Chapter 2

Skill Demand and Supply in the New Economy: Issues for Rural Areas

Ruy A. Teixeira and Paul L. Swaim*

The rise of the new service-driven economy is supposedly increasing skill demand, while skill supply is declining or slowing down due to a nationwide "education crisis." Considerable evidence suggests that both trends are real, at least in some form. Some type of new economy transition is, in fact, increasing skill demand, while an education crisis of some dimension is holding back skill supply. Moreover, depending on such hard-to-measure factors as content change within jobs, this imbalance between demand and supply is potentially substantial and serious. These trends raise a number of important issues concerning the types of jobs and levels of earnings available to rural individuals and the general economic development prospects of rural areas.

Introduction

The United States is in the midst of a significant economic transition, as the formerly dominant system of mass-production manufacturing continues to decline. Variously described as the transition to a "service economy," "information economy," "postindustrial economy," or simply the "new economy," this transition is dramatically changing the industrial and occupational structure of the United States.[6] In the process, the structures of jobs are also significantly changing. Because of these changes, many new-economy analysts argue that jobs now require a higher level and somewhat different range of skills than previously and that this trend is likely to continue.

At the same time, many observers believe that an "education crisis" is gripping the country. These observers claim that schools are providing ever-

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* The authors are social science analysts in the Agriculture and Rural Economy Division, Economic Research Service, U.S. Department of Agriculture.

[6] In this chapter, we use the term "new economy" because the other terms somewhat prejudge the nature of the economic transformation going on.

poorer education, turning out young adults who, if not actually illiterate, have skills that are woefully inadequate to the demands of a technological society. Thus, at the same time that new economy analysts are claiming that today's jobs demand higher levels of skill, the education crisis analysts are claiming that the supply of workers with these skills may be declining or, at best, failing to keep pace. If the demand for skills is going up while the supply of skills is declining or stagnant, then a serious imbalance between skill demand and supply may be evolving.

Such an imbalance would be a matter of great concern, posing a serious challenge to contemporary education and training policy. On the aggregate level, such an unfavorable relationship between skill demand and supply could seriously erode the Nation's international economic competitiveness, a possibility that has been widely discussed. And, on the level of people's everyday lives, such developments could have important implications for the types of jobs and levels of earnings available to people with a given amount of education and training. Those who are well-educated and trained will do well in a situation of high skill demand and short supply, while those who are relatively poorly educated and trained will be disadvantaged. If this demand-supply relationship is the same or worse in rural areas, it could significantly dim the economic prospects of rural individuals and places, since levels of education and training in these areas have historically lagged behind the rest of the country.

Much of what will happen will depend on answers to two questions: (1) to what extent are the skill trends identified above real, and (2) if they are real, to what extent do they apply to rural areas? In this chapter, we attempt to answer the first of these questions by reviewing the extensive literature on skill trends, both demand (job skill) and supply (worker skill). However, we cannot address the second question of applicability to rural areas by drawing on previous work. Previous research on skill trends has generally lacked a spatial dimension, and some key data on skills simply are not available for rural-urban comparisons.

Skill Demand in the New Economy

The skills required for jobs in the new economy are generally believed to be cognitive in nature, involving thinking, reasoning, reading, and other mental activities. Workers in these jobs increasingly absorb and manipulate information, rather than physical objects, to successfully perform their duties. Specific skills are thought to include at least the following: (1) basic literacy, (2) basic numeracy (the ability to comprehend the significance of numbers as well as to manipulate them), (3) problem-solving abilities, (4) abilities to learn and to adapt, and (5) the ability to work cooperatively.

The last three skills are associated particularly strongly with the new economy because they are believed to have emerged relatively recently as common job requirements, while literacy and numeracy (albeit on lower levels) have been requirements of many jobs for a long time (*1, 19, 28, 52*).[7]

Not all contemporary jobs require the full range of these skills, no more than all mass production jobs were limited to a narrow range and low level of skills. But the general pattern of how jobs are structured may have shifted decisively toward a more complex, cognitively oriented set of skills. Below, we consider the empirical evidence on whether this trend in skill demand has actually taken place.

Empirical Evidence on Skill Demand

Occupational change can affect job skill levels in two basic ways, which, while they can and do take place simultaneously, are important to keep separate conceptually. The two basic ways are through *compositional shifts* in the job structure, where the distribution of individuals into jobs with different skill levels changes, and through *content shifts*, where the actual content of the jobs individuals do changes (*44*).

Compositional Change

The weight of the evidence suggests that cognitive skill levels have risen due to compositional change since 1960 (*3, 15, 39, 45*). The most recent and complete of these analyses covers 1960-85 and finds that compositional upgrading of job skill levels took place in each decade (1960's, 1970's, and 1980-85), though the rate of increase declined substantially over time (*15*). For example, the "substantive complexity" of jobs went up 0.69 percent per year in the 1960's, 0.46 percent per year in the 1970's, and only 0.28 percent per year in the 1980's (table 1).[8] Compositional change may be broken into two components: change occurring through industry shifts (the changing

[7] Italicized numbers in parentheses identify literature cited in the References at the end of this chapter.

[8] "Substantive complexity" of jobs is a factor-analytic score created from Dictionary of Occupational Titles (DOT) variables that measure general educational development, vocational preparation, relationship to handling data, and worker aptitudes. The *DOT* is a compendium of occupational titles in common use in civilian U.S. labor markets. The compendium is based on survey information collected at irregular intervals by job analysts for the U.S. Employment Services. A variety of information about each occupational title is contained in the *DOT*, including ratings of the educational development, training time, physical capabilities, temperaments, and aptitudes necessary for the job. There have been four editions of the *DOT*: 1939, 1949, 1965, and 1977. The 1977 edition contained information on some 12,855 different occupations.

Table 1--Compositional change in substantive complexity of jobs, 1960-85

Period	Annual rate of change	10-year rate of change[1]	Industry component	Occupation component
		Percent		
1960-70	0.69	7.1	55.2	44.8
1970-80	0.46	4.7	44.6	55.4
1980-85	0.28	2.8	49.9	50.1

[1] To facilitate comparison of time periods, data have been converted to 10-year rates of change—the change that would have occurred if the annual rates of change in each time period had continued for a full 10 years.

Source: (*15*).

distribution of individuals *across* industries); and change occurring through occupation shifts (the changing distribution of individuals to occupations occupation shifts (the changing distribution of individuals to occupations *within* industries). Industry shifts affect skill levels by changing the relative weight of industries with different average skill levels. Occupation shifts change the relative weight within industries of occupations with different specific skill levels.

Compositional upgrading during 1960-85 was about equally attributable to industry and occupation shifts ((*15*) and table 1). The occupation shifts are generally attributable to the growth of professional, technical, and managerial (PTM) occupations. The industry shifts are accounted for by an overall shift of employment to the service sector, which has higher average skill levels than the goods-producing sector, and employment shifts within both the service and goods-producing sectors toward industries with relatively high skill levels.[9]

The overall U. S. economic trend has been toward growth of industries with higher skill levels, but the job structure for all industries still contains many low-skill jobs. Some low-skill industries have, in fact, expanded substantially

[9] The service sector includes trade, finance, insurance, real estate, personal services, business services, public administration, and professional services (such as health, education, welfare, and research). The goods-producing sector includes agriculture, mining, construction, manufacturing, transportation, communication, and utilities.

in the recent past. This expansion of certain low-skill industries, however, has not been as rapid as the growth of some relatively high-skill industries. This pattern is particularly clear for the services-producing sector, which accounts for most jobs and which has accounted for virtually all recent employment expansion.

A study of the Canadian economy provides the best data illustrating this pattern (*30*). That study used the Canadian version of the *Dictionary of Occupational (DOT)* to identify high-skill and low-skill industries within the service sector. Business services, professional services (such as health and education services) and public administration tend to have relatively high skill levels, and consumer-oriented services (such as retail trade and personal services) tend to have much lower skill levels. Industries at both the high and low ends of the skill distribution had grown substantially in the recent past, but the high-skill industries (business, professional, public administration) had grown more rapidly. This relatively rapid growth in the high-skill "information economy" industries decreased the relative weight of low-skill consumer-oriented services within the service sector and contributed to skill upgrading in the Canadian economy.

A 1989 study confirmed this pattern for the U.S. economy, but it relied on an indirect measure of skill, educational attainment, rather than data from the *DOT* (*2*). The analysts of that study divided the service sector into "information-knowledge" (high-skill) services and "other" (low-skill) services. The use of educational attainment as a measure of skill suggested that the information-knowledge services were substantially more highly skilled than the other services.

In both 1973-79 and 1979-87, information-knowledge services grew faster than other services, although both types of services grew substantially in each period (table 2). The data suggest that the relatively rapid growth of high-skill information-knowledge services has contributed to skill upgrading within the service sector, despite the offsetting influence of growth in relatively low-skill service industries.

Thus, growth in the service sector should not be viewed as just low-skill or high-skill job growth but rather as the result of offsetting trends. On the one hand, the information-knowledge services have grown substantially, producing many relatively high-skill jobs. Those jobs lead some observers to optimistically view the rise of a "service economy," where everyone is engaged in processing information. On the other hand, low-skill consumer-oriented service industries have also grown substantially, producing many relatively low-skill jobs. This aspect of service-sector growth worries other observers who foresee a Nation of "hamburger flippers" if the decline in manufacturing continues. These different assessments seem to be at least

Table 2--Share of employment, employment growth, and educational level of industry groups, 1987

Industry group	Share of employment	Annual growth rate, 1973-87	Proportion with college degree
		Percent	
All	100.0	2.1	22.9
Other service[1]	39.0	2.6	17.1
Information-knowledge service[2]	27.7	3.2	40.3
Classical industry[3]	26.5	.6	13.6
Extractive[4]	3.6	.2	12.4
Information-knowledge manufacturing[5]	3.2	1.9	29.9

[1] Hospitals; other health services; social welfare services; personal and recreation services; private household services; eating and drinking places and hotels; vehicle sales; retail trade; wholesale trade; automobile service and repair; and guard, cleaning, and repair services.
[2] Education; professional services; business services except janitorial services and detective and protective services; communications; financo, insurance, and real estate; and public administration.
[3] Construction, durable and nondurable goods manufacturing (except those included in information-knowledge manufacturing), transportation, and public utilities.
[4] Agriculture, forestry, fishing, and mining.
[5] Electronic computing equipment; office and accounting machines; radio, TV, and communication equipment; professional and photographic equipment; scientific and controlling instruments; and printing, publishing, and allied industries.
Source: (2).

partially rooted in the tendency to focus on one service-sector trend to the exclusion of others.

Content Change

Occupational shifts toward professional-technical-managerial jobs and industry shifts toward the service sector (and, within the service sector, toward information-knowledge services) are increasing skill requirements in the economy. This increase in skill demand, however, appears moderate, partially reflecting the offsetting influence of growth in relatively low-skill

industries within the service sector. Moreover, the increase in skill demand due to compositional change actually appears to be slowing down over time, rather than speeding up.

These results do not support a strong version of the new economy argument, although they are consistent with a scaled-down version that emphasizes the mixed and moderate nature of current skill changes. However, while many new economy analyses focus on content change, the results presented above are confined to compositional change. That is, many analysts contend that the focus of skill change lies within individual occupations—in changes in how the work for given jobs is done—rather than in how the aggregate distributions of industries or occupations have changed over time.

Content shifts are intrinsically more difficult to measure than composition shifts. Surveys like the decennial Census, Occupational Employment Statistics (OES) survey, and Current Population Survey (CPS) allow us to keep careful track of changes in industry and occupation distributions, but changes in job content are not monitored as closely. For example, the OES survey is conducted on a 3-year cycle and the smaller CPS is done monthly, but there has not been a new edition of the *DOT*—the only survey that tracks job content—since 1977.

Thus, to quantitatively estimate the effect of content shifts on skill levels, the best we can do is to compare the third (1965) and fourth (1977) editions of the *DOT*. Such a comparison found a modest upgrading of skill levels through content change between 1965 and 1977 (*43*).

That comparison of those two *DOT* editions may seriously underestimate the magnitude of content change taking place in the U.S. job structure, however. First, because the last edition contains information that is at least 13 years old, the observed content change results are generally out of date.[10] Even if job content trends have remained unchanged since 1977, the amount of upgrading since 1965 should be larger than that estimated by the study.

Second, content upgrading trends may well have changed since 1977 because the pace of technological change, especially computerization, has accelerated. Personal computers, for example, were not widely available until after 1977, though today they are commonplace. These rapidly evolving new technologies, as they have become integrated into workplace tasks and organization, may have substantially accelerated the rate of job content

[10] The actual job content information in the fourth edition was gathered over a period of years going back to 1966.

change.[11] Some recent case study-based analyses support this interpretation, at least for certain "best-practice" firms (*11, 38, 49, 52*).

Third, the skills measured by the *DOT* reflect its origins in the period when mass production dominated the economy. Thus, the types of skills rated tend to be those common at the time, particularly in manufacturing, rather than cognitively based skills whose importance has increased substantially since then. The *DOT* is probably strongest on those cognitive skills, mainly verbal and mathematical, related to basic academic preparation and weakest on the more applied cognitive skills such as problem solving and the ability to learn and adapt. To the extent these latter skills have become more important, content change estimates based on the *DOT* will be too low.

Finally, there is fairly strong evidence that skill scores across editions of the *DOT* may be affected by a stability bias (*1, 24*). That is, the assessments of job content by *DOT* raters may not have been truly independent between editions, but rather affected by a tendency to assume jobs remained the same. If this stability bias was a factor, *DOT*-based estimates of job content change will be too low, perhaps a great deal too low.

All these arguments suggest that we do not really know the extent of skill content change in the U.S. economy. The actual amount of content change in jobs could range from a modest upgrading to much more dramatic changes. Thus, a weak version of the new economy argument receives the only clear empirical support, but the stronger version of the argument cannot be ruled out, since available data do not allow us to evaluate it. Moderate upward shifts in skill levels, therefore, should be viewed as a lower bound estimate of recent changes in skill demand.

Occupational Projections

The evidence described above comes from analyses of job skill trends between two points in time in the recent past. However, the argument presented at the beginning of this chapter focuses on a continuing economic transition, rather than one that has ended. Therefore, even if historical analyses do not provide clear evidence for the strong version of the new economy argument, analysis of probable future trends in job skill levels could provide that evidence.

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[11] However, the rate of compositional change in this period actually slowed down. If technological change affects job composition and job content in parallel ways, a case could be made for a slowdown in the rate of content change. We believe, however, that the mechanisms by which technological change affects content and composition are different enough to allow for a divergence in outcomes (see (*44*) for a good discussion of this point).

The most direct evidence on future job skill trends comes from a 1987 study (*18*). That study, widely disseminated under the title *Workforce 2000*, assessed skill changes in the economy as a whole to the year 2000 and used direct skill measures based on the *DOT's* general educational development (GED) score combined with the 1984 Bureau of Labor Statistics (BLS) occupational projections. The report finds that, on a scale from 1 to 6, the average GED of jobs in fast-growing occupations will be 3.8, that of jobs in slowly growing occupations will be 2.7, and that of jobs in declining occupations only 1.9. These findings are among the most widely publicized from that report.

Less widely publicized is the estimated overall effect of these changes in the job structure on skill levels: the GED of jobs will rise from 3.1 in the report's base year (1984) to only 3.2 by the year 2000. Furthermore, a more recent study that uses both the 1986 and 1988 BLS projections and a variety of *DOT* skill measures shows that the effect of future compositional change on skill levels appears to be modest and that future compositional change will slow from the previous fairly modest rate of compositional change (*25*) (table 3).

A closer look at the *Workforce 2000* figures reveals part of the reason why estimated overall skill level growth appears relatively modest. The occupational group that makes the largest contribution to total employment growth is the service occupations, dominated by low-skill occupations like cooks, waiters, household workers, janitors, and security guards. Because the GED of this occupational group is only 2.6, substantially lower than that of the overall job structure, the growth of this occupational group makes a negative contribution to overall skill level growth.

These occupations are concentrated in consumer-oriented service industries, the low-skill segment of the service sector. In contrast, the high-skill, high-growth occupations (such as lawyers, doctors, health and legal paraprofessionals, engineers, teachers, technicians, and programmers) are concentrated in professional and business services and government, the high-skill segment of the service sector. Thus, the service sector will probably continue to contain low-skill and high-skill segments, because both will grow substantially. The debate on how to assess service sector growth will also probably continue. Some observers will see the growth of a Nation of hamburger flippers, and others will see the evolution of a Nation of information processors. These assessments will probably depend on which trend within the service sector observers choose to focus on.

Other problems with the *Workforce 2000* report mostly center around its failure to analyze the BLS and *DOT* data in enough detail, so that the kinds

Table 3--Compostional change in skill levels of jobs, 1979-2000

Skill[2]	10-year rates of change[1]		
	1979-86	1986-2000[3]	1988-2000[3]
		Percent	
Handling data	5.07	1.24	1.31
Verbal aptitude	2.65	.66	.72
Specific vocational preparation (SVP)	2.38	.53	.59
Handling people	2.45	.72	.72
General educational development (GED)	2.35	.60	.65
Intellectual aptitude	2.35	.55	.63

[1] To facilitate comparison of time periods, data have been converted to 10-year rates of change—the change that would have occurred if the annual rates of change in each time period had continued for a full 10 years.
[2] All skill measures are from the *Dictionary of Occupational Titles* (*DOT*).
[3] Based on the BLS employment projections for years indicated.
Source: (*25*).

of trends described above can be seen.[12] Despite these problems, *Workforce 2000* and the other studies cited provide some evidence that compositional change in the job structure will probably continue to modestly upgrade cognitive skill levels.

Analyses based on BLS projections of aggregate occupational change, or any other data source, for that matter, can provide no insight on possible future upgrading in job content; projecting changes in job content is intrinsically very difficult. Even lacking such data, however, one can identify several factors that may contribute to future upgrading in job content.

[12] Studies that are in progress will examine these data in detail, including the different ways the trends identified in the BLS projections will probably affect rural and urban areas (see (*25*) for initial results from this research).

Technological change, chiefly more advanced information technology, may require workers with higher levels of cognitive skills for proper implementation of the technology. *Flexible automation* may require workers with adaptability and problem-solving skills, since the focus of production will constantly shift.[13] *International competitive pressures* may call for the deployment of technology in flexible and innovative ways which, in turn, may call for more cognitively sophisticated workers. Because indications are that technological change will continue to accelerate, that flexible automation will become more common, and, especially, that international competitive pressures will intensify, the influence of these factors on content change is potentially large and could increase over time.

This suggests that, while we lack good data on probable future changes in job content, a reasonable possibility exists that these changes could be substantial. Thus, while only the weak version of the new economy argument receives empirical support from analysis of future compositional change, the strong version of the argument cannot be ruled out, especially if U.S. employers respond to competitive pressures with a strategy of job enrichment (see (*25*) for a more extensive discussion of this point).

Overall Assessment

Today's workers must possess somewhat higher, more sophisticated cognitive skill levels than in the past. That skill upgrading trend is likely to continue, at least on some level. This upgrading stems from two sources.

Changes in the industry/occupation structure reflect the rise of the service sector, especially its high skill "information-knowledge" segment and the increased proportion of professional-technical-managerial jobs. The overall increase in skill demand from this source, however, seems modest.[14] Moreover, the rate at which these compositional shifts are increasing skill demand appears to be slowing down, to the point that some analysts believe this source of change in skill levels may be essentially exhausted (*31*).

The second source is changes within occupations in job content as a result of technological and organizational change. This source has contributed toward increasing skill demand in the economy, but the magnitude of that contribution is very difficult to estimate because of lack of appropriate data.

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[13] Flexible automation is based on computer-controlled, integrated production units that can produce various parts or products in small batches. (See (*36*) for a good discussion of the skill requirements of such automation).

[14] However, because skills like education tend to remain fixed after people enter the workforce, a relatively small increase in overall skill demand could significantly affect the labor market situation of workers, especially younger workers.

The outdated and otherwise-flawed *DOT* data suggest moderate change, but some recent case studies suggest far more extensive change, at least in certain "best practice" firms. However, we do not have data to determine the breadth of the new technological and organizational practices documented in the case studies.

These uncertainties complicate current and future estimates of skill demand. The magnitude of content change would affect whether levels of skill demand are changing only moderately, as the data on compositional change suggest, or quite substantially. The only certainty appears to be that skill demand is increasing, at least on some level.

Thus, we treat the weak version of the new economy argument as our lower bound on the skill demand side and the strong version of the argument as our upper bound, contingent on the generalizability of new technological and organizational practices.

Skill Supply in the New Economy

There are two basic sources of skill supply in the economy: academic training through the system of elementary, secondary, and postsecondary schools and vocational training through both schools and workplaces. For each type of training, one must consider both the composition (or amounts) of training received by the population and the content (or quality) of that training.

Academic Training

The amount of academic training received by individuals is typically measured by the number of school years completed and is referred to as educational attainment. Statistics on educational attainment are easily available and probably the most familiar source of data on skill supply in the economy. The content of academic training, however, has no standard measure. The various tests that purport to measure academic skills all cover somewhat different areas and are far less accessible and easy to understand than data on educational attainment.

Trends in Educational Attainment

Average skill levels, measured as educational attainment, have risen dramatically. From 1950 to 1988, the share of the population 25 and over that has graduated from high school has risen from about 35 percent to over 75 percent, while the share of college graduates has risen from 6 to 20

percent. Despite this impressive rise, there are several grounds for concern about the composition of academic training in the population.

One such reason for concern lies in a recent slowdown in the growth of educational attainment. The supply of educated workers, particularly college graduates, grew dramatically in the 1970's, but that growth slowed during the 1980's (*29*). That slowdown may create problems during the 1990's.

School dropout rates are another cause for concern, because they remain quite high in many communities despite the worsening labor market prospects for workers lacking a high school diploma. Dropout rates have actually increased among black and Hispanic youths in some central cities with high concentrations of poverty.[15]

Low educational attainment among experienced workers who are required to learn new job skills may also cause difficulties. Displaced workers, especially, often lose jobs in declining industries and occupations and, hence, are unlikely to become reemployed in their accustomed line of work. Among the approximately 1.5 million full-time workers displaced annually in the United States, those with relatively few years of schooling experience significantly longer spells without work and larger earnings losses once reemployed (*48*).

Finally, workforce projections suggest that the educational attainment of some future labor force entrants may leave much to be desired. *Workforce 2000* projects that an increasing share of new labor market entrants in the coming decade will be blacks, Hispanics, and immigrants, all groups who currently possess below-average levels of schooling and are particularly at risk of not completing high school (*8*).

Workforce projections also show slower growth of the labor force as a whole. These slow growth rates, projected to decline from an annual rate of almost 3 percent in the 1970's to a little over 1 percent in the 1990's, suggest that the economy may have greater difficulty working around possible shortfalls in educational supply (*13*, *14*). Employers who have become accustomed to screening large numbers of applicants to find suitable recruits may have increased difficulty hiring sufficient numbers of workers with adequate basic education.

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[15] Dropout rates in central cities--where 56 percent of black Americans live--are four times the national average rate of 14 percent. In some New York City schools, four out of five freshmen drop out before graduation. Chronically depressed rural areas, particularly in the South, also have high dropout rates.

The factors discussed above indicate that skill supply in the United States may not be keeping pace with increased demand in terms of the amount of academic training. This situation seems consistent with the idea of an "education crisis," although only with a weak version of the argument.

However, many "education crisis" analyses focus on the content of what people learn in school, rather than the amount of time they spend there. That is, many analysts believe the problem lies not with the number of years people attend school, but rather with the level of cognitive skills attained by those years of school attendance. It is here that a strong version of the education crisis argument receives some support.

Perhaps the best known content-related trend is the decline in average scores on widely administered tests, such as the Scholastic Aptitude Test (SAT), from the mid-1960's through about 1980 (table 4). Although average test scores have since recovered some of the lost ground, many other indicators suggest that the content of education received in primary and secondary schools may be unsatisfactory.[16]

Recent analyses of various tests suggest that many high school graduates lack the general cognitive skills and knowledge needed to acquire job-specific skills once in the labor force. The 1986 National Assessment of Educational Progress (NAEP), which provides an overview of the current level of literacy and numeracy of young adults, illustrates this finding (*13*).[17]

The 1986 literacy tests showed that more than 90 percent of Americans aged 21-25 had the most basic reading and reasoning skills, such as the ability to "follow simple directions, solve single-step problems, and make inferences when all of the necessary information appears in a single sentence" (*28*). More than 30 percent, however, had difficulties gathering information from several sentences and solving nonroutine or multistep problems. Althougn

[16] The increased emphasis on testing students for very basic verbal and computational skills, as well as test-directed classroom drilling, is probably responsible in part for recent improvements in student performances on these tests. However, this emphasis may also be responsible for simultaneous declines in students' abilities to perform higher level reasoning tasks such as solving multistep problems or integrating information from several sources (*33*).

[17] The NAEP is probably our best source of data on the cognitive skill levels outlined earlier in this chapter. The NAEP becomes less useful the farther away one moves from conventional academic skills like literacy and mathematical problem solving. The NAEP tests have little to say about students' abilities to solve problems in applied situations, to learn and adapt, and to work in cooperative situations. To the extent these skills are becoming more important in today's economy, the NAEP will be an inadequate source of data in some critical areas.

Table 4--Scholastic Aptitude Test (SAT) scores, 1963-86

Year[1]	Verbal	Mathematics	Total
		Score	
1963	478	502	980
1964	475	498	973
1965	473	496	969
1966	471	496	967
1967	466	492	958
1968	466	492	958
1969	463	493	956
1970	460	488	948
1971	455	488	943
1972	453	484	937
1973	445	481	926
1974	444	480	924
1975	434	472	906
1976	431	472	903
1977	429	470	899
1978	429	468	897
1979	427	467	894
1980	424	466	890
1981	424	466	890
1982	426	467	893
1983	425	468	893
1984	426	471	897
1985	431	475	906
1986	431	475	906

[1] Sources are for school year ending in that year. Averages for 1972-1986 are based on college-bound seniors. Averages for 1963-1971 are estimates provided by the College Entrance Examination Board; background information needed for specific identification of college-bound seniors was not available before 1972.

Source: (*46*).

high school graduates scored higher than did dropouts, a substantial fraction were weak in literacy and problem-solving skills.

The level of competence in mathematical and scientific reasoning is probably even lower. This finding should not be surprising because fewer than half of all high school students take a math or science class after the 10th grade. The 1986 NAEP indicates that just 6.4 percent of 17-year-old students "demonstrated the capacity to apply mathematical operations in a variety of

problem settings."[18] Similarly, only 7.5 percent of this group can "integrate specialized scientific information" (*32*).[19]

Comparing cognitive achievement levels of U.S. students with student achievement levels in other countries is also instructive. These comparisons show a large gap between the science and math competence of young Americans and their counterparts overseas, starting as early as eighth grade (table 5). By the end of high school, Japanese students average more than four U.S. grade level equivalents higher in math and science than do American students (about twice the grade level gap between whites and blacks in the United States) (*5*).

This gap between American and foreign students is often attributed to the diversity of the student population in the United States or the failure of the U.S. schools to provide a good basic education to those high school students who are not planning to go on to college. However, the best American high school students also score well below their international counterparts in mathematics and science (*5*). Most observers, however, conclude that the student elite is relatively well served, because much of the elite's learning deficit is later made up by America's diverse and extensive system of higher education.[20]

Many outside of the student elite progress through primary and secondary schools without ever attaining threshold levels of literacy and problem-solving skills. Such students are rarely able to compensate for this deficit through postsecondary education and training. If Japan's schools produce the world's best lower half, many U.S. students complete their schooling without having obtained a solid basis for a lifetime of productive employment and on-the-job learning. As the summary report of the 1986 NAEP mathematics assessment concludes: "The fact that nearly half of the 17-year-olds do not have mathematical skills beyond basic computation with whole numbers has serious implications. With such limited mathematical abilities, these students nearing graduation are unlikely to be able to match

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[18] For example, fewer than one in three could answer a question such as: George had 3/4 of a pie. He ate 3/5 of that. How much pie did he eat?" (For a discussion of the results, see (*12*).)

[19] NAEP data only go back to the early 1970's, but the trend line on most NAEP tests roughly parallels that observed for the SAT's and similar tests. NAEP scores generally show a decline in the 1970's, followed by some recovery of lost ground in the 1980's (*12, 27, 46*).

[20] The relatively small proportion of U.S. students majoring in the sciences and engineering is, however, a cause for concern. An overly theoretical engineering curriculum and an MBA curriculum that slights technology may also reduce the contribution of university-educated workers to industrial productivity (*11*).

Table 5--Mathematics achievement of 8th grade students by country, 1982[1]

Country	Sample size	Average correct responses
	Number	*Percent*
Japan	8,091	63.5
Netherlands	5,418	58.1
Hungary	1,754	56.6
Belgium (Flemish)	3,073	54.0
France	8,317	53.5
Canada (British Columbia)	2,168	52.3
International mean	**59,101**	**52.0**
Belgium (French)	2,025	51.5
Canada (Ontario)	4,666	49.5
Scotland	1,320	49.3
England and Wales	2,612	48.4
Finland	4,382	46.4
New Zealand	5,176	46.4
United States	6,648	46.0
Sweden	3,451	43.5

[1] Data are from the Second International Mathematics Study, conducted by the International Association for the Evaluation of Educational Achievement for the U.S. Department of Education, Center for Education Statistics. Reported scores are average percentage correct on 157 items from the study. Eighth grade was defined as that grade in which a majority of students attained age 13.0 to 13.11 by the middle of the school year. For Japan, the 7th grade was used because the Japanese considered the test more appropriate for that grade.

Source: (*46*).

mathematical tools to the demands of various problem situations that permeate life and work" (*12*). Thus, if one looks beyond the amount of academic training people receive to the content of that training, there are strong grounds for speaking of an "education crisis." The case seems particularly compelling to the extent that jobs in the new economy are requiring, or will require in the future, reasonably high levels of literacy,

numeracy, and problem-solving. American workers do not appear to be developing these skills through their academic training.

The evidence for a crisis is sharpest, however, when considered in the context of international economic competition. If competitive pressures really do call for enrichment of job content to boost productivity, the American workforce seems ill prepared to handle such enrichment. Our international competitors, in contrast, appear to have a fairly solid base of workforce cognitive skills with which to pursue technological innovation and productivity enhancement. This difference could yield a significant competitive advantage to our economic rivals.

Vocational Training

The other source of skill supply in the economy is vocational training through schools and workplaces. Vocational training can, at least in theory, offset the harmful effect of low academic achievement by teaching specific job skills and contextual problem solving. Indeed, individuals who do poorly on general-purpose tests of reasoning skills are sometimes quite adept at applying the same reasoning skills in job-specific contexts that are more familiar and comfortable.

There are no measures of the amount and content of vocational training received by the workforce that are comparable to those for educational attainment and achievement. This reflects the generally haphazard and poorly organized system of vocational training in the United State—a system, in fact, frequently referred to as a "nonsystem."

A fair amount of vocational training takes place in the United States. To begin with, about 5 million students enroll annually in high school vocational education programs. Postsecondary institutions have also become an important source of vocational training. While just 13 percent of community college enrollments were in vocational programs in 1965, that proportion has now climbed to about two-thirds. Many of these schools also offer remedial programs designed to improve reading, writing, communication, and mathematical skills that could be considered vocational in nature (*21, 34*).

The most important source of job training for most of the workforce, however, is on-the-job training. A 1983 BLS study found that, although 45 percent of all workers needed no specific training to qualify for their job, 28 percent received their qualifying training on the job, and 9 percent received company-provided formal training off the job (*50*). Estimates of employer costs for worker training confirm the importance of this source in promoting worker skills. Spending on formal training programs in 1983 was estimated

at about $30 billion annually, and the implicit costs of informal instruction and learning by doing are probably much higher (*10*).

If the data on the amount of vocational training tend to be vague, data on the content of that training are even weaker. Perhaps the most is known about vocational training in secondary schools. Until recently, most of the accumulated evidence about these programs suggested that relatively few participants acquired skills that substantially enhanced their employment prospects (*51*). However, more recent evidence suggests that vocational programs in secondary school do benefit some students, but only those who take a sequence of vocational courses specifically relating to their future occupation (*4, 8*).

The limited effectiveness of high school vocational training contrasts with what appears to be a much more dynamic and successful record for postsecondary vocational training. Numerous accounts credit community and technical colleges with playing a valuable role in providing vocational training closely tailored to the hiring needs of local employers (*20*). However, because little actual data on the content of these training programs exist, these anecdotal evaluations should be treated cautiously.

The extensive "nonsystem" of employer-provided training is very difficult to describe from a content standpoint, also because of a lack of appropriate data. However, two potential problems of this nonsystem may be noted. The first is that a relatively high proportion of formal training is targeted to professional employees, with the amount of training received varying directly with the amount of prior education of the employee (*9*). The second is that training for line workers tends to be of the "follow Joe around" variety, with little attempt to systematically impart needed cognitive skills to workers. These patterns contrast rather strongly with those in West Germany and Japan, where employer-provided training tends to be broadly targeted to the entire production workforce and oriented toward complementing the academic education system through cultivation of pertinent cognitive skills (*20*). Employer-provided training in the United States seems too diffuse and poorly targeted to play a similar complementary role to the U.S. educational system.

Although a fair amount of vocational training takes place in the United States today, the content of this training appears to make it an unreliable source of skill supply. Thus, problems posed by an "education crisis"—of whatever dimension—become even sharper, because vocational training cannot be relied upon to take up the slack.

Overall Assessment

The evidence presented here indicates that talk of an education crisis may be justified, although the depth of such a crisis is open to question. The crisis, such as it is, stems from two sources.

The first source has to do with the amount of academic training people are receiving. The growth of supply of workers with high levels of educational attainment is apparently slowing down. Dropout rates remain high, and low educational attainment among experienced workers hinders the ability of these workers to adapt to the new economy. Finally, the future workforce will grow slowly, with new workforce entrants disproportionately composed of workers with historically low levels of educational attainment. All these factors mean that levels of educational attainment may not be adequate to meet skill demands from a changing economy.

The second source stems from the *content* of the academic training received by workers. The cognitive skills imparted to most Americans by their years in school are probably not high, are particularly deficient in key areas linked to the new economy, and have declined in recent years from their already-modest levels, although some of that lost ground was recovered in the 1980's. Moreover, the cognitive skills of the U.S. workforce appear markedly lower than those of their counterparts in other developed countries, a situation that augurs poorly for U.S. economic competitiveness. These factors suggest that educational content in the United States is substantially below desirable levels.

The situation with vocational training is less clear than that with conventional academic training. Although vocational training may not be facing a crisis, it is an unlikely candidate to remedy cognitive skill deficiencies traceable to an "education crisis" of either small or large scale. This reality could complicate efforts to deal with the negative effect of educational system problems.

Whether these educational system problems should properly be viewed as a relatively small-scale crisis or a more serious, large-scale crisis depends on several factors. To the extent that the problem is located in levels of educational attainment, the crisis seems more small-scale and potentially solvable through enhanced educational attainment growth rates. To the extent that the content of education is judged to be the critical problem—as, for example, it appears to be in the context of international competition—the crisis seems deeper and less susceptible to straightforward solutions.

Issues for Rural Areas

The weight of the evidence presented in this chapter suggests that an imbalance between skill demand and supply is evolving, at least in some form. Some type of new economy transition is increasing skill demand, while an education crisis of some dimension is limiting skill supply. Furthermore, depending on such hard-to-measure factors as content change within jobs, this imbalance may be, or could become, substantial and serious.

These changes in skill demand and supply will affect the types of jobs available, how people are rewarded for doing those jobs, and the general economic development prospects of different areas. These trends, therefore, raise a number of issues that should be explored for rural areas.

Not all of those issues can be explored, however, because of limited available data. For example, the issue of content change within jobs is critical to assessing skill demand. Thus, knowing how much content change has taken place within rural, as opposed to urban, jobs would help us understand how skill demand varies between rural and urban areas and consequent implications for job availability and compensation levels. However, this issue is no easier to investigate on the rural-urban level than it is on the national level; adequate data do not exist.

The issue of educational content and actual levels of cognitive skills is also critical to an assessment of skill supply. Therefore, an accurate assessment of how educational content varies between rural and urban areas would help us understand how the supply of cognitive skills available to employers differs between the two areas. National level analyses, at least, are possible here, but data limitations (chiefly relating to confidentiality) still preclude analysis on the rural-urban level.

These data problems mean that the strong, content-driven versions of the new economy/education crisis arguments cannot be tested for rural areas. However, existing data do allow us to explore the implications of the weaker versions of these arguments for rural areas. Because only the weaker versions of the arguments will be tested, findings from these investigations should be viewed as constituting a lower bound for the problems and challenges rural areas will face in years ahead.

The weak versions of the new economy/education crisis arguments focus around compositional (distributional) changes in skill demand and supply. On the demand side, the changing distribution of jobs among different industries and occupations seems to be increasing skill demand. On the supply side, changing distributional patterns of educational attainment seem to be holding back skill supply.

Skill demand and supply deriving from these distributional trends can be estimated somewhat easily using existing data, and these estimations can be done both nationally and at the rural-urban level to see how demand and supply differ between the two types of areas. Such estimations also can be pursued on the level of skill categories rather than overall skill levels. In this way, the relative demand for low-skill and high-skill jobs can be specified.

Estimates on this level can tell us a great deal about the differences in job availability between rural and urban areas. These estimates also allow us to examine the relationship between demand and supply by estimating the income derived from jobs at different skill levels. Together, these estimates can then allow us to assess whether individuals in rural labor markets are being comparatively advantaged or disadvantaged by new economy distributional changes.[21]

Such analyses will help illuminate how new economy/education crisis trends affect the fate of *individuals* in rural areas. The types of jobs available and their relative levels of compensation (both at different skill levels within rural areas and at the same skill level between rural and urban areas) are clearly matters of much concern to these individuals. However, the economic fate of rural *places* cannot be reduced to the well-being of individuals in rural areas (although they are certainly related). Many rural individuals may well prosper while the places they live in (or used to live in) continue to decline.

Thus, another useful analysis would look at how skill demand and supply trends are affecting the development of local economies, not just the individuals within those economies. In particular, such an analysis should look at skill supply and local economies. If skill demand is increasing, one would expect the local supply of skills to be a key factor in local economic development. This idea can be tested by looking at local distributions of educational attainment and their relation (or lack thereof) to job generation in local areas.[22] Such an analysis can be done nationally, and at the rural-urban level, so that any special relationship between skill supply and rural economic development can be understood.

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[21] In another chapter, we have operationalized skill demand by using the 1980 distribution of education by job type as a standard and performing shift-share analyses on this basis. Using actual skill scores from the *DOT* to perform these analyses would have been preferable, but time pressures did not permit this to be done. The series of studies being conducted by Teixeira and Mishel will, however, use the *DOT* scores to look at similar skill demand questions.

[22] An analysis of educational co nt, not just distributions of educational attainment, would be useful, but data limitations pre de that approach.

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