Can occupational labor shortages be identified using available data?

Labor market data, combined with background information on a specified occupation, anecdotal evidence, and factors of demand and supply work in combination to assess occupational shortages

Carolyn M. Veneri

The Nation's economy has enjoyed more than 7 years of expansion, during which the national unemployment rate declined from 7.5 percent in 1992 to 4.5 percent in 1998, the lowest level since 1969. The 1998 unemployment rate dipped below 2 percent in some States. As the labor market tightened over this period, shortages in certain occupations were widely reported in the media, led by stories of unmet needs for workers skilled in information technology. Groups such as the Information Technology Association of America and the U. S. Department of Commerce's Office of Technology Policy identified what they considered "substantial evidence that the United States is having trouble keeping up with the demand for new information technology workers."[1] Shortages also were reported for construction laborers and craftworkers. According to the National Center for Construction Education and Research, "Sixty-five percent of the contractors responding to its third annual survey in 1997 reported shortages in one or more crafts."[2] Related stories in papers across the country proclaimed the resurgence of a shortfall of registered nurses, a need for qualified teachers, and even shortages of workers such as roustabouts and nannies.

No specific sources of data exist that provide a measure of occupational shortages. In the absence of any definitive measure, analysts generally rely on labor market data to corroborate anecdotal reports of employers' difficulties in filling jobs. Such data include trends in employment and earnings, as well as the unemployment rate for a particular occupation. This article discusses the meaning of shortages and analyzes the adequacy of available data in identifying, quantifying, and evaluating occupational shortages.

Carolyn M. Veneri is an economist in the Office of Employment Projections, Bureau of Labor Statistics.

Defining a shortage

Shortages occur in a market economy when the demand for workers for a particular occupation is greater than the supply of workers who are qualified, available, and willing to do that job. Jobs remain vacant as employers seek to hire more workers than are willing to work at the prevailing wage or salary.

Despite the simplicity of this concept, the term "labor shortage" is often used to describe a variety of situations, some of which are not generally considered by economists to be actual shortages. When labor is plentiful, employers become accustomed to hiring a particular caliber of candidates with specific training or level of experience. However, when the labor market tightens, the number of job applicants is likely to shrink, and employers may have difficulty finding that same caliber of candidates. The employers may be able to fill positions by offering higher wages; otherwise, they may have to settle for candidates who do not match their notion of "ideal." Under these labor market conditions, the issue becomes one of the *quality* of job candidates, not necessarily *quantity* of people willing and able to do that job. From the employers' perspective, a short-

age of workers exists; from the job market perspective, the existence of a shortage could be questioned because the job was filled by a qualified worker.

Economists who have studied occupational shortages generally hold the view that in an unconstrained market, supply will equal demand at the "true" market price. If demand exceeds supply, salaries will be bid up until the market clears. Thus, in theory, most labor shortages should disappear as employers increase wages to attract more workers. However, different types of shortages resulting from various labor market situations may require very different responses from both employers and workers.

Much of the theory about defining and identifying occupational shortages stems from research that has focused on wage movements and analysis of the engineer-scientist labor market. For example, David M. Blank and George J. Stigler, in their classic 1957 study on the demand for and supply of scientific personnel, found that the term "shortage" often is used in a variety of senses, and presented three definitions or meanings.[3] The first definition acknowledged the concept of a shortage in terms of what is considered socially acceptable—the social demand model. This model assumes there is a shortage of members of a specific profession if the number of available workers is less than the number needed, as established by some social criterion or goal—for example, a certain number of elementary school teachers thought necessary to maintain a particular class size or a certain number of physicians thought necessary to treat a certain number of the population. In the second definition, shortages occur when "the quantity of the labor services in question that is demanded is greater than the quantity supplied at the prevailing wage."[4] And, the third definition, which they concluded was the most natural shortage in an economy with a free labor market, occurs "when the number of workers available (the supply) increases less rapidly than the number demanded at the salaries paid in the recent past."[5] Blank and Stigler used this third definition and a comparison of relative earnings to analyze the labor market data for engineers in the 1930s, 1940s, and 1950s. They concluded that when a shortage occurs, "salaries will rise, and activities which were once performed by … [a particular class of worker] must now be performed by a class of workers who are less well trained and less expensive."[6]

Expanding on this framework, Kenneth Arrow and William Capron presented a model "which explains the dynamics of the market adjustment process," and applied their conclusions to the scientist-engineer shortage of the 1950s.[7] Like Blank and Stigler, they indicated the importance of the behavior of wages, but also focused on the pace of demand. Arrow and Capron introduced the concept of a "dynamic shortage," in which demand continually grows more rapidly than supply.[8] The causes of a dynamic shortage, they explained, are a rapid and persistent rise in demand for a particular occupation, a low elasticity of supply, and a slow market reaction speed. Time lags, or slow "reaction time," result from the time it takes to actually complete a wage adjustment; that is, "the time it takes the firm to recognize the existence of a shortage at the current salary level, the time it takes to decide upon the need for higher salaries and the number of vacancies at such salaries, and…the time it takes employees to recognize the salary alternatives available and to act upon this information…."[9] Slow reaction time also takes into account supply-side lags, specifically, the impeded recognition of opportunities and responses by potential entrants to the field and by training institutions may exaggerate a shortage.

Adding to the work of both Blank and Stigler and Arrow and Capron, a study by Walter Franke and Irvin Sobel in the 1960's shifted focus from wage behavior to the argument that institutional constraints were responsible for the lagging adaptation of wages and supply.[10] They defined a shortage as "a situation existing over an extended period of time in which employers were unable to hire at going wages or salaries sufficient numbers of qualified persons to fill positions for which there were budgeted funds and for which personnel were required to meet existing demands for services."[11] Their indepth analysis of six skilled and technical occupations in the Chicago and St. Louis areas was conceived in 1963. They sought to explain how shortages could coexist with high levels of unemployment and worker displacement.

Among their conclusions, Franke and Sobel found that, "While market pressures tended to push market institutions in directions which led to amelioration of shortages, the response was frequently delayed and sluggish."[12] They also concluded that changes in relative wages played a minor role and therefore should not be used as a "unitary instrument for dealing with a shortage." Instead, they focused on the entire labor market process and evaluated, to the extent possible, factors such as trends in employment and earnings, current demand and supply, and even factors such as hiring practices.

Other studies of occupational labor shortages have built on the theory and definitions put forth by the studies discussed above. For example, Malcolm Cohen, using labor market indicators as a means of determining labor market imbalances, combined available indicators to measure excess demand and test for shortages.[13] Along these same lines, occupational case studies conducted by John W. Trutko and several colleagues combined analysis of existing data sources with secondary sources to assess labor shortages and identify factors that may cause them.[14] These researchers use the same indicators identified by Cohen (and in several instances, his database) to evaluate demand and supply and examine individual sources of disequilibrium.

Most studies of labor shortages acknowledge the existence of different types of shortages which, in turn, elicit different types of responses from both employers and workers. Labor shortages can result from a sudden or persistently rapid increase in demand which outpaces the job market's capacity to

supply workers, as in the case of the "dynamic shortages" analyzed by Arrow and Capron. Often, this type of shortage results from an increase in demand for particular goods or services. Even though wages and the labor supply also may be increasing, a shortage may result because they cannot keep up with demand. However, an increase in demand alone may not necessarily lead to a shortage if the supply of labor is flexible enough to adjust sufficiently.

Shortages resulting from inflexible supply, on the other hand, can occur in occupations for which demand and the level of compensation fail to attract a sufficient number of jobseekers. When years of education and specialized training are required of an occupation, a lag will continue to exist between supply and demand, even if employers increase wages. This is the case with occupations such as physicians and college or university faculty. A decrease in the supply of labor can also create a labor shortage, especially in tight labor markets where employers face keener competition for workers. If wages are higher in other occupations, workers are faced with more choices, making employment in one occupation or for one employer more or less attractive than another. Take, for example, math majors: their background and skills are generally in high demand, and many often can choose between a job as a mathematics teacher or a more lucrative private sector position in a field such as financial services or information technology.

A slow reaction or response time by employers or by workers also will slow market adjustment time. It may take time for employers to recognize the difficulty of finding workers or for workers to realize the opportunities available. Also, response time may be slowed by institutional barriers, such as limited enrollment capacity in training institutions or requirements such as licensing and certification. An example is public school teachers—they must be licensed, which generally requires a bachelor's degree, completion of an approved teacher training program with a prescribed number of subjects and education credits, and supervised practice teaching.

A reluctance on the part of employers to raise wages often causes, or at least contributes to, a shortage. In some cases, the wage or salary level cannot increase because of a fixed compensation structure within an organization. Again, using a shortage of math teachers as an example, many school systems have regulations governing salaries which stipulate that all teachers have the same pay scale, regardless of the subject they teach; some school systems find this an obstacle in the case of math teachers, as they cannot compete with the salaries offered to math majors by employers in private industry.

In some cases, however, a reluctance of employers to raise wages or salaries may also be because the company places a higher priority on avoiding increases in costs. If wages are increased to attract new employees, the employers may then have to increase the wages of workers already on their payrolls to avoid dissension among tenured, more experienced employees.

Besides increasing wages, employers can respond in a number of other ways when faced with the difficulty of filling vacancies, but generally try the least expensive response first. One reaction to a perceived shortage involves an increase in recruiting efforts. This can be accomplished by stepping up advertising campaigns and by expanding the recruiting area, which could involve greater use of employment agencies, rewarding existing employees who bring in new workers, or offering bonuses to new hires for joining the firm. For instance, to cope with an information technology staff crunch, employers offer pay premiums, hiring bonuses, retention incentives, and continually look for innovative ways to recruit new workers by offering benefits such as a relaxed working environment, flexible work hours, child and elder care, and onsite services ranging from fitness centers to car washes.[15]

Employers may handle staffing shortages by increasing the use of overtime, restructuring the workforce, or using workers from one occupation to perform the tasks of another occupation. To illustrate: in response to a shortage of registered nurses in the late 1980s, hospitals asked existing staff to work more overtime and restructured the work to make more use of nursing aides, licensed practical nurses, and other hospital workers.

Employers who have difficulty filling vacancies may also opt to relax or reduce the minimum qualifications for the job or expand worker training, or both (in many cases, the two go hand-in-hand). After relaxing the hiring specifications, employers may find that the work can be completed by conducting additional training to bring less qualified workers up to speed. This may involve providing financial assistance to persons still in school, with the stipulation that workers will stay with the firm for a specified time once the training is completed.

Identifying conditions

No single empirical measure of occupational labor shortages exists, nor does it appear that one can easily be developed. Data available through the Nation's statistical programs, however, can be used to observe some aspects of supply and demand and assess job market conditions. Research indicates that available data on employment, unemployment rates, and wages can be evaluated to assess the existence of or the potential for a shortage.[16]

"Snapshots" of the labor market over time allow an evaluation of changes in demand and supply for a particular occupation. For example, dramatic growth in employment in a particular occupation over time is likely to reflect a significant rise in demand for that type of worker. Likewise, an uncharacteristically low unemployment rate for a specific occupation may imply that the demand for workers exceeds the supply, as could rapidly rising relative wages in a particular occupation.

Assessing supply and demand in a specific occupation also requires analysis of factors such as educational qualifications,

training, and entry requirements. Clearly, job market conditions for occupations which require specific academic training and a license (physicians and registered nurses, for example), must be analyzed differently than for jobs which often are filled by high school students (fast food preparation and service jobs, for example). Data on academic completions collected by the U.S. Department of Education provide information on the supply of graduates by field of study and level of degree for any given year.

Most research studies emphasize the importance of considering multiple measures of labor market conditions, and then tracking the measures over time to determine whether conditions of a shortage exist. Malcolm Cohen, believing that "the determination of labor market imbalances must rely upon indicators," combined several labor market indicators in a labor model developed specifically to test for potential future shortages and surpluses.[17] His study of the feasibility of using labor market indicators to measure or test for shortages addressed the difficulty of directly measuring supply and demand using available statistical data. Much of the difficulty stems from problems of interpreting the data, especially when measures from different data sets lead to different conclusions about job market conditions. Cohen also indicated that difficulties in interpretations may arise because of weaknesses in the data.

Surveys that provide data on employment and wages are subject to sampling errors as well as response errors.[18] Thus, changes in employment from one period to the next must be analyzed with care. Experience has shown that occupational coding errors in surveys can be significant and trends in employment growth in two major surveys that provide such data—the household-based Current Population Survey (CPS) and the establishment-based Occupational Employment Statistics (OES) survey—often differ in the short run. For example, over the 1992–96 period, employment growth of management analysts in the two surveys is vastly different, with the CPS showing growth of 65 percent and the OES, only around 8 percent.

A major drawback in using detailed occupational unemployment rates in analyses of shortages is that the unemployment rate is calculated based on a person's last job, rather than the longest job held or occupation in which he or she trained and is actually looking for work. This means an individual with experience as a computer programmer who is seeking a programming job, but who last worked as a cashier, is classified as an unemployed cashier, not an unemployed programmer.[19]

In a similar manner, data on supply for many occupations are incomplete or unavailable. For example, registered nurses must be graduates of nursing programs and must pass a national licensing examination. Thus, the number of nursing school graduates may be a reliable measure of the *potential supply* of registered nurses. However, the supply of computer professionals cannot be measured in a similar manner because there is no universally accepted way to prepare for a job in the computer field—for jobs such as a system analyst, computer programmer, or computer engineer, to name a few. Data on college graduates indicate that persons with degrees in a variety of majors find employment in computer-related occupations.

Job vacancy data by occupation would be an obvious input to analyses of occupational shortages. But, comprehensive occupational vacancy data do not exist. Although trade associations sometimes sponsor surveys of job vacancies, national data are not currently collected by any government agency. The Bureau of Labor Statistics has conducted pilot studies on occupational job vacancies[20] and is reinstituting a Job Openings and Labor Turnover Survey that will provide a broad measure of job vacancies, but not by occupation. It is important to keep in mind that just because employers have vacancies do not mean a shortage exists in that occupation. Trends in vacancy data would need to be evaluated along with other labor market indicators in order to understand the labor market for a particular occupation.

What the data show

Despite all of the caveats, if shortages in an occupation were to develop during the Nation's 1991–98 expansionary period, the occupation's employment growth would be strong; the occupation's wages would increase relative to other occupations, indicating the market response by employers to attract more workers; and the unemployment rate for that occupation would be expected to decline or remain relatively low. For this analysis, occupations were evaluated to determine whether, for the 1992–97 period (for which data were available when the analysis was conducted), the occupation's employment growth rate was at least 50 percent faster than average employment growth, the wage increase was at least 30 percent faster than average, and the occupation's unemployment rate was at least 30 percent below average (in each case, "average" was defined by the total for all workers). This somewhat arbitrary set of criteria was established to eliminate any occupation that could be considered a "borderline" case in terms of what the data might show if less stringent criteria were used.[21]

Only 68 occupations were included in the analysis because of a desire to maintain comparability between data from the OES-based National Industry-Occupation Employment Matrix and the CPS.[22] All data analyzed were derived from the CPS. Wage and salary employment, rather than total employment, were used to examine employment trends because data on median weekly earnings of full-time wage and salary workers was used as the measure for wage rates. The occupational unemployment rates are also for wage and salary workers. Note that unemployment rates for detailed occupations are calculated by the Bureau of Labor Statistics, but are not published because the sample sizes in many cases are not sufficiently large to provide statistically reliable estimates. For similar reasons, median weekly earnings data are not published for occupations with fewer than 50,000 employees.[23]

Despite the favorable conditions of the 1992–97 labor market, only 7 of the 68 occupations met the three conditions discussed above: management analysts; special education teachers; dental hygienists; marketing, advertising and public relations managers; airplane pilots and navigators; purchasing agents and buyers; and mechanical engineers. (See table 1.)

In the case of special education teachers, reports of shortages are supported by data in table 1. According to information published by the Bureau of Labor Statistics in its 1998–99 edition of the *Occupational Outlook Handbook*, over the 1996–2006 period, "[s]pecial education teachers have excellent job prospects, as many school districts report shortages of qualified teachers." In a 1993 case study of special education teachers conducted for the U.S. Department of Labor's Employment and Training Administration, John W. Trutko and colleagues found a national shortage of special education teachers that was characterized as severe and persistent.[24] From 1992 to 1997, employment of special education teachers increased 43.8 percent, more than four times faster than the average for all occupations. Median weekly earnings in this occupation increased 24 percent over the period, compared with 13 percent for all occupations, and the average 1.6 percent unemployment rate was much lower than the national rate of 5.1 percent for all wage and salary workers.

There is little or no evidence available that supports a tight labor market for the other six occupations. No anecdotal reports could be found. It appears questionable that these data alone can be used as an indicator that any shortages exist.

Do the data corroborate other anecdotal reports of occupational shortages? As mentioned earlier, reports abound of the need for information technology workers. Highly qualified personnel are reported to enjoy rising starting salaries, multiple job offers, creative recruiting efforts, and an overall hiring climate that have been equated with a professional sports "free-agent" market. Unemployment rates for computer systems analysts and scientists and computer programmers have been consistently lower than the national rates over the 1992–97 period. Yet, the labor market conditions for this period indicate that neither the occupational group consisting of computer systems analysts, engineers, and scientists nor the computer programmer occupation has exhibited both higher than average employment growth and higher than average growth in wages. (See table 2.)

The earnings potential of information technology workers has been widely reported. Salary increases for these occupations are reported to be larger in the past year than in previous years. Historically, workers in the computer field earned higher salaries than workers in other fields; indeed data from the CPS show that median weekly earnings for computer systems analysts and scientists and computer programmers to be consistently higher than the average for all workers. However, the same is true for virtually all professional specialty occupations. Furthermore, annual increases in weekly earnings for computer occupations have been comparable to wage increases for all professional specialty occupations. In relative terms, over the 1992–97 period, the average of the annual change in median weekly earnings for computer engineers, scientists, and systems analysts was close to the average for all occupations. The same is not true for computer programmers: over the

Table 1. Occupations with above-average employment growth, above-average increase in earnings, and below-average unemployment for the 1992–97 period

[Numbers in thousands]

Occupation	Employment data from the Current Population Survey (CPS)[1]							National Industry-Occupation Employment Matrix Time Series[2]	CPS[1]	
									Median weekly earnings (current dollars)	Unemployment rate
	1992	1993	1994	1995	1996	1997	Percent change, 1992–97	Percent change, 1992–96	Percent change, 1992–97	Average, 1995–97
Total, all occupation	108,182	109,656	112,232	114,262	116,040	118,874	9.9	9.8	13.0	5.1
Management analysts	132	141	176	205	218	242	83.3	7.8	17.9	1.8
Teachers, special education	267	284	308	310	340	384	43.8	13.9	24.2	1.6
Dental hygienists	73	76	95	94	94	105	43.8	23.2	19.6	1.1
Managers, marketing, advertising, and public relations	505	482	554	654	644	702	39.0	9.5	19.8	2.3
Airplane pilots and navigators	93	97	103	113	113	117	25.8	30.7	21.9	1.1
Purchasing agents and buyers, n.e.c.	218	256	225	256	247	266	22.0	1.9	17.7	2.5
Mechanical engineers	299	291	334	324	346	347	16.1	.8	18.3	1.6

[1] The Current Population Survey (CPS) is a nationwide household survey, conducted each month by the Bureau of the Census for the Bureau of Labor Statistics.

[2] The National Industry-Occupation Employment Matrix Time Series is based on data from the Occupational Employment Statistics (OES) survey, a periodic mail survey of nonfarm establishments that collects occupational employment data on workers by industry.

NOTE: Data are for all wage and salary workers; earnings data are for full-time wage and salary workers only.

Table 2. Employment, wage rates, and unemployment rates for selected occupations for which anecdotal evidence suggests a shortage, 1992–97

[Numbers in thousands]

Occupation	Employment data from the Current Population Survey (CPS)[1]							National Industry-Occupation Employment Matrix Time Series[2]	CPS[1]	
									Median weekly earnings (current dollars)	Unemployment rate
	1992	1993	1994	1995	1996	1997	Percent change, 1992–97	Percent change, 1992–96	Percent change, 1992–97	Average, 1995–97
Total, all occupations	108,182	109,656	112,232	114,262	116,040	118,874	9.9	9.8	13.0	5.1
Computer systems analysts and scientists	663	726	867	882	1,033	1,175	77.2	38.2	13.3	1.4
Computer programmers	537	565	523	533	541	609	13.4	2.2	22.6	1.7
Registered nurses	1,785	1,844	1,936	1,961	1,971	2,043	14.5	7.8	7.3	1.5
Carpenters	844	867	902	928	908	1,015	20.3	15.3	13.4	10.9
Electricians	605	610	607	670	702	722	19.3	11.8	13.5	5.0
Plumbers, pipefitters, and steamfitters	368	366	435	434	484	476	29.3	9.5	17.8	7.3

[1] The Current Population Survey (CPS) is a nationwide household survey, conducted each month by the Bureau of the Census for the Bureau of Labor Statistics.
[2] The National Industry-Occupation Employment Matrix Time Series is based on data from the Occupational Employment Statistics (OES) survey, a periodic mail survey of nonfarm establishments that collects occupational employment data on workers by industry.
Note: Data are for all wage and salary workers; earnings data are for full-time wage and salary workers only.

same period, the average of the annual change was higher than the average for all occupations, although the data show a more significant increase in earnings over the 1995–97 period than in previous years. Yet, employment of programmers did not increase much faster than average from 1992 to 1997.

Anecdotal evidence about registered nurses provides additional insights. A pervasive, nationwide shortage of nurses was reported in the late 1980s. Data for the 1984–88 period showed rapid growth in demand for hospital registered nurses and expansion of their responsibilities, but stagnation in their real earnings.[25] This prompted passage of the Nursing Shortage Reduction and Education Extension Act and implementation of the Immigration Nursing Relief Act of 1989. Soon after reports of shortages, however, the overall economic picture began to change. The hospital industry responded by increasing overtime work, retention and recruitment efforts, and nursing wages. By 1992, there was no more talk of a shortage.

In mid-1998, reports of nursing shortages resurfaced. A July 1998 newspaper article, citing the American Association of Colleges of Nursing, reported that employers are once again struggling to fill vacancies, but that the shortage was regional and related to certain nursing specialties.[26] Employers have responded by training new nursing graduates to fill such specialties as emergency room or critical care. Given this fact, national data do not appear sensitive enough to identify labor market shortages. (See table 2.)

Similarly, anecdotal evidence, such as articles in newspapers and trade publications, indicate a shortage of qualified construction workers. According to the National Center for Construction Education and Research, in 1997, shortages were most severe in three specific regions of the country: the West, the East, and "a chunk of middle America."[27] The shortages were attributed to the low unemployment rate nationwide, which contributed to a dwindling pool of workers. Employers complain about the lower skill level of available workers and high incidence of workers "jumping ship" in response to offers of higher pay.

In particular, the National Center for Construction Education and Research mentioned electricians and carpenters. The CPS data show that employment in both of these occupations grew faster than average from 1992 to 1997.[28] In 1997, the unemployment rate for electricians was around the national average, but the rate for carpenters, as usual, was double the national average. However, the relative change in the unemployment rate for these occupations was large over the 1992–97 period: the rate for carpenters declined from 2.6 times to 1.7 times the average for all occupations, and electricians declined from 1.5 times the average rate to less than average. For both occupations, however, growth in wages was only on par with that for all occupations, according to median weekly earnings figures from the CPS.

Anecdotal evidence also suggests employers have difficulty finding qualified plumbers and pipefitters. Median weekly earnings for this occupation increased faster than average between 1992 and 1997, and employment growth was almost three times higher than the average. Although the unemployment rate remained higher than average, it declined from 1.7 times the national average to 1.6 times.

Because this analysis focused on current occupational shortages, occupational employment projections were not included in the analysis of labor market indicators. However, many discussions of occupational shortages emphasize the importance of predicting or assessing future shortages, including the studies by Cohen and by Trutko and colleagues.[29] Therefore, the ability to analyze BLS occupational projections within the context of other labor market indicators becomes significant. This can only be done, however, for occupations for which there is comparability between CPS and OES data.[30] Of the seven occupations whose indicators met the three conditions discussed above, only special education teachers and dental hygienists are projected among the top 30 fastest growing occupations between 1996 and 2006.[31] Airplane pilots and navigators and mechanical engineers are projected to have average growth rates and purchasing agents and buyers are projected to have even slower rates, around 6 percent. However, computer systems analysts, engineers, and scientists are projected to be the fastest growing occupations over the period.

IN SUM, CPS and OES data provide insight into changes in labor market conditions for specific occupations. Used alone, however, these data are not adequate to definitively identify the existence of labor market shortages for a specific occupation. Besides, limiting analysis to indicators such as employment, unemployment, and wages does not present a complete picture of the market for a particular occupation. The labor market data should be combined with background information on the occupation and knowledge of the workings of the labor market. In addition, information on supply, such as data on demographic characteristics, education by field of study, and employer's requirement regarding education and training plays a significant role in completing an analysis of an occupation's labor market. Current and potential occupational shortages can best be analyzed on a case by case basis, and the analysis should focus on one occupation or a group of related occupations and should provide a detailed investigation into factors affecting supply and demand. Conclusions about shortages should not be based on general labor market statistics alone or anecdotal evidence alone. □

Footnotes

[1] *America's New Deficit: The Shortage of Information Technology Workers* (U.S. Department of Commerce, Office of Technology Policy), p. 3.

[2] "Labor Woes: You Know How Bad It Is," *Rural Builder*, May 1998, p.26.

[3] David M. Blank and George J. Stigler , *The Demand and Supply of Scientific Personnel* (New York, National Bureau of Economic Research, Inc.,1957), p. 23.

[4] Blank and Stigler, *The Demand and Supply of Scientific Personnel*, p. 23.

[5] *Ibid*., pp. 23–24.

[6] *Ibid*., p. 24.

[7] Kenneth J. Arrow, and William M. Capron, "Dynamic Shortages and Price Rises: The Engineer-Scientist Case." *Quarterly Journal of Economics*, May 1959, p. 292.

[8] Arrow and Capron, "Dynamic Shortages and Price Rises," p. 301.

[9] *Ibid*., p. 299.

[10] Walter Franke and Irving Sobel, *The Shortage of Skilled Technical Workers* (Lexington, MA, Heath-Lexington Books, 1970).

[11] Franke and Sobel, *Shortages of Skilled Technical Workers*, p. 7.

[12] *Ibid*., p. 298.

[13] Malcolm S. Cohen, *Labor Shortages as America Approaches the Twenty-first Century* (Ann Arbor, The University of Michigan Press, 1995).

[14] John W. Trutko, Burt S. Barnow, Amy B. Chasanov, and Abhay Pande, *Labor Shortage Case Studies*, Research and Evaluation Report Series 93-E (U.S. Department of Labor, Employment and Training Administration, 1993).

[15] "Companies Combat IT Labor Crunch," *Computerworld*, Mar. 9, 1998.

[16] Researchers who have used data in this way include Cohen and Trutko, Barnow, Chasanov, and Pande.

[17] Cohen, *Labor Shortages*, p. 25.

[18] A brief explanation of sampling errors and response errors appears in *Employment and Earnings*, a monthly publication of the Bureau of Labor Statistics.

[19] Detailed occupational unemployment rates are collected but not published because the small sample sizes for detailed occupational groups affects the statistical reliability and they are not analytically meaningful for reasons indicated in the text.

[20] See Lois Plunkert. *Job Openings Pilot Program: Final Report* (Bureau of Labor Statistics, 1981). Also, see *Employee Turnover and Job Openings Survey: Results of a Pilot Study on the Feasibility of Collecting Measures of Imbalances of Supply and Demand for Labor in an Establishment Survey* (Bureau of Labor Statistics, 1991).

[21] Occupations were considered to have met the criteria if the employment growth between 1992 and 1997 was at least 50 percent faster than the average for all occupations, if the wage growth was at least 30 percent higher, and if the unemployment rate (an average of 1995–97 rates) was more than 30 percent lower than average.

[22] The National Industry-Occupation Employment Matrix provides another source of historical employment data. However, matrix data are based on the Occupational Employment Statistics survey and pose comparability problems. Projected employment data also are from the National Industry-Occupation Employment Matrix. Therefore, any discussion of projected employment within the context of occupational shortages would require comparability. Only 68 occupations were found that were comparable and displayed changes in employment in the same direction.

[23] Annual averages are published in January issues of *Employment and Earnings*, a monthly publication of the Bureau of Labor Statistics.

[24] Trutko, Barnow, Chasanov, and Pande. *Labor Shortage Case Studies*, pp. 3–27.

[25] Immigration Nursing Relief Advisory Committee, *Report to the Secretary of Labor on the Immigration Nursing Relief Act of 1989*, March 1995.

[26] See Sheryl Silver, "Nursing Shortage Back in full Swing," *The Washington Post*, July 1, 1998.

[27] "Labor Woes: You Know How Bad It Is," p. 26.

[28] Although, during this period, only average growth was indicated by the national industry-occupation employment matrix time series.

[29] See Cohen, *Labor Shortages as America Approaches the Twenty-first Century*; and Truko and colleagues, *Labor Shortages Case Studies.*

[30] For purposes of developing occupational employment projections and career guidance materials such as the *Occupational Outlook Handbook*, the Bureau of Labor Statistics has established a crosswalk between the industry-occupation matrix and the CPS.

[31] See George T. Silvestri, "Occupational employment projections to 2006," *Monthly Labor Review*, November 1997, p. 77.