



Is There A Rural-Urban Technology Gap?

Results of the ERS Rural Manufacturing Survey

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Advanced technology use is less prevalent in rural than in urban manufacturing plants, but plants of comparable size in the same industry use about the same level of technology, regardless of urban/rural location. The rural gap comes about because the mix of rural industries is more heavily weighted with "low-technology" industries. Both rural and urban businesses rate inadequate worker skills as the most important barrier to use of new production technologies and management practices, while lack of knowledge is the chief barrier to use of telecommunications technology. Rural and urban businesses have similar access to technical assistance, skilled labor, and capital. Rural manufacturers report more problems with employee turnover and infrastructure than urban plants, but these are reported as minor problems by most businesses.

Many leaders in industry and government view advanced manufacturing technology as a key to global competitiveness. New innovations can help businesses respond to changing markets, cut costs, and improve product quality. What does reliance on advanced technology mean for rural economic development? Are rural businesses keeping up with the revolution in technology and management? Do relatively isolated rural businesses need better access to information, capital, or skilled workers to help them learn about and implement new innovations? The answers to these questions have important implications for the rural economy, since manufacturing businesses form the economic base of many rural communities, accounting for 17 percent of jobs in U.S. nonmetropolitan areas.

Rural Plants Lag in Technology Use

Previous comparisons of advanced technology use in rural and urban areas found mixed results. Two studies (Harrison and others; Little and Triest) found that advanced technology

use tends to be slightly higher in suburban locations than in rural areas and central cities, but a third study (Gale) found no rural-urban difference. Those studies, however, were limited to a narrow range of industries and were based on surveys that had relatively few rural respondents.

In contrast to previous studies, data from ERS' 1996 Rural Manufacturing Survey (see "About the Survey," p. 8) show a clear rural gap in the use of advanced telecommunications and production technologies. Rural plants were less likely than urban plants to use five of six telecommunications technologies and three of five advanced production technologies (table 1). The rural-urban gap was greatest for Internet (10.8 percentage points), modems, local area networks (LAN's), and computer-aided design (CAD) (about 9 percentage points each). A smaller gap of 4 to 6 percentage points existed for computer-assisted machining and inter-company/within-company computer links. There is no rural-urban gap in use of numerically or computer-controlled machines

Why Plants Use New Technologies and Management Practices

Computer-aided design and computer-controlled machines promote flexibility by automating design and fabrication processes and permitting rapid changes in product specifications. Computer networks, the Internet, and satellite communications speed the flow of technical and market information and material requirements. New management techniques, such as Total Quality Management, quality circles, and work teams, promote problem-solving, quality assurance, and flexibility by rotating workers among different tasks, devolving decisionmaking to production line workers, and demanding greater attention to quality.

Rural-Urban Counties

In this report, “urban” plants are located in Metropolitan Statistical Areas defined by the U.S. Office of Management and Budget, and “rural” plants are located outside metro areas. A more detailed measure based on the ERS rural-urban continuum classifies metro and nonmetro counties into five urbanization categories:

Core metro: Central counties of an MSA with population of 1 million or more.

Other metro: All other metro counties.

Urbanized nonmetro: Nonmetro counties where at least 20,000 people live in urban places (cities or towns).

Less urbanized nonmetro: Nonmetro counties where 2,500 to 19,999 live in urban places.

Completely rural nonmetro: Nonmetro counties where fewer than 2,500 people live in urban places.

and programmable controllers, and rural plants lead urban plants in use of satellite communications.

While rural plants seem less likely to use advanced telecommunications and production technologies, they are more likely to use new management practices. Rural respondents were more likely than urban respondents to use job rotation and employee problem-solving groups, while rural and urban respondents were equally likely to use the other three practices (self-directed or self-managed work teams, Total Quality Management (TQM), and statistical process control). This result is surprising, since use of these management methods often involves a change in

workplace culture, and rural workers are reputed to be more resistant to change.

Technology Gaps Exist in the Smallest Towns

The technology gap is mainly in the most rural nonmetro counties (table 2). Advanced technology use in nonmetro counties with a large town or city is equivalent to rates of use in urban areas. Use of advanced production and telecommunications technology is highest in the largest metro areas and decreases as location becomes more rural. Conversely, management practice use is highest in the most rural counties and lowest in medium and smaller metro areas.

Table 1—Use of technologies and management practices by rural manufacturing plants

Technology/management practice	Rural rate of use ¹	Rural gap ²
	Percent	Percentage points
Production technologies:		
Numerically- or computer-controlled machines (CNC)	51.2	-1.9
Programmable controllers	46.7	2.6
Computer-aided design/engineering (CAD/CAE)	44.8	-9.0*
Local area network (LAN)	33.2	-9.2*
CAD linked to computer-aided machining (CAD/CAM)	21.1	-5.5*
Management practices:		
Job rotation	58.8	6.0*
Self-directed or self-managed work teams	49.3	2.0
Employee problem-solving groups or quality circles	49.1	4.3*
Total quality management (TQM)	45.0	1.5
Statistical process control	36.5	-1.5
Telecommunications technologies:		
Fax machines	98.1	-1.4*
Within-company computer links ³	65.8	-4.2*
Modems	64.2	-9.5*
Inter-company computer links	27.4	-4.1*
Internet	24.3	-10.8*
Satellite communications	7.5	2.7*
		<i>Number</i>
Average number of production technologies reported	2.09	-0.24*
Average number of management practices	2.39	0.12*
Average number of telecommunications technologies	2.53	-0.17*

* Denotes statistically significant difference.

¹Rural is defined as nonmetropolitan. ²Difference between rural and urban rates of use. ³Plants in multi-unit firms only. Source: ERS Rural Manufacturing Survey, 1996.

Table 2—The most-rural plants use fewer technologies, but more management practices

Plant location	Production technologies	Management practices	Telecommunications technologies
	<i>Use index¹</i>		
Core metro county	104	102	105
Other metro	101	94	95
Urbanized nonmetro	99	103	98
Less urbanized nonmetro	90	104	94
Completely rural nonmetro	79	109	88
Mean	100	100	100

¹Index = (Average number of technologies/National average) x 100.
Source: ERS Rural Manufacturing Survey, 1996.

Technology Use Varies by Industry

Advanced technologies are more suitable for some industries than others. Accordingly, use of advanced technology varies considerably by industry. In the industrial machinery and equipment industry, use of advanced production technology is about 25 percent higher among rural plants than the overall average, but about 34 percent below average in lumber and wood products (primarily saw mills) and leather products (table 3). Many rural-oriented industries (food and tobacco, textiles, apparel, and lumber and wood products) are among the lowest in use of advanced production technology. For example, food processing, one of the industries with low use of advanced technology, accounts for 19 percent of rural manufacturing shipments, but only 12 percent of urban shipments. Industries with high use of advanced technologies (industrial machinery, instruments, electrical equipment, and primary metals) tend to be urban-oriented, but industrial machinery, for example, is also a large source of rural manufacturing jobs. A similar pattern exists for telecommunications use. Most rural industries report high use of management practices: 91 percent or higher for every rural industry except leather products.

Industry Mix Accounts for Technology Gap

The mix of industries in rural areas is more heavily weighted toward those using fewer advanced technologies. Does the lower rate

of advanced technology use in rural areas reflect a rural barrier to innovations, or does it just reflect a difference in the rural-urban industry mix?

When average technology use by rural-urban category is standardized for industry mix, the technology gap is eliminated for all but the completely rural category (fig. 1). Even in the completely rural category the gap closes to only a few percentage points. A similar calculation eliminates the gap in telecommunications use. This suggests that similar plants in rural and urban areas use similar technology. The lower average usage in rural areas arises largely because the mix of rural industries is more heavily weighted with plants from “low-technology” industries.

Large Plants Use More Technologies

While average technology use varies considerably among industries, it also varies among establishments within industries. For example, 12.5 percent of plants in industrial machinery (the industry with highest average technology use) used none of the advanced production technologies, while 10 percent of plants in lumber and wood products (the industry with lowest production technology use) used 4 or more of the advanced production technologies.

Industry is an important determinant of technology use in a particular plant, but other characteristics are also important. Plant size and branch plant status are two key characteristics associated with advanced technology.

Indexes

Indexes of industry and rural-urban use of production technologies, management practices, and telecommunications technologies were computed by finding the ratio of the average number of technologies reported by plants with a particular characteristic to the average for all plants in the survey. The index equals 100 when technology use for a subgroup of plants equals the national average. Separate indexes are computed for production technology, new management practices, and telecommunications technology.

Adjustment for Industry Mix

Average technology use was computed for 19 two-digit industries in each of the five rural-urban categories shown in table 2. A weighted average of the 19 industry values was calculated for each rural-urban category using the distribution of establishments in the core metro category as weights. This calculation holds constant the mix of industries. As such, it gives a better comparison of within-industry technology use across rural-urban categories.

Plants that are part of a larger firm with numerous locations may have an advantage over single-unit plants in acquiring the information, expertise, and capital needed to adopt new technologies. Technology adoption may be more feasible in larger plants because they can spread fixed costs of acquiring new equipment over more units of output. Adoption of new management practices may require less investment in equipment, but often involves considerable training costs. Communications technology and attention to management organization may also have a greater payoff in larger multi-plant firms.

Use of advanced production and telecommunications technologies was strongly associated with plant size among rural plants (table 4). Small rural plants (fewer than 50 employees) used advanced production technologies at about half the rate reported by the largest rural plants (250 or more employees).

The pattern for telecommunications use was similar, but slightly less dramatic. Use of management practices increases more modestly with plant size.

Branch plants are much more likely than single-unit plants of similar size to use new management practices and telecommunications technologies, but branches and single units are similar in their use of advanced production technologies. The branch and single-unit indexes for telecommunications differ by more than 30 percentage points in each size class. This may reflect the greater need for communication with other branches and headquarters in large multiunit firms. The branch/single-unit gap in management practice use is also more than 30 percent for the smallest plants, but shrinks to 9 percent for the largest plants.

Accounting for plant size does not help explain the rural-urban gap in technology use

Table 3—Indexes of technology and management practice use by industry, rural manufacturing plants

Industry	Production technologies	Management practices	Telecommunications technologies
	<i>Use index¹</i>		
Food and tobacco	78	113	96
Textiles	78	98	102
Apparel	74	91	91
Lumber and wood products	66	92	81
Furniture	90	93	85
Paper	101	125	117
Printing and publishing	103	91	111
Chemicals	98	122	121
Petroleum and coal products	85	91	103
Rubber and miscellaneous plastics	95	120	103
Leather products	65	86	77
Stone, clay, and glass	73	94	82
Primary metals	109	116	103
Fabricated metal products	105	104	92
Machinery and equipment	125	105	93
Electrical equipment	110	124	111
Transportation equipment	101	107	96
Instruments	111	97	100
Miscellaneous manufacturing	78	103	93
Rural average	92	104	95

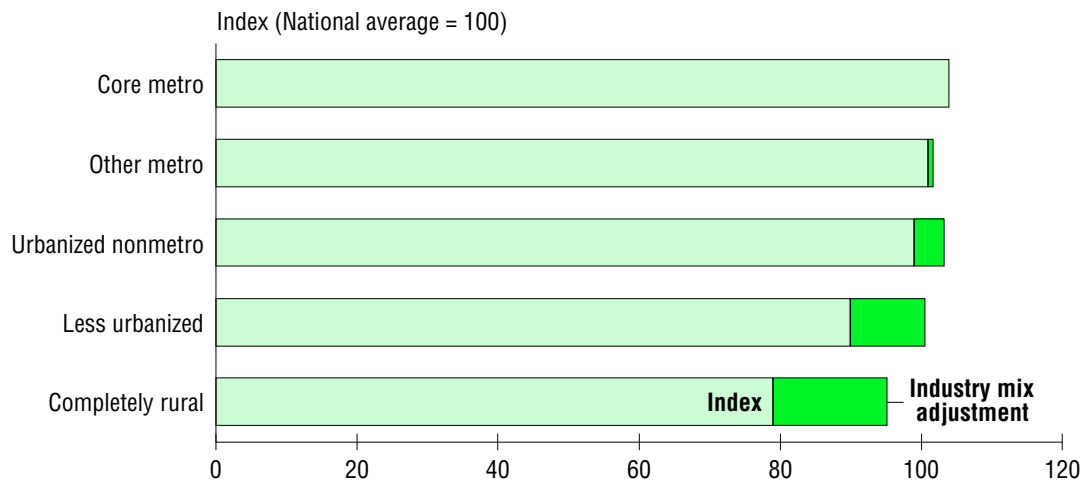
¹Index = (Average number of technologies/National average) x 100.

Note: Highest indices are shown in **bold italic** type.

Source: ERS Rural Manufacturing Survey, 1996.

Figure 1

Industry mix explains most of the rural-urban gap in production technology use



Note: Technology use indexes adjusted for industry mix.
 Source: ERS Rural Manufacturing Survey, 1996.

because rural plants tend to be larger than urban plants. Eleven percent of rural plants have 250 or more employees, compared with 8 percent of urban plants. Rural plants also are more likely to be branch plants than are urban plants. These characteristics tend to boost the rural rate for use of advanced technologies and new management practices.

Inadequate Worker Skills and Knowledge Are Key Barriers

What problems do manufacturing establishments face in adopting new technologies and management practices? Are rural businesses at a disadvantage in technology adoption due to limited access to information, capital, and skilled workers? Respondents to the RMS were asked to evaluate the importance of five potential problems related to implementation of new technologies and management practices and four problems that can limit use of telecommunications. The leading problem was “adequacy of worker skills,” cited by 32 percent of respondents as a major problem (fig. 2). Another labor force factor, employee turnover, was identified as a major problem by 14 percent of respondents. In written comments, many respondents complained that workers were resistant to change. A number of comments also emphasized the problem of high employee turnover due to availabil-

ity of alternative jobs in tight labor markets. A significant number of respondents (18 percent) said that “obtaining sufficient capital” was a major problem, but capital was cited less often than worker skills.

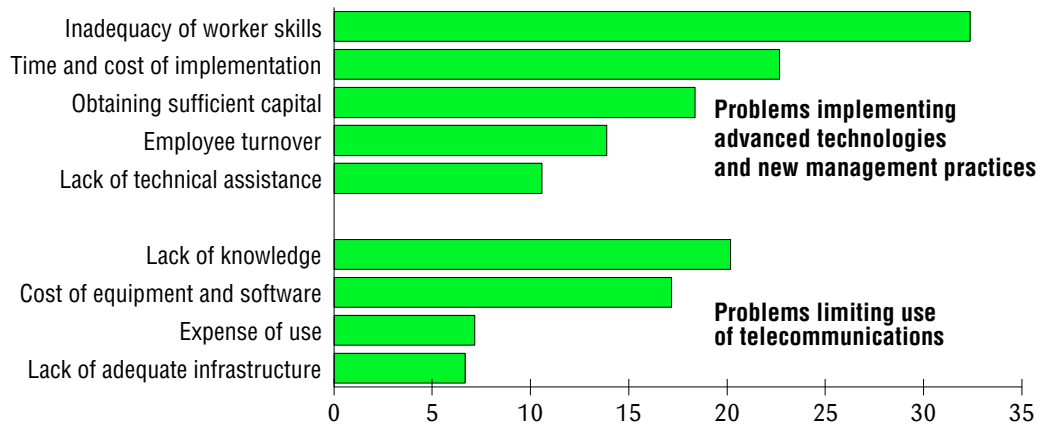
While labor and capital appear to be more important barriers to technology adoption, a significant minority of respondents reported a demand for technical assistance. About 11 percent of respondents rated “availability of adequate technical assistance” as a major problem (the lowest percentage of the five potential problems), while 40 percent of respondents stated that it was a minor problem (fig. 2). These respondents indicate that there is some unsatisfied demand for technical assistance, but labor force and capital are apparently in shorter supply than technical information. Other results from the Rural Manufacturing Survey confirm that rural businesses are less likely to obtain assistance within their local area. Is access to assistance a bigger problem for rural businesses? Apparently not; about 11 percent of both rural and urban plants report technical assistance as a major problem.

Lack of information seems to be a bigger problem in the use of telecommunications technology. Twenty percent of respondents listed lack of knowledge as the most important barrier to telecommunications use. Lack of knowledge is a major problem limiting telecommunications use for both rural and

Figure 2

Problems associated with adoption of new technologies, management practices, and telecommunications, all establishments

Percent of plants



Source: ERS Rural Manufacturing Survey, 1996.

Table 4—Branch plants use more telecommunications technologies and management practices than single unit plants of the same size

Plant employment	Branch plants	Single units	Difference
		<i>Index¹</i>	
Production technologies:			
Under 50 workers	74	74	0
50-249	108	105	3
250 or more	146	147	-1
Management practices:			
Under 50 workers	121	89	32*
50-249	126	102	24*
250 or more	142	133	9*
Telecommunications:			
Under 50 workers	106	70	36*
50-249	121	90	31*
250 or more	142	111	32*

* Statistically significant difference.

¹Index = (Average number of technologies/National average) x 100.

Source: ERS Rural Manufacturing Survey, 1996. Nonmetro plants only. Headquarters plants excluded.

urban plants, so rural businesses do not appear to be at a disadvantage in their access to information about telecommunications.

The availability of adequate infrastructure, a commonly cited problem in rural areas, is the least important problem associated with telecommunications use. Only 7 percent of respondents identified lack of infrastructure as a major problem.

Worker Turnover, Telecommunications Infrastructure Bigger Problems in Rural Areas

Availability of telecommunications infrastructure, while a relatively minor problem limiting telecommunications use, is more important in rural areas than in urban (fig. 3). Only 5 percent of respondents in large urban areas said infrastructure was a major problem, compared with 13 percent in less-urbanized rural areas and 10 percent in completely rural areas. Overall, about a third of rural respondents identified telecommunications infrastructure as a minor problem, but lack of knowledge was the most-often cited barrier to telecommunications use for rural plants.

Rural and urban businesses have similar access to skilled labor and capital; however, employee turnover is clearly a bigger problem in rural areas. About 21 percent of less-urbanized and completely rural respondents said employee turnover was a major problem—more than twice the rate of large urban counties (9 percent)—and about 40 percent said turnover was a minor problem in each location. The greater problems with employee turnover in rural areas are surprising, since the smaller labor markets in rural areas would tend to provide fewer opportunities for job changes. This result may reflect the larger mix of low-wage, low-skill, nonunion jobs in rural manufacturing, where wages often increase slowly with job tenure and workers have less incentive to remain with the same employer.

Rural businesses do not appear to have less access to capital than urban businesses. A smaller percentage of rural (15 percent) than urban (19 percent) respondents identified “obtaining sufficient capital” as a major problem in adopting technology, indicating that urban businesses may have slightly more difficulty than rural businesses in obtaining capital.

Conclusions

A significant rural-urban gap exists in use of advanced production and telecommunications

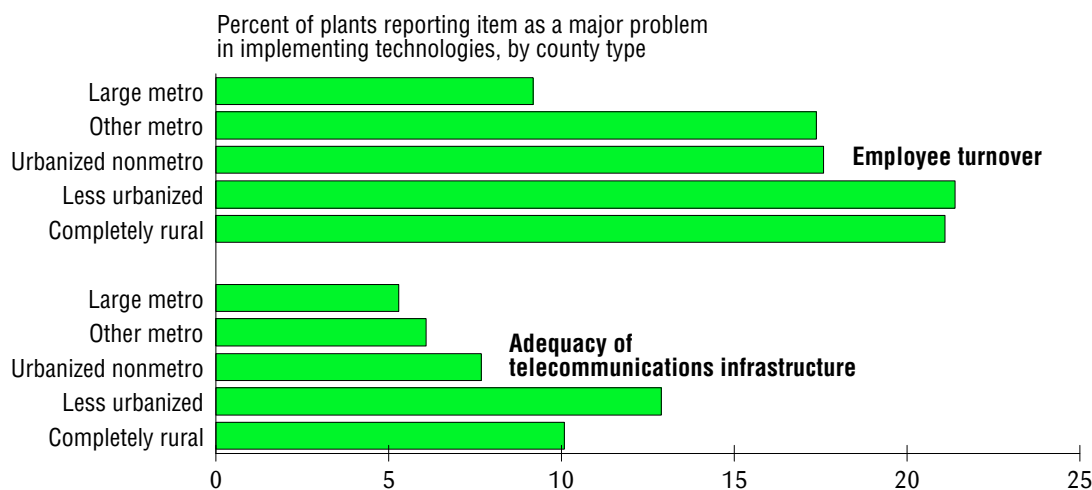
technologies. The gap appears to be a result of industry structure rather than slower adoption rates in rural areas. The lower rate of rural technology use is primarily due to the mix of “low-tech” labor- and raw-materials-intensive industries drawn to rural locations.

Availability of technical assistance is generally cited as a minor barrier to advanced technology use, but lack of knowledge is cited as the chief barrier to telecommunications use. The established channels for delivering technical information, including trade shows, sales and service staff of equipment suppliers, trade publications, and university- and government-based industrial extension, apparently serve rural and urban businesses fairly well. However, there seems to be a significant unsatisfied demand for information on telecommunications technologies among both rural and urban businesses.

Upgrading of telecommunications infrastructure has been a priority for government at local, State, and Federal levels. This does not, however, appear to be a major concern of manufacturing businesses. Telecommunications infrastructure upgrades could still be justified to support businesses in other sectors and bring the benefits of telecommunications to rural households. Better infrastructure may also be part of a strategy to attract more technology-intensive manufacturing plants to rural locations.

Figure 3

Employee turnover and infrastructure are bigger barriers to rural technology use



Source: ERS Rural Manufacturing Survey, 1996.

Both rural and urban manufacturing businesses rate worker skills as the biggest barrier to technology adoption. Training programs may not address the problem. Other research shows that the important skills employees are said to lack (work attitude, receptiveness to change) are not easily imparted by most

training programs. With high employee turnover, employers may be unable to capture the benefits of job-specific training. Addressing these labor force problems while keeping labor costs competitive appears to be the major challenge facing both rural and urban manufacturing businesses in the 1990's.

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About the Survey

The data in this report are from a sample of rural and urban businesses in the 1996 ERS Rural Manufacturing Survey. The survey results are more comprehensive than those in previous studies of rural technology use, allowing researchers to evaluate barriers to technology adoption (as perceived by businesses).

The Rural Manufacturing Survey is a nationwide study of factors affecting competitiveness of rural and urban businesses. Telephone interviews were conducted with 2,844 rural and 1,065 urban establishments, representing all manufacturing industries. The survey asked manufacturers whether or not they used five advanced production technologies, five management practices, and six telecommunications technologies (see table 1 for listing). These technologies and management practices are used by manufacturing businesses to improve worker productivity, product quality, and organizational flexibility.

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