
- Occupational employment

These components provide the overall analytical framework needed to develop detailed employment projections (see chart 1). Each component is solved sequentially, with the results of each used as input for successive components and with some results feeding back to earlier steps. Within each step, many iterations are made to ensure internal consistency as assumptions and results are reviewed and revised.

Labor force

The future size and composition of the labor force is determined by projections of the age, sex, and racial composition of the population and by trends in labor force participation rates—the percent of the specified group in the population who will be working or seeking work. The population projections, prepared by the U.S. Bureau of the Census, are based on trends in birth rates, death rates, and net migra-

tion. With the population projections in hand, BLS analyzes and projects changes in labor force participation rates for approximately 130 age, sex, and race or Hispanic origin groups.

Projections of labor force participation rates for each group are developed by first estimating a trend rate of change, usually based on participation rate behavior during the prior 8-year period. Second, the rate is modified when the time-series projections for the specific group appear inconsistent with the results of cross-sectional and cohort analyses. This second step ensures consistency in the projections across the various demographic groups. Finally, the size of the anticipated labor force is calculated by multiplying the labor force participation rates by the population projections.

Aggregate economic growth

The second phase of the BLS projections process develops projections of the gross domestic product (GDP) and the major categories of demand and income. These results provide aggregate measures that are consistent with each other and with the various assumptions and conditions of the projections scenarios. The values generated for each demand sector and subsector are then used in the next phase in developing detailed commodity purchases for personal consumption, capital formation, foreign trade, and government.

Recent projections have been based on a macroeconomic model developed by Data Resources, Inc. This model has approximately 340 behavioral equations, which represent the key relationships influencing the growth and composition of the U.S. economy. The model is driven by a set of nearly 300 exogenous variables, which are specified by BLS and together define a particular growth scenario for the U.S. economy.

Final demand

The BLS projection procedure then moves from the aggregate to the industrial level. For the industry output projections, the economy is disaggregated into approximately 180 sectors , encompassing all U.S. economic activity, both public and private. The framework for this procedure is the set of input-output accounts of the United States which provides detailed information on the purchases of commodities, both by final users and by industries for use in producing other goods and services. The goal of this stage of the projections is to produce a forecast of final expenditures for each of the commodity sectors in the input-output table.

[1] The number of sectors may vary from one projection study to the next depending on data availability.

Final demand is one way to view GDP; it is GDP distributed among final users, broadly categorized into four groups:

- Personal consumption expenditures (PCE)
- Business investment
- Foreign trade
- Government purchases

PCE represents demand on the part of persons and nonprofit institutions serving individuals. Rent and the imputed rental value of owner-occupied dwellings are included in this category, but the actual purchase of dwellings is classified as investment. Investment includes both fixed capital goods-the purchase of durable equipment and structures by business and nonprofit institutions-and the value of changes in business inventories of raw materials, semifinished goods, and finished goods. Purchases by persons of owner-occupied and rental structures are also included here. Foreign trade includes both exports and imports of goods and services. Government demand is defined as the goods and services purchased by all government units-local, State, and Federal. It includes employee compensation, but does not include transfer payments, interest payments, grants, or subsidies, all of which are accounted for under personal consumption expenditures or other categories of demand.

Final demand, along with intermediate flows of goods and services among industries, determines total output at the commodity and industry level of detail. Industry output, in turn, is the key determinant of employment requirements. Projections of demand are, therefore, a key element in the system since variations in the structure of the demand for goods and services, combined with changes in the means of producing these goods and services, results in changing patterns of employment demand in future time periods.

To project final demand, the same kinds of judgments and assumptions are made as those that enter into the macroeconomic model. For example, demand for residential construction at the total level depends heavily on demographic and income forecasts. Breaking total residential construction down into the components of single-family, multifamily, and mobile homes depends on the same determining variables. Judgments are also made with regard to the effect of technological developments-such as computers and robots-on the mix of investment goods as well as on purchases by other components of final demand.

The initial projections of the various categories of final demand generated by the macroeconomic model provide a starting point for the analysts, who review all aspects of demand to ensure that the models remain balanced and con-

sistent throughout the development of a new set of projections. Although the four basic types of final demand, personal consumption expenditures, foreign trade, investment, and government spending, are subject to different procedures, they have, for the most part, two basic steps in common. First, the detail available from the macroeconomic model is further disaggregated. For example, the 18 personal spending categories are expanded to approximately 80 more detailed product categories. The sum[2] (or sums) of the more finely detailed estimates is then compared with the controls from the macroeconomic model and one or both is adjusted. There is considerable flexibility in terms of how to reconcile the competing estimates and the actual procedure used varies. Second, for each of the detailed categories of final demand, a projected distribution by commodity (bridge table) is estimated and used to allocate spending to commodities.[3] Final demand is always expressed on a product, or commodity, basis. The translation from commodity demand to industry output takes place at a later stage of the projections. The basic procedure can be summarized in the following relationship:

$$e = Gc$$

where

e = vector of final demand by commodity sector

c = vector of final demand by product type

G = bridge table in which each column contains the allocation of a product type to commodities in percent terms.

The projected bridge tables (G) reflect such factors as expected changes in technology, consumer tastes or buying patterns and the industrial composition of exports. They allow the analyst to provide for shifts in the commodity makeup of a given demand category. The operative principle in this procedure is to begin with the most detailed demand estimates possible. Generally, more detailed demand categories are composed of a smaller number of commodities making the resultant bridge coefficients more stable. Having the data at this level of detail also allows more precise adjustment for changes in technology, tastes and other structural factors. The bridge table also serves a second function in converting goods expenditures from purchasers to producers value. This entails separating the producer or plant value of the commodity from the distribution and transportation activities (margins) needed to deliver it to the final consumer. Thus, the value of each category of final expenditure is ultimately allocated to one or more commodities and, where appropriate, to the trade and transportation sectors.

The demand bridge table provides the crucial link between the functional view of the economy embedded in the macroeconomic model and the sectoral view needed to develop industrial and occupational employment projections. However, before the analyst can make use of the detailed bridge tables, the expenditure data from the macroeconomic model must be disaggregated to match the product detail of the bridge tables. This is done differently for each of the major demand categories. In addition, the specific procedures used may vary from one projection study to the next as research leads to improved data and models.

Input-output

Estimating the intermediate flows of goods and services in the economy required to produce the GDP is the next stage of the BLS projections process. By definition, GDP reflects only sales to final purchasers. Intermediate material inputs, such as the steel incorporated into automobiles, are not explicitly reflected in the GDP estimates. Therefore, to derive an estimate at the industry level of the employment and capital necessary to produce a given level of GDP, it is first necessary to translate that GDP to a total output concept. An input-output model provides just such a translation and, at the same time, allows BLS analysts to explicitly take into account other expected phenomena, such as technological changes, shortages or surpluses, or any other factors which affect the production process.

The BLS input-output model consists of two basic matrices for each year, a “use” and a “make” table (expressed in coefficient form). The “use” table, the principal one, shows the purchase of commodities by each industry as inputs into its production process. In coefficient form each column of this table shows the pattern of commodity inputs per dollar of industry output. Projecting this table must take into account the changes in the input pattern or the way in which goods or services are produced by each industry. In general, two types of changes in these input patterns are made in developing a future input-output table: (a) those made to the inputs of a specific industry (as, for example, the changes in inputs in the publishing industry); and, (b) those made to the inputs of a specific commodity in all or most industries (as for example increased use of business services across a wide spectrum of industries). The “make” table shows the commodity output of each industry. It allocates commodity output to the industry to which it is primary and to all other

[2] The U.S. National Income Accounts have recently adopted a chain-weighted Fisher index to calculate real aggregates. In this system the details do not necessarily add to their higher level aggregates creating special problems for balancing the detailed demand submodels with the macroeconomic controls. The principal of forcing consistency, however, is the same.

[3] In some cases, such as exports of goods and services, no further disaggregation of the macroeconomic controls is done and the projection procedure consists of only the second step.

industries where the commodity is produced as a secondary product. In coefficient terms this table shows the industrial distribution of production for each commodity. Unlike the "use" table the "make' table is generally held constant or changed very little over the projection period.

Once projected values of the "use" and "make" relationships are available the projection of commodity demand developed in preceding steps is converted into a projection of domestic industry output using the following relationship:

$$g = D(I - BD)^{-1}e$$

where,

g = vector of domestic industry output by sector

B = "use" table in coefficient form

D = "make" table in coefficient form

I = identity matrix

e = vector of final demand by commodity sector

This particular formulation assumes that industries produce their primary and secondary products using the same technology, the industry technology assumption. This means that the technology of industries as expressed in the "use" table is independent of the commodity distribution of their output.

Industry employment

Industry employment is projected in both numbers of jobs and hours for both wage and salary workers and the self-employed. Projections are developed according to the following procedure implemented for each industry.

The demand for wage and salary hours is projected using an estimated equation derived from the first order conditions of a constant elasticity of substitution production function modified to include a time variable. This equation relates an industry's labor demand to its output, its wage rate relative to its output price, and a time trend. Annual average weekly wage and salary hours per job are then estimated as a function of time and the unemployment rate. The projection of average hours is then used to convert the projection of wage and salary hours into jobs.

The number of self-employed and unpaid family workers (SEUFW) is derived by first extrapolating the logit of the ratio of the group to the total for each industry as a function of time and the unemployment rate. The extrapolated ratio is then used to derive the level of self-employed and unpaid family workers from the number of wage and salary jobs by first calculating the total number of jobs and then subtracting the number of wage and salary jobs from the total. The hours for self-employed and unpaid family workers are then calculated by applying their estimated annual average weekly hours to their levels. Finally, total hours for each industry is derived by summing wage and salary and self-employed and unpaid family worker hours.

The results produced by these procedures together with industry output provide a measure of labor productivity. Implied rates of change in productivity are examined closely for consistency with historical trends. At the same time attempts are made to identify industries which may be expected to deviate from past behavior because of changes in technology, demand, or other factors. Where appropriate, changes to the initial employment estimates are made either by modifying the employment demand relationships themselves or by modifying results from earlier steps of the projections process.

Occupational employment

The technique used to develop the occupational employment projections is based on an industry-occupation matrix showing the distribution of employment for over 250 industries and 500 detailed occupations. Occupational staffing patterns for the industries are based on data collected by State employment security agencies and analyzed by BLS. In coefficient terms this table represents industry staffing patterns where each column represents the occupational distribution of employment in a specific industry. The change in occupational requirements is seen as being jointly determined by shifts in these coefficients and by the structure of industrial employment developed in the preceding step.

Because staffing patterns of industries may change over time, the projection method must account for such shifts. This is done in a series of steps. First, historical data are reviewed to identify trends. Factors underlying these trends are then identified through analytical studies of specific industries and occupations, technological change, and a wide variety of other economic data. Finally, judgments are made as to how the pattern will change in the future. Factors underlying this change are numerous, including technological developments affecting production and products, innovations in the ways business is conducted, modifications of organizational patterns, responses to government policies, and decisions to add new products and services or stop offering old ones.

Some expected trends may not be evident in the historical data. For example, an analysis of the past would not point toward the future impact of robots on staffing because this technology has not been used much in most industries. However, robots are expected to have a significant impact on some occupations, especially in the automobile and similar assembly industries. Information of this nature is identi-

fied in studies conducted by the BLS Office of Productivity and Technology as well as other research-oriented organizations.

The change projected for a specific occupation may be small, moderate, or significant; the precise percentage reflects the judgment of the staff members based on the analyses described above that relate to that occupation. In general, changes in coefficients averaging about 10 percent are considered to be small; changes of 20 percent are moderate; and changes of 30 percent or more are considered to be significant. Documentation released with the projections provides detail on the assumptions developed for each of the occupations for which changes to the base-year coefficients are made.

Once projected staffing patterns are available they are used to allocate each industry's projected employment to detailed occupations. These estimates can then be summed across industries to yield total employment for each detailed occupation as follows:

$$o = Sl$$

where,

o = vector of wage and salary employment by occupation

l = vector of wage and salary employment by industry

S = staffing pattern matrix in which each column contains the allocation of industry employment to occupations in percent terms.

The estimates described above relate only to wage and salary employees. Other classes of workers, primarily the self-employed, are analyzed separately. They are then combined with wage and salary workers to produce a forecast of total occupational demand for the United States.

Final review

An important element of the projection system is its comprehensive structure. To ensure the internal consistency of this large structure, the BLS projection procedure encompasses detailed review and analysis of the results at each stage for reasonableness and for consistency with the results from other stages. For example, the close relationship between changes in staffing patterns in the occupational model to changes in technology is also an important factor in determining industry labor productivity. Specialists in many different areas from inside and outside the projection group review all of the relevant results from their particular perspective. In short, the final results reflect innumerable interactions among staff members who focus on particular sectors in the model. Through this review, the projection process at BLS converges to an internally consistent set of employment projections across a substantial number of industries and occupations. Although changes introduced at this stage are somewhat difficult to quantify in terms of their influence on the final result and may be quite subjective, they are, nonetheless a very important component of the overall projection effort.

Assumptions

BLS makes many underlying assumptions to carry out the projection process. The projections themselves should be considered as likely outcomes in light of the assumptions. First, assumptions are made concerning general economic or social conditions. Recent projections, for instance, have included the following assumptions:

- Work patterns will not change significantly over the projection period; for example, the average workweek will not change markedly;
- broad social and educational trends will continue;
- there will be no major war;
- there will not be a significant change in the size of the Armed Forces; and
- fluctuations in economic activity due to the business cycle will continue to occur.

The assumptions that fall into this first major category have both an overall and a particular effect. For example, the assumption that social trends will continue implies that our society will continue to provide for the education of the young in a way which is broadly similar to current practices. This would be considered the overall effect. The particular effect of this assumption would be to influence the projected level of local government expenditures for education and, consequently, the demand for teachers.

Second, BLS analysts try to identify factors which in the past have exerted a strong influence on the structure of employment. Once such factors have been identified, a judgment is made as to whether those factors will continue to have a similar influence in the future. Conversely, analysts try to identify new or emerging forces which may prove important in future years. Every attempt is made to document these types of assumptions and to indicate how they might influence future employment growth.

During the 1970s and early 1980s, for example, employment of cashiers in retail stores grew at the expense of other sales occupations as these stores centralized their cashier

services. This factor, in the judgment of BLS economists, will no longer cause changes in the types of workers retail stores hire because the shift to centralized cashier operations in the stores has been completed.

Finally, BLS economists set ranges of acceptability for variables normally considered as results of the various projection methods, such as the level and rate of growth of real gross national product (GDP), the unemployment rate, the rate of growth of labor productivity, and other key results of the various stages of the projection process. The purpose is to ensure consistent results rather than to impose absolute levels on the various items involved. With these three classes of assumptions in mind, BLS economists then specify three alternative projection scenarios, a low, moderate, and high level of projected economic activity. By offering three scenarios, BLS allows the user of the projections to select that combination of assumptions which best represents the user's own notions of future economic potential.

Presentation

The projections are first published in the *Monthly Labor Review*, usually in the fall of odd-numbered years, and subsequently appear in BLS bulletins and the *Occupational Outlook Quarterly*, which also prints articles on such topics as new and emerging occupations and changing job market conditions for existing occupations.

Two publications containing extensive information on occupational change are released as a part of each biannual projection study; the *Occupational Outlook Handbook* and *Occupational Projections and Training Data*. The *Occupational Outlook Handbook* covers about 250 occupations. Besides outlook data, it includes information on the nature of the work, training requirements, working conditions, and earnings. The *Handbook* is available in the vast majority of career information centers in the country's high schools, colleges, and libraries, where it is used as a primary source of information for people in the process of choosing a career. *Occupational Projections and Training Data* presents detailed statistics on employment, occupational separations, and education and training completions. Most of the data presented are for the occupations included in the *Handbook* and supplement that resource. In addition, bulletins and reports dealing with topics of special interest are typically developed as a part of each projection study.

Accuracy

The projection process at the Bureau of Labor Statistics does not end with the development and publication of a set of projections. Once the target year is reached, BLS evaluates the projections to determine what changes in assumptions or models would have made them more accurate. Knowing the sources of errors helps improve the projection process. It also highlights for users the imprecise nature of making statements about future economic conditions, industrial activity, or employment growth and provides some empirical basis for attaching subjective probabilities to the results of current projection studies.

Projections Data Base

The BLS approach to employment projections requires a large amount of specialized data, much of which is assembled especially for this purpose. On the other hand, all of the data used originates in existing general purpose statistical surveys and programs. The job of BLS in this case is to adapt these sources to the particular needs of the forecasting system and, most importantly, to meld them into a coherent overall picture of the industrial and occupational structure of the economy

The data requirements of the system fall into four broad areas¾population and labor force, GDP by detailed product, interindustry data, and industrial and occupational employment. Data on the size and work status of the population defined by age, sex, race and ethnicity is available through the decennial population census and the monthly Current Population Survey (CPS). Only minor adjustments are required to provide the demographic data base which supports the labor force projections. These sources, particularly the CPS which is a monthly survey of households, are also extremely important in assembling other types of data as discussed below.

Final demand by detailed product is mostly extracted from the U.S. National Income and Product Accounts. Because the accounts are constructed primarily by the commodity flow method they are relatively rich in product detail. The BLS system uses time-series data on somewhat over 200 product groupings derived from this source.

The U.S. input-output accounts are the source of two critical items, the use and make tables which define the structure of production and the bridge tables which allocate the final demand product groups to detailed commodities. Input-output is the area of greatest difficulty in data development. The U.S., like many other countries, does not produce detailed annual input-output tables, and its benchmark tables (released every 5 years) are not available for years after the survey period. The latest table (currently 1987) is generally updated to a more recent year or years by estimating the row and column sums and then applying a modified a balancing procedure commonly referred to as RAS[4] to

adjust the base matrix to the new sums. While this is not an ideal procedure it does provide a more up-to-date starting point for the projections and can yield information about trends in the technical coefficients which is useful for projecting them into the future. The bridge tables are an integral part of the input-output accounts and share the same problem of lack of timely data. The approach to updating them is also similar except that explicit adjustments are used in place of the more mechanical RAS balancing technique. In addition to updating the input-output and bridge tables, numerous adjustments are made to provide consistency with the industrial and occupational employment data described below.

Time-series data on industry and commodity output is maintained for each sector in the BLS system. These, of course, are key variables in the projection system and are also used in updating the benchmark input-output table. The series are based on a wide variety of basic source data such as annual production and sales surveys conducted by the Bureau of the Census and data on tax collections from the Internal Revenue Service. The contribution of BLS is to assemble these myriad sources of data into a set of industry output measures which are consistent both over time and with the benchmark input-output table.

Time series on employment and hours by industry are derived from three BLS sources for different groups of workers: The Current Employment Statistics survey (or establishment survey) for nonagricultural wage and salary employment, production worker employment, and weekly hours; the Current Population Survey, (or household survey), for agricultural employment except agricultural services, self-employed and unpaid family worker jobs and hours, and private household workers; and unemployment insurance data for employment in agricultural services.

Data needed to develop the occupational staffing pattern matrix are derived from several sources. Information on the occupational distribution of wage and salary workers by industry (staffing patterns) is derived from the Occupational Employment Statistics (OES) survey conducted by State employment security agencies under a BLS-State cooperative program for all but a few industries. The OES survey is conducted on a 3-year cycle, with roughly a third of the economy covered each year. About 775 detailed occupations in more than 350 industries are surveyed, nearly all at the 3-digit Standard Industrial Classification (SIC) level. In developing the base-year matrix, occupations having fewer than 5,000 workers are generally aggregated into similar larger occupations or appropriate residuals. Also, most industries employing fewer than 50,000 workers are aggregated into residuals within the same 2-digit SIC, if their staffing patterns are comparable to the residual.

In some industries adjustments are made to OES survey staffing patterns because some occupations are not listed separately in the survey questionnaire, but are included in a residual category. To develop economy-wide employment estimates for these occupations it is necessary to disaggregate data from OES survey residuals. Data from the decennial census are used for these adjustments.

Adjustments also have to be made to staffing patterns derived from sources other than the OES survey. For example, the occupational classifications used to classify Federal Government workers are more detailed than those used in the matrix. Similarly, estimates of occupational employment for self-employed workers, unpaid family workers, and for workers in the private household industry and agriculture, except agricultural services, are derived from the CPS and must be adjusted to make them comparable to the occupational classification used in the matrix.

Once these data have been assembled, they are arrayed in a matrix that shows occupational employment distributed in percentages by industry. Because these percentages are derived from surveys conducted in different years, they are applied to total industry employment estimates for the base year in order to develop occupational employment estimates.

Maintaining and improving this data base is a prime concern to BLS. When the projection effort at BLS first got underway very little of this information was readily available and a considerable effort was needed to define and assemble the basic data on which the projections are based. BLS continues to devote significant resources to this task since improvement in methods and techniques invariably involves developing new or refined data series.

[4] Ronald E. Miller and Peter D. Blair, *Input-Output Analysis: Foundations and Extensions* (Prentice-Hall, Inc., Englewood Cliffs, NJ, 1985), 276-294.

Technical References

(Note: Projections are updated every other year and normally appear in the November issue of the *Monthly Labor Review* in odd-numbered years. New BLS bulletins related to the projections are released shortly thereafter.)

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