Robert M. Gibbs and G. Andrew Bernat, Jr.

Rural Industry Clusters Raise Local Earnings

*Industry clusters have become a popular strategy for rural econom-
ic development, yet their benefits to the local areas have not been
fully examined. Labor is expected to be more productive within
clusters, which should translate into higher wages. Our analysis
confirms this, showing that workers' earnings in rural industry
clusters are about 13 percent higher than those of comparable
workers outside clusters. The wage boost is similar for workers
regardless of age or education level.*

The poor performance of the rural economy in the
1980's led economic development experts to search
for new ways to stimulate local growth. One
promising avenue for development was to encourage the
location and expansion of business establishments that are
linked by their interdependence as customer and supplier,
or by their use of common local resources. Such spatial
concentrations of activity, or industry clusters, were
expected to raise productivity for all establishments in the
cluster, thus encouraging other firms to locate there, and
raising local income.

The idea that spatial clustering can raise the productivity
of establishments is hardly new, having its antecedents in
economic writings over a century ago. Not surprisingly,
clusters have traditionally been equated with cities, as
cities are by nature relatively large clusters of economic
activity. Yet clusters can also benefit rural economies.
Although prospects for the rural economy as a whole
have improved significantly since the 1980's, competition
for new firms among many local areas remains keen. The
industry cluster appears to be a durable component in the
development specialist's arsenal.

Some of the local area benefits from industry clusters
have been measured, but the potential effect of raising
workers' earnings has gone relatively unexamined. In
this article, we report findings from an analysis of manu-
facturing establishments showing that workers in rural
industry clusters earn about 13 percent more, on average,
than other rural workers with the same education and
experience. The boost from cluster employment appears
to be about the same in rural and urban areas, once indus-
try mix is taken into account. And although one might
think that the best educated and most highly skilled
workers should benefit the most, we find that the wage
premium from cluster employment is about the same
regardless of age or education level. This is good news
for less educated and younger rural workers in a period
of rising wage inequality in the United States.

We will first describe in greater detail what industry clus-
ters are, and why they are a desirable development strate-
gy. Next, we introduce our method for identifying clus-
ters and for measuring their effects on workers' earnings.
Finally, we present the results of our analyses of earnings
in both rural and urban labor markets and discuss the
implications of our findings for the success of rural devel-
opment efforts.

What Is an Industry Cluster?

A variety of definitions for industry clusters has been
used, partly because there are several kinds of clustering

Robert Gibbs is a regional economist in the Food Assistance, Poverty
and Well Being Branch of the Food and Rural Economics Division, ERS.
G. Andrew Bernat, Jr., is chief of the Analysis Branch, Bureau of
Economic Analysis, U.S. Department of Commerce.

and partly because the characteristics associated with clusters are often difficult to measure. We define industry cluster as a group of establishments located within close geographic proximity of one another, which either share a common set of input needs, or rely on each other as supplier or customer.

Clusters may be as simple as a collection of manufacturing plants that locate in an area to take advantage of natural resources, or to be near a large market or labor pool. In these cases, transportation costs or labor costs to these firms will be lower than if they were located elsewhere. But the classic industry cluster implies a more sophisticated relationship among establishments. For example, the production of computer components may require a wide variety of specialized parts. As the specifications and characteristics of its products change, the factory will need a different set of material inputs. The more quickly these newly designed inputs can be acquired, the more quickly new components can be produced and the more competitive the factory will be in national and international markets. A factory that is located near its principal suppliers will be able to obtain redesigned parts more quickly, as engineers from the computer component factory and the input suppliers work closely together on the new designs. A similar, but isolated, factory would have much more difficulty acquiring inputs to meet its changing needs. The increase in the variety and availability of inputs and the reduction in their costs reflect *external economies of scale*. Once a group of establishments begins to rely on one another in this manner, and input costs fall, these clusters attract additional firms, and the process becomes self-sustaining.

Defined in this manner, clusters imply a mix of industries linked together both geographically and functionally. An important subset of clusters, though, is identified primarily as a cluster of similar establishments that draw upon common suppliers. Sometimes called *sectoral* clusters because they consist mostly of one industrial sector, these groups are probably much more common in rural areas than the broader, more complex type of cluster. Several clusters of this type have become well-known in the rural development literature, including the carpet industry in northwest Georgia, furniture manufacturing in the Piedmont region of North Carolina and Tupelo, Mississippi, and manufactured housing in Indiana.

The size of the area within a cluster depends on the type of cluster under consideration. A typical assumption is that suppliers and customers can communicate with each other face-to-face on a regular basis, and that goods can move quickly from one to the other on short notice. Some clusters may cover several counties, as in the North Carolina furniture cluster, while others can be contained wholly within a single town, as was true for many years with the cluster of carpet-making establishments in Dalton, Georgia.

Manufacturing Clusters Are Well-Distributed Across Rural America

In this article, we focus our attention on sectoral clusters among manufacturing establishments. Services may sometimes form clusters in and of themselves, as in the clustering of the insurance industry in Hartford, Connecticut, or banking in New York and San Francisco. Most service industries, however, serve either consumers directly or as input suppliers to goods production. Service clusters are also less common in rural areas and less important to the rural economy.

Our method for identifying clusters for each industry separates counties into four groups: (1) counties without establishments in a given industry, (2) those with non-clustered establishments, (3) peripheral counties of clusters, and (4) central counties in clusters, those with the highest concentration of establishments relative to their neighbors (see "How We Identify Industry Clusters" for more information). Our analysis of industry clusters includes all counties in the last two groups, unless otherwise noted. Using a classification of industries based on two-digit SIC codes (with slight alterations), we found that all of the 18 resulting manufacturing industries have clusters that include nonmetro counties. The heaviest incidence of rural clustering appears in the Northwest (including much of Idaho), the industrial Northeast and Great Lakes regions, and the Southeast. With a few exceptions, clustering is noticeably absent from much of the Great Plains and the Rocky Mountain States, as well as scattered pockets in the East (fig. 1). For mapping purposes, areas without establishments are combined with areas containing nonclustered establishments.

Every industry had at least one cluster center in a nonmetro county, with printing and publishing having exactly one nonmetro center, and lumber and wood products having the most at 183 (table 1). A large proportion of all nonmetro counties are included in at least one cluster. Lumber and wood product clusters include 848 nonmetro counties, for instance, and over 300 nonmetro counties form parts of the stone, clay, and glass clusters.

The importance of industry clusters in the rural economy is also evident by comparing the number of establishments in clusters with the number of counties. In most manufacturing industries (15 of the 18 we studied), at least one-third of establishments are located in clusters, and the average share of an industry's establishments in clusters is 48 percent. Yet, clusters typically comprise just 26 percent of the counties with establishments in that industry. That is, a large proportion of establishments are clustered, but these clusters include a relatively small pro-

The local Moran statistic measures whether the "neighboring" counties of a county with a high value of a particular variable have either high or low values for that variable. Three steps are involved in calculating the local Moran.

First, a spatial weights matrix defining which counties are considered neighbors is constructed. The form of the spatial weights matrix depends on the context. For this study, counties are considered neighbors if their centroids (the geographic centers) are no more than 100 miles apart. This criterion was chosen because it is about as far as most round-trip truck deliveries occur. According to the 1993 Commodity Flow Survey, 41 percent of the value of single-mode truck shipments were to destinations of 99 miles or less.

Second, the values are expressed as deviations from the overall average. For example, if the overall average of the variable of interest is 10, the deviation from the mean for a county with a value of 20 is 10, the deviation from the mean for a county with a value of 5 is -5, and the deviation from the mean for a county with exactly the overall average is 0.

Third, the local Moran statistic is calculated for a given county by multiplying the county's value, expressed as the deviation from the mean, by the average of all neighboring counties, also expressed as a deviation from the mean. If a county and the average of its neighbors are both either above-average values or below-average the local Moran for the county will be positive. In contrast, the local Moran will be negative if the deviation from the mean for the county and for its neighbors have opposite signs. For example, if the county has an above-average value and the average of its neighbors is below-average, the local Moran will be negative.

Fourth, the resulting local Moran statistic is compared to a critical value which indicates the largest (in absolute value) local Moran that would be expected to occur simply by chance. In this study, a county with both an above-average value for the variable and a local Moran that exceeds the critical value is considered to be a central county in a cluster. All neighboring counties, as defined by the spatial weights matrix, are considered to be peripheral parts of the cluster.

portion of counties. This contrast is a mark of the degree of geographic concentration present. Geographic concentration varies by industry, but tends to be unrelated to the degree of technological advance or demand for high-skill labor.

These results challenge the view that clusters of industrial activity are strictly an urban phenomenon. The majority of national cluster employment is located in metro counties, as is true for employment overall. Yet industry clusters and urbanization are clearly not synonymous. Moreover, the range of manufacturing industries with rural clusters, and their wide geographic coverage, suggest that the clusters identified with our method are not merely concentrations around sources of raw material or low-wage labor. If indeed rural clusters behave as urban clusters, dependent upon and sustaining external economies of scale, then we may expect similar economic benefits to flow to the local rural economy.

Why Should Wages Be Higher in Industry Clusters?

As we noted earlier, firms in clusters can lower production costs and obtain access to specialized goods and services. Another way of stating this is that output will be higher for a given dollar amount of input—that is, establishments will be more productive. Higher productivity will encourage additional plants to locate in the cluster, or existing plants to expand, thereby raising employment growth in the area.

Industry clusters may induce other positive changes in the local economy, including changes in the local work-force. As the density of employment and the number of employers rise, the division of labor and job specialization increase as well. Many jobs will require more advanced or specialized knowledge and may become more task-specific. Skill levels, in turn, will increase among the local work force, and more specialized workers become more proficient at their tasks. In addition, workers are more likely to find a job whose requirements match their particular skills and abilities. Average wages in the local labor market should rise both because of higher skill levels and because those skills are being put to better use.

Along with increased specialization, ease of information sharing also contributes to higher productivity in industry clusters. Flows of high-value information among entrepreneurs and workers in close physical proximity make good job-skill matches easier because workers are more aware of employment options. Information sharing, especially among more skilled workers, increases the transfer of new skills and techniques and leads to faster rates of "skill accumulation." At least one recent study suggests that the faster rate of human capital growth in areas of concentrated economic activity is the key factor in explaining higher labor productivity and higher wages in clusters (Glaeser and Maré, 1994).

Industry Clusters Raise Local Earnings

Previous research has measured the effects of economic concentration on raising wage rates and has tested competing hypotheses about why higher wages are observed (Rauch, 1993; Glaeser and Maré, 1994). Without exception, these studies equate cities with such concentration,

Figure 1
Nonmetro manufacturing industry clusters
Nonmetro clusters are less common in the Great Plains and Rocky Mountains

Clusters:

- Cluster center
- Cluster periphery
- Non-cluster
- Metro
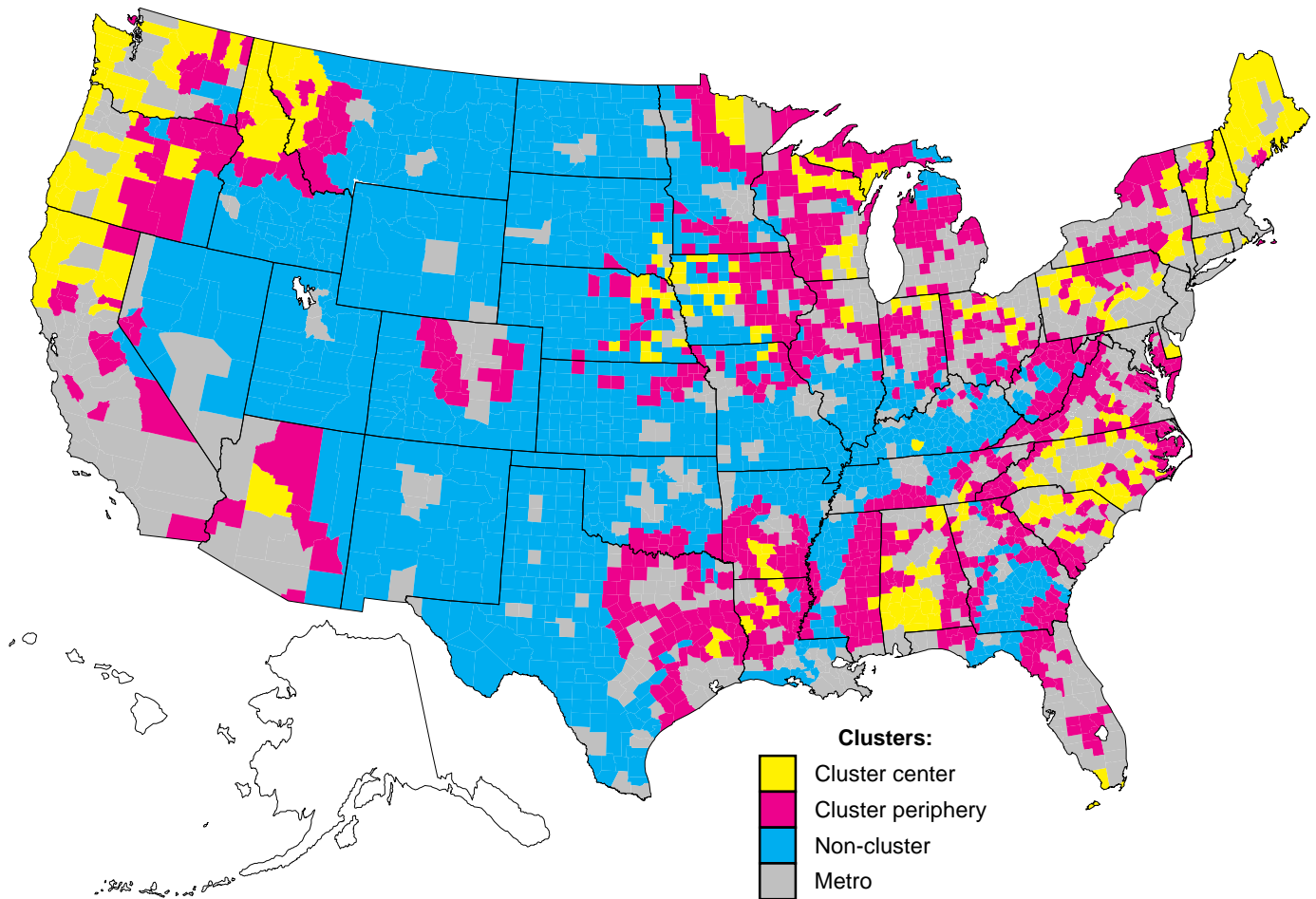
Note: Industry clusters were not identified in Alaska and Hawaii.
Source: Calculated by ERS using data from County Business Patterns.

even though many of the productivity-enhancing characteristics of large urban labor markets are present in smaller labor markets with sectoral clusters.

A critical difficulty in measuring the impact of sectoral cluster employment on earnings is that clusters are often associated with other characteristics of the local area. If we simply compare wages in clusters to wages in non-clusters, then, we may overstate or understate the true effect of sectoral clusters *per se*. For example, a portion of the higher wages observed in cities can be explained by higher costs, particularly land costs, associated with urban living. Since industry clusters are correlated with urbanization, we need to separate the effects of each on wages to correctly measure the effects of sectoral clustering. Establishments are also larger, on average, where they are clustered, and wage rates are higher in large

plants due to higher unionization rates and higher output per worker.

Since we want to measure the impact of cluster employment on individuals' wages, we also want to hold constant those personal characteristics that help determine earnings. Key characteristics include education, experience, occupation, health status, gender, and ethnicity. Finally, wages vary by region, and our analysis accounts for residence by the four major Census regions. (See "About the Data" for the way we constructed these variables in the econometric model.)

Using ordinary least squares regression analysis, we estimated the additional wages received by those employed in an industry cluster compared with workers who were not, holding all other characteristics constant. At the national level, when all 18 manufacturing industries are

Table 1

Selected characteristics of rural industry clusters

All manufacturing industries have at least one cluster centered in a rural county

Industry	Counties in clusters		Clusters as a share of all counties with establishments		Share of establishments in clusters	
	Center	Total	Center	Total	Center	Total
	Number		- - - - - - - - - - - - - -Percent- - - - - - - - - - - - - -			
Food	10	227	0.7	14.9	10.0	38.3
Tobacco	12	13	63.2	68.4	87.8	92.2
Textiles and apparel	46	239	10.8	45.8	66.5	95.1
Lumber and wood	183	848	11.1	51.3	45.9	94.2
Furniture	3	146	4	18.7	5.2	33.0
Paper	6	157	1.2	32.0	11.4	51.1
Printing/publishing	1	207	0	10.1	3.8	27.1
Chemicals	4	149	.5	18.3	6.5	33.1
Petroleum refining	18	113	5.5	34.7	19.5	48.8
Rubber and plastics	10	215	1.1	23.8	12.8	47.7
Leather products	11	51	3.5	16.3	22.6	38.5
Stone, clay, and glass	14	319	.9	20.2	9.7	42.7
Primary metals	13	163	2.3	28.3	15.7	49.1
Fabricated metal	4	208	.3	16.5	8.2	41.6
Machinery and computing equipment	2	213	1	13.1	6.1	35.7
Electronic equipment	2	115	3	15.0	6.9	34.4
Transportation equipment	7	162	8	17.7	11.1	37.8
Professional equipment	2	81	.4	17.1	6.1	31.4

Source: Calculated by ERS using data from County Business Patterns.

considered together, the average cluster-employed worker earns about 7 percent more than other comparable workers, holding other factors constant (fig. 2). Thus, independent of all other characteristics of the worker and his or her job, cluster employment raises worker earnings. The wage premium associated with cluster employment exceeds even that of urbanization.

**Earnings Are Higher in More Rural Labor Markets**

We might expect the wage benefits of cluster employment to differ significantly in rural and urban labor markets for several reasons. Probably the most important reason is that cluster effects in urban markets are a part of the general benefit of working in an urbanized area—more frequent contacts with more highly skilled workers, the possibility of better worker-job matches, and so forth. Thus, once we control for urbanization, the residual effect of working in a cluster may be small for urban residents. However, rural clusters may be smaller on average than their urban counterparts, with fewer of the advantages associated with cluster employment. These competing forces make it difficult to form a firm expectation of urban and rural cluster differences in earnings.

We divided the 395 labor market areas delineated by Tolbert and Sizer into "more urban" areas, those with

Figure 2

Wage premiums in industry cluster employment

The wage premium for workers in clusters is about twice as high in more rural labor markets as in urban markets
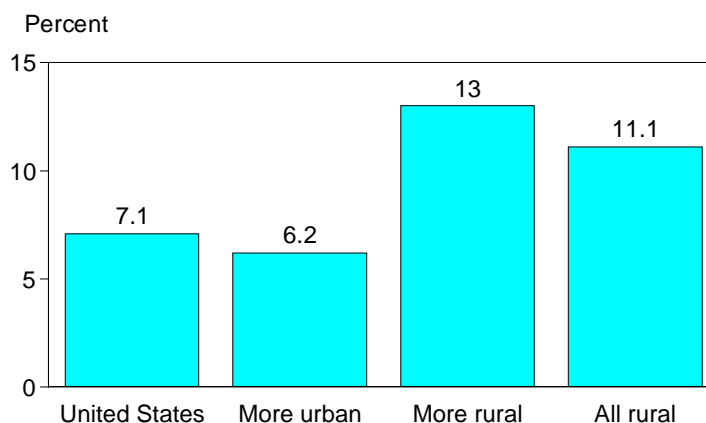
Note: Values shown are the percentages by which cluster-employment wages exceed noncluster-employment wages.

Source: Calculated by ERS using the 1990 Public Use Microsample from the Census of Population.

more than 70 percent of their population in metro counties, and "more rural" areas, those with less than 30 percent of the population in metro counties. The wage effects of industry clusters in the "more rural" group is twice that of the "more urban" group—13 vs. 6 percent higher earnings (fig. 2). The two groups showed other differences as well. Average establishment size, for instance, has a larger influence on more rural wages, indicating that *internal scale economies* are important in these labor market areas. In more urban labor market areas, wages are more strongly affected by the proportion of the population that is officially metro.

We also isolated the relatively small group of labor market areas that had no metro counties within their borders and estimated wage premiums associated with clusters in that group. Cluster wages in the no-metro group are 11 percent higher than wages outside clusters—lower than for the "more rural" areas, but still significantly above both the national and more urban wage premiums.

Wage Premiums Vary Significantly by Industry

So far we have treated industry clusters as a whole, but we should expect the wage gains from cluster employment to vary by industry. Wage premiums should be greater, for example, in industry clusters where close contact among skilled workers is more likely to increase the diffusion of technical knowledge or where the characteristics of the local labor pool are decisive for determining the best plant location. Thirteen of the 18 manufacturing industries we analyzed at the national level exhibited positive wage premiums, ranging from a 4.1-percent wage premium in food processing to almost 12 percent in the stone, clay, and glass industry (table 2). However, contrary to our expectations, the size of the wage premium appears to be unrelated to production technology levels or average skill requirements.

Although rural cluster wage premiums as a whole are larger than urban wage premiums, few rural industries *individually* exhibit positive wage effects. That is, combining all rural industries into a single analysis masks the fact that cluster wages are no higher than noncluster wages in most rural industries. This can be explained in part by the fact that just six industries account for most of the rural cluster employment in our data, but also by differences in the industrial composition of rural and urban clusters. Three rural industries—food processing, textiles and apparel, and lumber and wood products—showed sizable gains to employment in clusters.

The Size of Cluster Premiums Depends on Age, but not Education

As we noted earlier, economic concentration is usually thought to be most advantageous to the best educated and most highly skilled workers. Yet our analysis fails to find much evidence of an educational advantage. Economic concentration should also benefit workers most when their knowledge and skills are accumulating the fastest, typically in their 20's and 30's. Here, the evidence supports that contention, with younger workers gaining the most from cluster employment.

Education and age are powerful predictors of earnings. For example, college graduates earn over twice as much, on average, as do high school dropouts, all other attributes held constant. Older workers also bring home larger paychecks than young labor force entrants. The effect of industry cluster employment on wage inequality, however, is uncertain. Cluster employment is believed to increase wage disparities between the most and least educated workers, but may actually mitigate the gap between younger and older workers.

As before, we calculated the wage premium for employment in industry clusters. This time, a separate premium is calculated for each education and age group in each type of labor market area. At every education level, workers earn significantly more money in clusters, both in

Table 2
Industry cluster wage premiums by industry
Wage premiums for cluster employment vary significantly by industry; few industries show large premiums in rural clusters

Industry	National premium	Rural premium
	Percent	
Food	4.1*	9.3*
Tobacco	-10.6	—
Textiles and apparel	8.2*	8.8*
Lumber and wood	4.3*	7.4*
Furniture	7.7*	—
Printing and publishing	6.3*	—
Chemicals	6.0*	—
Petroleum refining	-6.9*	-19.5
Rubber and plastics	1.4	—
Leather products	1.5	-6.0
Stone, clay, and glass	11.9*	11.5
Primary metals	5.9*	—
Fabricated metal	6.5*	—
Machinery and computing equipment	6.7*	—
Electronic equipment	5.3*	—
Transportation equipment	4.3*	—
Professional equipment	8.7*	—

  Notes: Premiums are expressed as the percent by which earnings in clusters exceed earnings outside of clusters, all other worker attributes held constant. Asterisk indicates that the premium is different from zero at the 10-percent level of significance. Dash indicates that sample sizes are too small for estimation.
  Source: Calculated by ERS using data from 1990 Census Public Use Microsample files.

more rural and more urban labor market areas (fig. 2). Yet in more rural areas, *relative premiums* (the percent by which cluster wages exceed noncluster wages) are similar for three of four education categories. Most importantly, high school dropouts and graduates seem to gain about as much from cluster employment, as a proportion of earnings, as do workers with college or advanced degrees, indicating that industry clusters do not give an advantage to the most highly educated. In more urban labor market areas, cluster-related gains are smaller than in more rural areas (except for those with some college experience) but similar for all four education groups. The smaller urban premiums for education groups are consistent with the smaller overall cluster-employment boost in urban areas.

The wage premiums for the three age groups show greater variation. In more rural labor markets, the youngest group, ages 35 and under, experiences the largest relative wage gains from cluster employment (7.7 percent), while the cluster premium for workers 55 and older is slight (1.7 percent). The findings are broadly supportive of the contention that cluster employment especially benefits up-and-coming workers.

The largest relative wage premiums for more urban workers occur in the middle group, 35-54, but otherwise agree with the more rural pattern. The rural-urban difference is understandable, in part, as a result of differences in rural-urban job structures. Even within industry clusters, rural job opportunities are unlikely to carry workers as far up their career ladders as is possible in urban areas. Hence, rapid skill and knowledge accumulation continues for a longer period of time in more-urban labor markets, and may even intensify.

The reader should be cautioned, of course, that ours is not a direct measure of individuals' increase in earnings over time, but rather a comparison of workers at different ages. Our data do not allow us to distinguish the direct effect of aging on wages from the effect of entering the labor force during a particular historical period, which also influences workers' long-term earnings. Nevertheless these results suggest that wage inequality between groups, based either on education or age, is not exacerbated by cluster employment. These findings should be welcomed by rural development specialists concerned about the effects of economic development on the local social fabric.

There Is Much More to Be Learned about the Benefits of Industry Clusters

This study has shown that industry clusters, far from being an exclusively urban phenomenon, exist across the rural United States, and are associated with higher wages after accounting for worker characteristics and industry composition. The results provide support for a cluster-based development strategy that will not only support

jobs but jobs that tend to pay higher wages than in the absence of a cluster. However, the benefits of higher wages are conditional on the success of the community in attracting and sustaining an industry cluster. As Barkley and Henry (1997) point out, a cluster-based industrial strategy "is not the industrial development solution for all rural communities."

Indeed, even where a cluster-based strategy is appropriate, higher wages may not necessarily follow. As we have shown, only a few rural industries actually exhibit higher wages in clusters. Moreover, research has only just begun to examine the factors that lead to successful labor market outcomes where clusters are present. The key determinants of a cluster's success in generating higher earnings may have less to do with the industry than with the specific production technology used, or with its ability to attract a strong research and development component as well as production. The research community doesn't know enough at this point to answer these kinds of questions with precision. The early returns, however, are promising enough to encourage much closer scrutiny of this emerging issue.

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About the Data

Most of the data used in the multiple regression analyses were drawn from the Public Use Microsample, Labor Market Area file, of the 1990 Census of Population. Below is a list of the variables included in the model, along with a description of their construction.

Variable	Categories or Definition
Age	(Continuous)
Age squared	(Continuous)
Gender	Female, Male
Race	Asian/Pacific Islander, Black, White
Spanish origin	Hispanic, non-Hispanic
Education	High school dropout, high school graduate, some college, college graduate, graduate or professional degree
Occupation	Managers; professionals; technical, clerical, and sales; craft workers; operators and transportation operators; service workers; farmers and laborers
Disability status	Disability limits work, no limits due to disability
Weekly hours	Usual weekly hours worked in 1989
Cluster employment	No/Yes (see box on method for identifying industry clusters)
Population of labor market area (LMA)	(Continuous)
Metro status	Percent of LMA population in metro counties
Average establishment size in industry/LMA	(Continuous)
Census region	Northeast, Midwest, South, West
Usual weekly earnings in 1989	(Continuous)

A Word About Labor Market Areas

Labor market areas are derived from commuting zones, which are collections of one or more counties exhibiting relatively large intercounty commuting flows. The zones are mutually exclusive and include all U.S. counties. Commuting zones were first constructed in 1986 by Charles Tolbert and Molly Sizer using journey-to-work data from the 1980 Census of Population. Tolbert and Sizer replicated their method, based on cluster analysis, with 1990 data. In cooperation with the Census Bureau, they linked commuting zone geography with a 0.45 percent Public Use Microsample known as PUMS-L. Because the Census Bureau prohibits geographic identifiers with fewer than 100,000 persons, some commuting zones were combined and the new geography named labor market areas. For more information, please see Tolbert and Sizer, 1996.