Understanding industry staffing patterns: the Occupational Employment Statistics survey and the National Employment Matrix

Dixie Sommers, Assistant Commissioner, U.S. Bureau of Labor Statistics

Abstract

The U.S. Employment Projections methods culminate in the application of the National Employment Matrix to translate industry employment projections to occupational projections. The Matrix depicts industry staffing patterns – distribution of each industry's employment by occupation -- and facilitates projecting change in these patterns to the target year.

The Matrix, in turn, is derived primarily from the Occupational Employment Statistics (OES) survey, a large employer survey yielding employment by occupation and wages for over 800 occupations, and distribution of employment by occupation for about 350 industries. OES survey data were introduced in the U.S. projections work in the late 1970's, replacing data from the decennial Census of Population.

The OES survey has the advantage of being statistically robust, with a large sample and relatively small sampling errors on national data, and providing a great amount of occupation and industry detail. For use in sub-national projections, OES provides geographic detail that permits generation of projections using state and area industry staffing patterns. For industries and classes of workers not covered by the OES survey, primarily agriculture industries and self-employed workers, we use household survey data.

To project industry staffing patterns, BLS economists examine past changes in staffing patterns and analyze information on technology, business practices, and other factors that affect the occupational mix of each industry. Based on this analysis, they adjust the staffing pattern to reflect their judgment of likely changes over the projection period. For the 2008-2018 projections, using projected staffing patterns rather than keeping staffing patterns unchanged resulted in employment change equivalent to nearly 30 percent of the projected change in total employment.

Introduction

Preparing employment projections is a complex process, involving a wide variety of data, procedures, and analyses. This paper provides a brief overview of the process used in the Employment Projections program in the U.S. Bureau of Labor Statistics (BLS), and explores in more detail the development of base-year and projected-year industry staffing patterns, that is, the distribution of employment in each industry by occupation.[1] These staffing patterns constitute the National Employment Matrix, a critical tool both for developing projections and for understanding the occupational structure of industries and the distribution of jobs in specific occupations.

In addition to describing the data and procedures, the paper discusses the impact of projecting staffing patterns on the final occupational projections, comparing the actual results with what would have been achieved by using static staffing patterns.

BLS Employment Projections Process Overview

Approach. Since the 1960's, BLS has produced long-term projections. Currently we produce 10-year projections every other year, with the most recent available projections for the 2008 -2018 period. Projections for 2010-2020 will be released in early 2012. BLS produces projections for the Nation as a whole, while the State workforce agencies produce similar projections for each State and for sub-State areas.

The BLS projections are built on the assumption of a full employment economy in the projection year, currently 2018. Thus, the projections assume a general labor market equilibrium, with no overall labor shortage or surplus. This approach requires that we set target or assumed values for certain variables, particularly the unemployment rate, that depict a full-employment scenario. Other target values and assumptions are set for variables such as energy prices, interest rates, and so forth. [2]

---

[1] A detailed description of BLS projections methods is available at
http://www.bls.gov/emp/ep_tech_documentation.htm

[2] Values for target and assumed variables for the 2008-2018 projections are published in Ian D. Wyatt and Kathryn J. Byun, "The U.S. economy to 2018: from recession to recovery," *Monthly Labor Review*, November 2009.

The BLS employment projections depict counts of jobs, not counts of persons, so direct comparison with the labor force projection is problematic. Also, the total employment level in the projections is conceptually different from the other total employment measures published by BLS.[3]

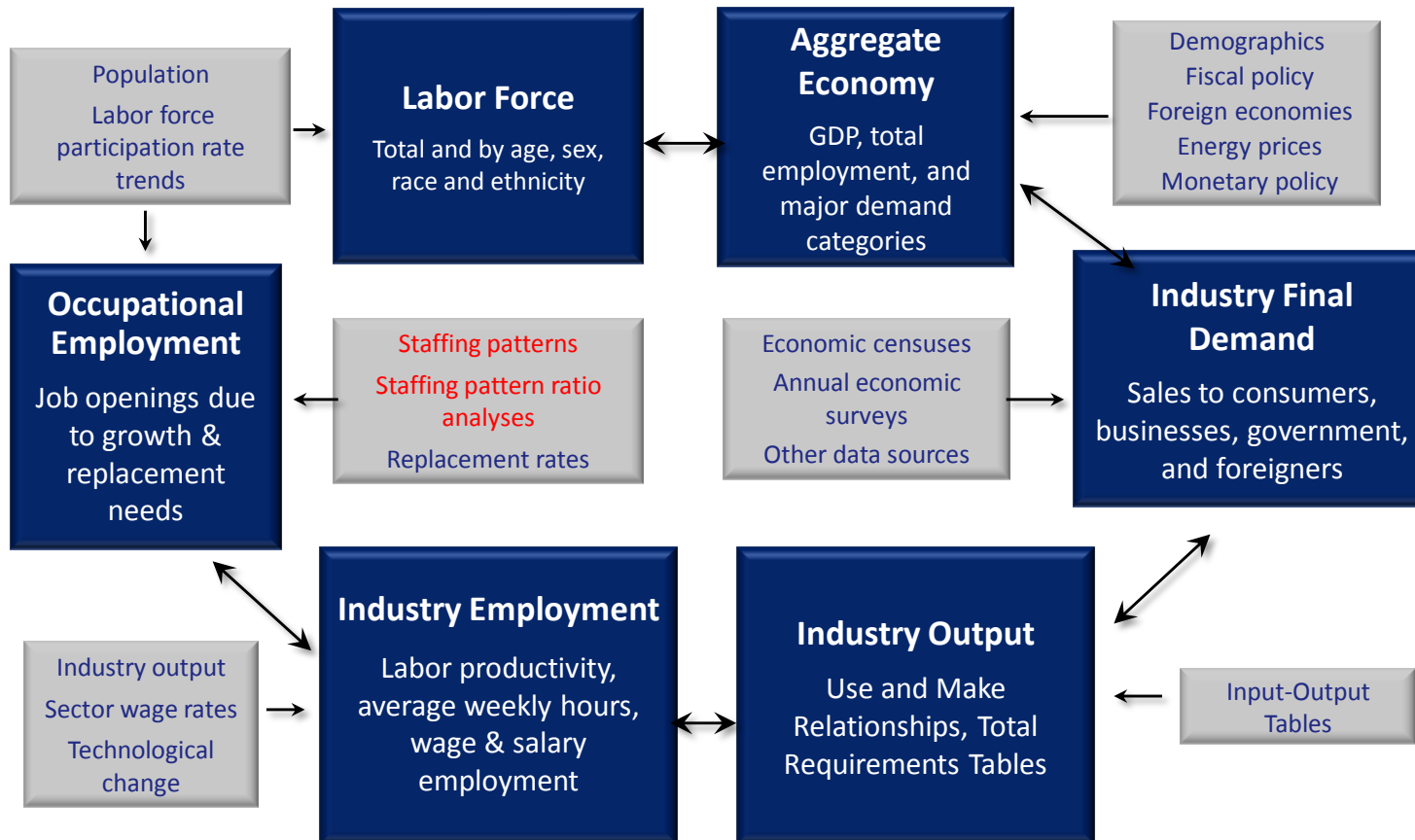*What we project.* Each projections round produces results for four major components:

1. Labor force size and composition, setting an overall labor supply constraint on economic growth,
2. Aggregate economy, including projections of Gross Domestic Product and its components,
3. Industry output and employment, and
4. Occupational demand, including employment and job openings from replacement needs.

Process overview. The BLS projections of industry and occupational employment are developed in a series of six interrelated steps, each of which is based on a different procedure or model and related assumptions: labor force, aggregate economy, final demand (GDP) by consuming sector and product, industry output, industry employment, and employment and openings by occupation. The process is generally depicted in Figure 1.

The focus of this paper is on the Occupational Employment component, where the National Employment Matrix staffing patterns and staffing pattern ratio analysis are used.

---

[3] The Matrix shows total employment as a count of jobs, not a count of individual workers. This concept is different from that used by another measure familiar to many readers, the Current Population Survey's total employment as a count of the number of workers. The Matrix's total employment concept is also different from the BLS Current Employment Statistics total employment measure. Although the CES measure is also a count of jobs, it covers nonfarm payroll jobs, whereas the Matrix includes all jobs.

Figure 1. Employment projections process

Population Labor force participation rate trends	**Labor Force** Total and by age, sex, race and ethnicity	**Aggregate Economy** GDP, total employment, and major demand categories	**Demographics** Fiscal policy Foreign economies Energy prices Monetary policy
Occupational Employment Job openings due to growth & replacement needs	**Staffing patterns** **Staffing pattern ratio analyses** Replacement rates	**Economic censuses** Annual economic surveys Other data sources	**Industry Final Demand** Sales to consumers, businesses, government, and foreigners
Industry output Sector wage rates Technological change	**Industry Employment** Labor productivity, average weekly hours, wage & salary employment	**Industry Output** Use and Make Relationships, Total Requirements Tables	**Input-Output Tables**

National Employment Matrix

The National Employment Matrix is the fundamental tool in the projection of occupational employment. The Matrix is a set of tables, one for each industry, showing the occupational distribution of employment in the industry for the base year (2008) and the projected year (2018). The Matrix for 2008-2018 includes 293 industries, generally at the 4-digit level of the North American Industry Classification System (NAICS), and 750 occupations, generally at the most detailed level of the Standard Occupational Classification (SOC). Data are presented for total, all occupations, and for each industry by occupation cell, as both employment levels and percent distributions or "ratios." Once developed, the matrix can be inverted to depict the industry distribution of each occupation, a very useful tool for understanding occupations and for career exploration and job search.

Occupational Employment Statistics. To create the Matrix, data on employment by industry by occupation are needed. The primary source used in the National Employment Matrix is the BLS Occupational Employment Statistics (OES) survey. The OES survey produces employment and wage estimates for over 800 detailed SOC occupations, and covers wage and salary employment in all industries except for most of agriculture, forestry, hunting and fishing, and private households. OES does not include self-employed or unpaid family workers. OES survey data were introduced in the U.S. projections work in the late 1970's, replacing data from the decennial Census of Population, at that time the only other source of detailed data on employment by industry by occupation.

OES data have several advantages over Census or other household survey data for use in the Matrix. OES is statistically robust, with a large sample of about 1.2 million establishments from a universe of about 9.0 million, and relatively small sampling errors on national data. The survey provides a great amount of occupation and industry detail, and for use in sub-national projections, provides geographic detail that permits generation of projections using state and area industry staffing patterns.

Because the large OES sample is collected over a three-year period, each year's published estimates contain data collected from establishments up to 3 years earlier. Thus, BLS discourages data users from treating the data as annual time series. Comparisons of OES

estimates are best made between years at least 4 years apart. OES has been conducted since the 1970's, with a variety of design changes and introduction of updated industry and occupational classifications as needed. Changes to procedures and classifications must be taken into account in making comparisons.

Current Population Survey. For industries and classes of workers not covered by the OES survey, as identified above, household survey data from the Current Population Survey are used. The CPS sample is too small to yield results by industry, occupation, and class of worker. Thus, the self-employed and unpaid family worker group is treated in the Matrix as an industry vector, broken down by occupation. CPS data on multiple job holding are used to adjust household persons-count data to the Matrix jobs count concept.

2008 Base-Year Matrix. Total base-year employment for an occupation is the sum of employment across all industries and class-of-worker categories. Occupational employment within each industry, divided by total wage and salary employment in each industry, yields the occupational distribution ratios used to project occupational employment. These ratios, referred to as staffing patterns, show occupational utilization by industry.

2018 Projected-Year Matrix. Projected-year matrix uses projected-year industry employment, resulting from the industry projections components of the process, and projected-year staffing patterns.

Projected-year staffing patterns are created through a process called ratio analysis, described below. Once this process is completed, the projected-year employment for each industry is multiplied by the projected-year occupational ratio to yield projected-year occupational employment. The same computation is made for the self-employed and unpaid family workers portion of the Matrix. Total projected-year occupational employment is the sum of the projected employment in each industry as well as self-employed and unpaid family workers.

Conducting Ratio Analysis

Historical data indicate that the occupational distribution within industries shifts over time as the utilization of some occupations changes relative to other occupations in the same industries.

For example, as businesses outsource certain functions, they will utilize fewer accountants, human resource workers, or building cleaners, depending on the function outsourced.

To derive projected-year staffing patterns, BLS economists use a "ratio analysis" process, putting the base-year staffing patterns under iterative qualitative and quantitative analyses. They examine historical staffing pattern data, generally from the OES, and conduct research on trends and conditions that may affect occupational utilization within given industries during the projection decade. Such causes include shifts in technology, business practices, the mix of goods and services produced, the size of business establishments, and onshore and offshore outsourcing. Their analyses incorporate judgments about new trends that may influence occupational utilization, such as the use of the Internet and electronic commerce.

Once these causes are identified, analysts recommend "change factors" that indicate the proportional change in an occupation's share of industry employment over the 10-year projection period. These change factors are multiplied by the 2008 occupational staffing ratios to derive projected staffing patterns. An occupation's projected share of an industry may increase (change factor greater than 1.0), decrease (less than 1.0), or remain the same (equals 1.0). Some factors apply to only one industry, while others may apply to many or all industries in which the occupation is found. For industries with the highest share of an occupation's employment, analysts provide brief descriptions of the reasons for their recommended change; these reasons are published along with the projections data.

Changes in occupational utilization, the proportion of an industry's employment which an occupation comprises, are classified using one of eight descriptors (Table 1).

Table 1. Change factor descriptors and related ranges			
Descriptor	**Change factor range (percent)**	**Descriptor**	**Change factor range**
Small increase	1.05 to 1.15	Small decrease	0.85 to 0.95
Moderate increase	1.15 to 1.275	Moderate decrease	0.725 to 0.85
Large increase	1.275 to 1.425	Large decrease	0.575 to 0.725
Very large increase	More than 1.425	Very large decrease	Less than 0.575

Impact of Ratio Analysis

The ratio analysis process has a significant impact on the final occupational projections. To depict this impact, we can compare the final projections with projections that would have been created without ratio analysis, that is, projections that use the base-year staffing patterns and the projected-year industry employment. In this calculation, the only source of change in occupational employment is change in industry employment.

For the 2008-2018 projections, ratio analysis resulted in shifting employment from one occupation to another equivalent to nearly 30 percent of the projected change in total employment, and 2.69 percent of the total 2018 projected employment.

The impact of ratio analysis varies considerably across major occupation groups (Table 2). For example, about 4.8 percent of the projected 2018 jobs in Business and financial operations occupations were shifted into the occupation group because of ratio analysis. The net 383,000 jobs shifted into this group accounted for a large share of the projected growth of 1,210,000 over the decade. On the other end of the scale, ratio analysis shifted a net 3.7 percent of 2018 jobs in Management occupations to other occupation groups, reducing the projected change for this group by about 346,000 jobs. In the middle of the pack, there was little net impact on the Sales and related and Construction and extraction occupation groups.

Limitations of Ratio Analysis

As with any projection method, ratio analysis has a number of limitations. The first is the difficulty of reviewing the large volume of data, as the National Employment Matrix as a large number of industry by occupation cells. The sheer volume of data to be researched and reviewed can overwhelm our time and staff resources. To manage this, we review cells where industries account for 1 percent of occupational employment and at least 1,000 employment. For the cells that are in scope, analysts tend to concentrate on the occupations and industries that are covered in detail our career information products.

The OES data are very useful in the ratio analysis process, identifying statistically significant changes in staffing patterns over time. These changes do not necessarily mean an analyst can assume a continuation of the pattern, however. For example, rapidly increasing

ratios for logging equipment operators in the logging industry are not likely to continue as the technology matures and productivity gains slow.

Useful as they are, the OES data are not really time series for reasons noted earlier. Thus, we do not make comparisons from one year to the next, but only between points further apart in time. Also, because of changes in occupational classification and survey methods, there are relatively few data points available for comparison, i.e., from 2002 to 2010. Sometimes, what appear to be statistically significant changes in staffing patterns are attributable to other factors, such as changes in the occupational classification system, forms, data collection methods, etc., rather than to actual ratio changes. It can be difficult for projections analysts to always recognize when this is the case.

Finally, the scaling process impact magnitude of changes by magnifying or shrinking the analyst's initial recommendations. Also, the scaling process may have more effect on cells that analysts are not reviewing, and may generate anomalies.

Table 2. Employment Impact of Ratio Analysis on the 2008-18 Projections Cycle
All numbers in thousands. Data discrepancies due to rounding.

Occupation group		Ratio analysis impact						2008-2018 projections		
		Jobs moved out	Jobs moved in	Net impact	Percent of 2018 jobs moved out	Percent of 2018 jobs moved in	Net percent impact	2008 Employ-ment	2018 Employ-ment	Projected employ-ment change
Total, All Occupations		-4467.4	4467.4	0.0	-2.69%	2.69%	0.00%	150,931.7	166,205.6	15,273.9
Highlighted Occupations										
30 fastest growing		-33.4	757.2	723.8	-0.40%	9.01%	8.61%	6,076.60	8,406.40	2,329.90
30 most job growth		-579.9	1883.9	1304	-1.11%	3.62%	2.46%	45,513.20	52,838.20	7,325.00
Major Occupation Group										
11-0000	Management	-473.5	127.0	-346.4	-5.05%	1.36%	-3.70%	8,912.4	9,366.6	454.2
13-0000	Business and financial operations	-74	456.8	382.8	-0.92%	5.68%	4.76%	6,834.4	8,044.3	1,209.9
15-0000	Computer and mathematical science	-166	289.5	123.5	-3.84%	6.69%	2.85%	3,540.4	4,326.1	785.7
17-0000	Architecture and engineering	-62.6	99.6	37.1	-2.15%	3.43%	1.28%	2,636.0	2,906.6	270.6
19-0000	Life, physical, and social science	-21.9	84.8	62.9	-1.26%	4.88%	3.62%	1,460.8	1,738.0	277.2
21-0000	Community and social services	-34.8	78.9	44.1	-1.10%	2.49%	1.39%	2,723.7	3,172.1	448.4
23-0000	Legal	-43.3	51.1	7.8	-2.82%	3.33%	0.51%	1,251.0	1,439.4	188.4
25-0000	Education, training, and library	-111.8	313.9	202.1	-1.07%	3.01%	1.94%	9,209.5	10,533.6	1,324.1
27-0000	Arts, design, entertainment, sports, and media	-31.9	104.7	72.7	-1.04%	3.41%	2.37%	2,740.9	3,073.4	332.5
29-0000	Healthcare practitioners and technical	-133.2	297.5	164.2	-1.47%	3.27%	1.81%	7,491.3	9,090.8	1,599.5
31-0000	Healthcare support	-60.6	215.8	155.2	-1.18%	4.21%	3.03%	3,982.4	5,129.5	1,147.1
33-0000	Protective service	-18.6	59.8	41.2	-0.51%	1.63%	1.12%	3,270.0	3,670.1	400.1
35-0000	Food preparation and serving related	-282.3	349.4	67.1	-2.25%	2.78%	0.53%	11,552.1	12,559.6	1,007.5
37-0000	Building and grounds cleaning and maintenance	-291.5	72.1	-219.5	-4.69%	1.16%	-3.53%	5,727.2	6,211.0	483.8
39-0000	Personal care and service	-89.2	191.8	102.6	-1.47%	3.16%	1.69%	5,044.2	6,074.8	1,030.6
41-0000	Sales and related	-283	303.3	20.3	-1.68%	1.80%	0.12%	15,902.7	16,883.1	980.4
43-0000	Office and administrative support	-1329.2	541.5	-787.7	-5.13%	2.09%	-3.04%	24,100.6	25,942.7	1,842.1

45-0000	Farming, fishing, and forestry	-28.9	14.3	-14.6	-2.65%	1.31%	-1.34%	1,035.4	1,026.3	-9.1
47-0000	Construction and extraction	-206.9	200.4	-6.5	-2.36%	2.28%	-0.07%	7,810.3	8,828.8	1,018.5
49-0000	Installation, maintenance, and repair	-71.6	200.2	128.6	-1.14%	3.18%	2.05%	5,798.0	6,238.2	440.2
51-0000	Production	-214.6	252.1	37.5	-2.22%	2.61%	0.39%	10,083.0	9,733.9	-349.1
53-0000	Transportation and material moving	-438.1	162.7	-275.4	-4.29%	1.59%	-2.70%	9,825.5	10,216.6	391.1