Manufacturing Earnings in BEA Component Economic Areas, 1996

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ECONOMISTS HAVE long been interested in why there is so much geographical variation in wages and salaries in the United States. This article takes a new look at this question by analyzing manufacturing earnings per job among BEA component economic areas (CEA's) in 1996, the most recent year for which data are available from BEA's regional accounts.[1]

The key findings of this analysis follow:

- High-earnings CEA's—the one-fifth of CEA's with the highest average manufacturing earnings per job—have a greater proportion of manufacturing jobs than do low-earnings CEA's—the one-fifth of CEA's with the lowest average manufacturing earnings per job. High-earnings CEA's also have a higher proportion of their manufacturing jobs in industry clusters, allowing establishments in these CEA's to take advantage of benefits associated with clustering, such as economies in transportation and access to common input suppliers. These CEA's also have large, well-educated, and diverse populations from which to draw their workers.
- Results from regression analysis show that industry mix is the most important factor associated with average manufacturing earnings per job in CEA's. The results suggest that high-wage industries tend to locate in regions with clusters of similar industries and with a large, well-educated workforce. The association between average manufacturing earnings per job and the mix of regional amenities in CEA's is weaker, though significant.[2]

The remainder of this introduction discusses why manufacturing was chosen as the focus of the article and why CEA's are used in the analysis. The second section discusses the geographic variation of manufacturing earnings per job and the factors associated with manufacturing earnings per job. The third section discusses the regression analysis. The three appendixes at the end of the article provide supplementary technical information.

The article focuses on manufacturing because manufacturing continues to play an important role in the economy in many areas, despite a long-run decline in manufacturing's share of the Nation's earnings and jobs. As measured by share of total earnings for 1996, manufacturing was the largest of the 11 industry groups in 105 of the 348 CEA's and the second largest in another 87 CEA's, and it accounted for at least 25 percent of total earnings in 94 CEA's.[3] Manufacturing's importance to regional economies goes beyond its share of earnings because it is part of the economic base in many regions.[4] As part of the economic base, manufacturing industries support a substantial number of jobs in nonmanufacturing industries through local spending by manufacturing workers and through local purchases by manufacturing establishments.

Also as part of the economic base, manufacturing may play a unique role in the process of regional economic growth. Other industries—such as farming, mining, and producer services—are often part of the economic base of a region,

1. CEA's are the counties or groups of counties that make up BEA's economic areas. The CEA's were defined during the 1995 redefinition of the BEA economic areas. The redefinition procedure consisted of three major elements. The first was the identification of "economic nodes," which are the metropolitan areas or similar areas that serve as centers of economic activity. The second was the assignment of counties to CEA's, where a CEA consists of a single economic node and the surrounding counties that are economically related to the node; the primary criterion for determining whether counties were economically related to a node was the level of commuting between counties. The third was the aggregation of the CEA's to the economic areas. For more information, see Kenneth Johnson, "Redefinition of the BEA Economic Areas," SURVEY OF CURRENT BUSINESS 75 (February 1995): 75–81.

2. A regional amenity is a characteristic of a region or location that people value but that is neither bought nor sold—for example, a pleasant climate.

3. The other 10 industry groups are farming; agricultural services, forestry, fishing, and other; mining; construction; transportation and public utilities; finance, insurance, and real estate; wholesale trade; retail trade; services; and government and government enterprises.

4. The economic base of a region consists of the industries that export their products outside the region. See Charles M. Tiebout, *The Community Economic Base Study* (New York: Committee for Economic Development, 1962) and Gordon F. Mulligan, "Multiplier Effects and Structural Change: Applying Economic Base Analysis to Small Economies," *Review of Urban and Regional Development Studies* 6 (1994): 3–21.

but manufacturing is viewed by some regional economists as having the greatest potential to lead a region's growth because many manufacturing industries have extensive interindustry linkages, exhibit increasing returns to scale, and have the ability to innovate.[5]

Because of the importance of manufacturing as an employer of local workers, as part of the economic base, and as a potential source of economic growth, manufacturing is often the focus of local economic development efforts. For this reason, identifying the factors most closely associated with regional manufacturing earnings per job is relevant to the formulation of local and regional economic development policies. However, policy prescription is beyond the scope of this article, which attempts only to provide a broad overview of some of the key factors associated with the geographic variation in manufacturing earnings per job.

Manufacturing earnings is the most widely used measure of the income generated from participation in current manufacturing production within CEA's.[6] Because manufacturing earnings per job is correlated relatively strongly with per capita income (the correlation coefficient between manufacturing earnings per job in CEA's and per capita income is 0.60 for 1996), a better understanding of its variation among CEA's may help explain why per capita income varies among regions, a question of longstanding interest in economics.[7]

CEA's are used in this analysis because they are large enough to encompass most of the economic activity in a local area yet small enough to permit the measurement of relatively local phenomena that may be important in determining the level of earnings. Counties are inappropriate for this analysis because a significant number of workers commute across county boundaries. As a result of commuting, the correspondence between per capita income and manufacturing earnings per job at the county level is relatively low because per capita income is measured on a place-of-residence basis, but manufacturing earnings per job is measured on a place-of-work basis. In contrast, CEA's are defined in such a way that relatively few workers commute across CEA borders, so the correspondence between per capita income and manufacturing earnings per job is relatively high.

States and BEA economic areas are inappropriate for this analysis because they often include more than one center or node of economic activity. Recent research indicates that industry clusters—groups of establishments in the same industry or in related industries located in close proximity to each other—play an important role in local economic growth and in determining the level of average wages. Using either of the large geographic units would increase the difficulty of measuring the association between industry clusters and manufacturing earnings per job.

Factors associated with the geographic variation in manufacturing earnings per job

One of the most striking aspects of the U.S. economy is the wide and persistent variation in wages and earnings per job among regions, the subject of many studies over the years.[8] Wages and earnings per job vary substantially among regions for most major industry groupings, but for manufacturing, the variation is particularly large. As shown in chart 1, high-earnings and low-earnings CEA's are found in every BEA region. In 1996, average manufacturing earnings per job for high-earnings CEA's was $51,600, 43.7 percent higher than the average for the middle-quintile CEA's, while the average for low-earnings CEA's was $27,100, 24.5 percent lower than the middle-quintile average (table 1).

In theory, such a large range between high- and low-earnings CEA's would not exist, because if either capital or labor is mobile among regions, the mobile factor(s) will move from regions with low returns to regions with high returns and thereby reduce the differences in earnings per job.[9] While there is by no means a consensus on all the factors that contribute to regional variation in earnings per job, most recent studies have identified three

5. R.I.D. Harris, "The Role of Manufacturing in Regional Growth," *Regional Studies* 21 (1987): 301–312. For similar arguments in a national context, see Stephen S. Cohen and John Zysman, *Manufacturing Matters: The Myth of the Post-Industrial Economy* (New York: Basic Books, 1987).

6. Manufacturing earnings is the sum of three components of personal income—wage and salary disbursements, other labor income, and proprietors' income. Each of these components is measured before the deduction of personal contributions for social insurance, which is excluded from personal income. For more information, see U.S. Department of Commerce, Bureau of Economic Analysis, *State Personal Income, 1929–93* (Washington, DC: U.S. Government Printing Office, June 1995): M–53; and Bureau of Economic Analysis, *State Personal Income, 1958–96* [CD-ROM] (Washington, DC: September 1998).

7. See, for example, Daniel H. Garnick and Howard L. Friedenberg, "Accounting for Regional Differences in Per Capita Personal Income Growth, 1929–79," SURVEY 62 (September 1982): 24–34 and Daniel H. Garnick, "Accounting for Regional Differences in Per Capita Personal Income Growth: An Update and Extension," SURVEY 70 (January 1990): 29–40.

8. While this study examines earnings per job, most other studies examined hourly wages. See, for example, Edward Montgomery, "Evidence on Metropolitan Wage Differences Across Industries and Over Time," *Journal of Urban Economics* 31 (1992): 69–83 and Stephen C. Farber and Robert J. Newman, "Accounting for South/Non-South Real Wage Differentials and for Changes in Those Differentials Over Time," *The Review of Economics and Statistics* 69 (May 1987): 215–223.

9. Farber and Newman, "Accounting for South/Non-South Real Wage Differentials and for Changes in Those Differentials Over Time," 216.

broad groups of factors: Worker characteristics, regional amenities, and various demand factors.

Over all but relatively short periods of time, the variation in regional manufacturing earnings per job is the result of a complex growth process that involves the interactions among these factors and among a host of other factors, such as technological change, economic policy, and historical circumstances. Thus, many of these factors can be said to contribute to average manufacturing earnings per job at a point in time, but over longer periods of time they will be affected by the level of average manufacturing earnings per job and by each other. Analysis of this process is beyond the scope of this article.

Worker characteristics.—Previous studies found that the most important factors are characteristics of individual workers, such as education, experience, gender, race, health, and occupation.[10] Some of these characteristics—particularly education—relate directly to a worker's productivity.[11] Occupation, experience, and health also have clear relationships to an individual's productivity and, therefore, to wages and earnings. Other characteristics, such as gender and race, have no direct relationship to an individual's productivity but have nevertheless been shown to be systematically related to an individual's wages and earnings.

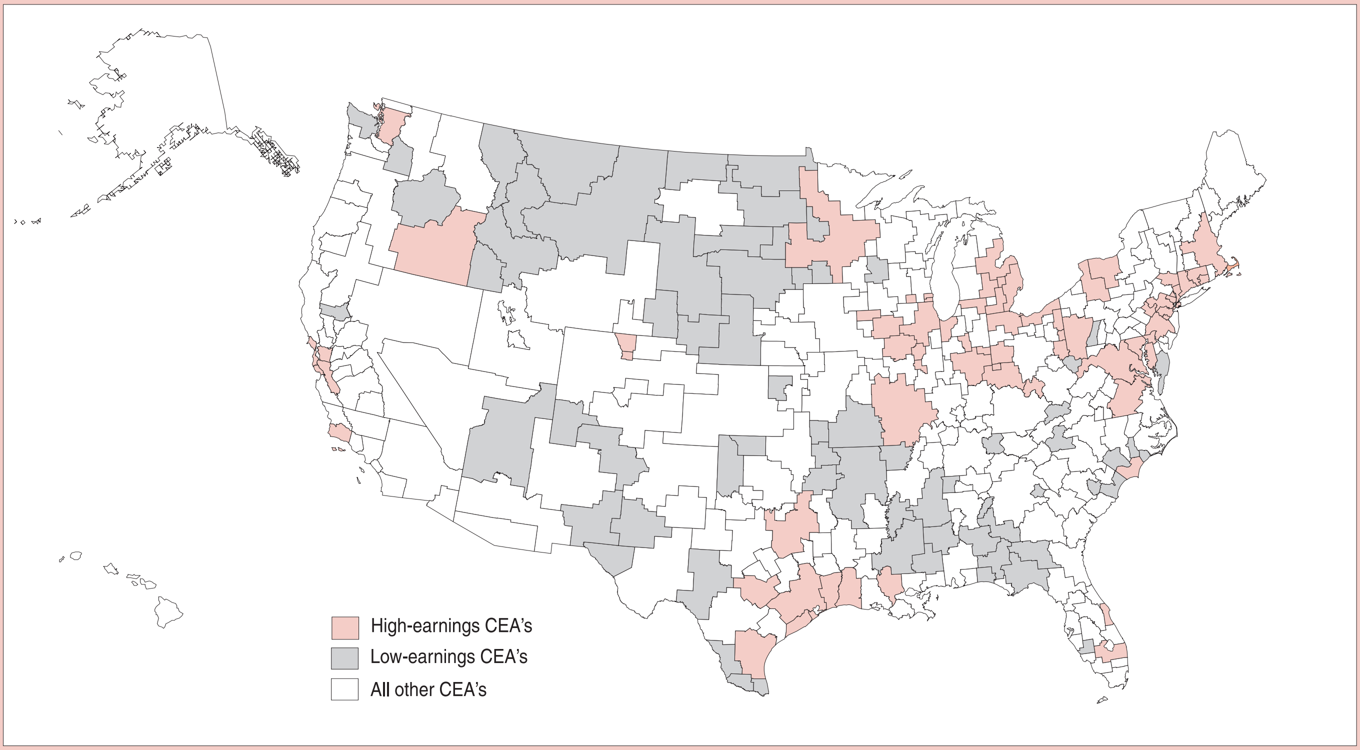
Regional amenities.—The second group of factors is regional amenities. While many of the earliest studies of regional wage variation focused primarily on worker characteristics, most of the recent research follows a hedonic approach, first used by Sherwin Rosen, in which regional

10. See, for example, Patricia Beeson, "Amenities and Regional Differences in Returns to Worker Characteristics," *Journal of Urban Economics* 30 (1991): 224–241; Jennifer Roback, "Wages, Rents, and Amenities: Differences Among Workers and Regions," *Economic Enquiry* 26 (January 1988): 23–41; Glenn C. Blomquist, John P. Hoehn, and Mark C. Berger, "New Estimates of Quality of Life in Urban Areas,"*American Economic Review* 78 (1988): 89–107; John P. Hoehn, Mark C. Berger, and Glenn C. Blomquist, "A Hedonic Model of Interregional Wages, Rents, and Amenity Values," *Journal of Regional Science* 27 (1987): 605–620; and Richard Voith, "Capitalization of Local and Regional Attributes into Wages and Rents: Differences Across Residential, Commercial, and Mixed-Use Communities," *Journal of Regional Science* 31 (1991): 127–145.

11. There is some disagreement over whether the strong relationship between education and earnings is due to education providing skills that increase the productivity of an individual or whether the educational level is a screening device for identifying more capable individuals.

CHART 1

Manufacturing Earnings Per Job, 1996



U.S. Department of Commerce, Bureau of Economic Analysis amenities play an important explanatory role.[12] Climate is perhaps the most obvious example of a regional amenity; other examples include proximity to beaches and mountains or proximity to cultural and entertainment facilities, such as museums, theaters, and shopping districts.[13]

According to Rosen's hedonic model, workers choose a location for their residence based on their preferences for the bundle of characteristics associated with each location. A worker who places a relatively high value on a particular amenity will favor locations with a high value of the amenity, even if wages are lower than at other locations. For example, a location with a warm climate will attract workers with a strong preference for warm weather. If enough workers are attracted to the location because of its warm climate, labor supply will rise relative to colder but otherwise similar locations, resulting in lower wages than at the colder locations.[14] In the case of a disamenity—for example, a high crime rate or air pollution—wages will tend to be higher in locations with high disamenities than in other locations because employers will have to offer relatively high wages to compensate workers for the presence of the disamenities.

Regional amenities contribute to regional variation in earnings per job because amenities are distributed unevenly across the country and are valued unequally by workers. Workers with a given set of characteristics who value a particular amenity will accept lower earnings per job to work in an area with high levels of that amenity, while workers who do not value the amenity will tend to work for higher earnings per job in locations with lower values of the amenity. Consequently, earnings per job are expected to be lower in high-amenity areas than in low-amenity areas, all other factors being equal.[15]

Demand factors.—The third group of factors is included to account for regional differences in the demand for workers that have different characteristics. One of the most important demand factors is the mix of industries in the region. Because earnings per job differ substantially among industries, regions with a high proportion of jobs in high-wage industries will have higher overall

12. Sherwin Rosen, "Wage-Based Indexes of Urban Quality of Life," in *Current Issues in Urban Economics*, ed. P. Meiszkowski and M. Strazheim (Baltimore, MD: Johns Hopkins University Press, 1979): 74–104.

13. Economists distinguish between pure amenities, such as natural characteristics of a location that do not change, and produced amenities, such as good schools, which may change. See Joseph Gyourko and Joseph Tracy, "The Importance of Local Fiscal Conditions in Analyzing Local Labor Markets," *Journal of Political Economy* 91 (1988): 1208–1231.

14. High-amenity locations may also tend to have higher land rents than low-amenity locations because the additional population attracted to a location by the amenity leads to a bidding up of land rents. There is some evidence that ignoring the effect of amenities on land rents may bias estimates of the value of the amenities downward; see Philip E. Graves and Donald M. Waldman, "Multimarket Amenity Compensation and the Behavior of the Elderly," *American Economic Review* 81 (1991): 1374–1381. However, this bias may only be important for smaller geographic areas such as cities and counties; for example, see J. Vernon Henderson, "Evaluating Consumer Amenities and Interregional Welfare Differences," *Journal of Urban Economics* 11 (1982): 32–59.

15. The regional difference in wages for workers of similar characteristics is often used as a measure of the value of amenities.

Table 1.—Characteristics of CEA's

	Units	Quintiles				
		1 (High-earnings CEA's)	2	3	4	5 (Low-earnings CEA's)
Manufacturing earnings per job	**Thousands of dollars**	**51.6**	**40.8**	**35.9**	**32.2**	**27.1**
Worker characteristics:						
Percentage of workforce with college degree	Percent	21.0	17.9	16.7	16.6	15.1
Percentage of workforce that did not finish high school	Percent	22.7	24.6	26.1	27.1	29.7
Percentage of population that is nonwhite	Percent	16.2	15.8	13.6	14.4	16.8
Percentage of the labor force that is female	Percent	45.5	45.4	45.6	45.5	45.7
Regional amenities:						
Cooling degree days	Hundreds	49.2	44.6	43.9	43.7	46.5
Average January temperature	Degrees	31.4	33.1	34.2	34.3	32.7
Average July temperature	Degrees	73.8	74.8	74.7	75.6	75.8
Average precipitation	Inches	37.9	35.7	38.0	37.4	34.7
Average elevation	Feet	741.0	932.8	1,239.4	1,065.4	1,656.5
Average commuting time	Minutes	21.1	19.6	19.0	18.0	16.8
Crime rate	Rate × 100	6.0	5.0	5.0	5.0	4.0
Demand factors:						
Industry-mix wages and salaries	Thousands of dollars	38.5	36.2	35.6	34.6	33.6
Manufacturing share of total jobs	Percent	25.0	22.0	19.0	16.0	15.0
Unemployment rate	Rate × 100	5.3	5.6	5.9	6.1	6.3
Population	Thousands	1,414.7	1,006.1	636.3	463.0	289.6
Population density	People per square mile	550.5	445.0	138.3	112.3	56.1
Percentage of manufacturing jobs in clusters	Percent	48.9	35.7	21.2	14.5	6.2

earnings per job than will regions with a large proportion of jobs in low-earnings industries. Previous studies used highly aggregated industry groups to account for industry mix and found a significant relationship between an individual's wages and the industry in which the individual worked.[16]

A second demand factor is the unemployment rate. It is often assumed that a high unemployment rate in a region indicates that labor supply exceeds labor demand, implying a negative relationship between earnings per job and the unemployment rate. At any given time, however, the relationship between earnings per job and the unemployment rate may be positive because labor markets adjust slowly.[17] One reason regional labor markets adjust slowly is that it takes time for workers to find new jobs or to move to another region. In addition, a region will have high average wages and a high unemployment rate if recently unemployed workers remain unemployed in the hope that a high-wage job will become available, rather than taking a low-wage job or migrating to another region, as economic theory suggests.[18]

A third demand factor is the relative productivity of the regional labor force. One potential source of productivity differences is the quality of the regional labor force, which reflects the characteristics of the workers. Another source of productivity differences is the agglomeration of economic activity, which is defined as the geographic concentration of a large number of establishments. For example, a city is an agglomeration of establishments in a wide variety of industries. Another type of agglomeration is an industry cluster, which is defined as an agglomeration of establishments in the same or related industries. To the extent that agglomerations raise output per worker, agglomeration will affect the regional variation in earnings per job because of the positive relationship between productivity and earnings.[19]

Regression analysis

This section describes the regression analysis used to measure the association between average manufacturing earnings per job in CEA's and characteristics of CEA's. The analysis largely follows earlier studies, with three major differences. First, only manufacturing is examined, rather than all industries. Second, the dependent variable in the regression is average earnings per job for each CEA rather than hourly wages for workers, as in most previous studies. Earnings per job is a more comprehensive measure of labor compensation than wages per hour because it includes proprietors as well as wage and salary workers. In addition, data on earnings per job are available for all CEA's, whereas data on hourly wages are unavailable for many sub-State regions. The disadvantages of earnings per job are that it does not account for differences in hours worked and that it includes both full-time and part-time jobs.

Third, the unit of analysis for this article is the CEA, whereas the unit of analysis in most previous studies was the individual worker. As a result, all regions of the United States can be included in the analysis. In contrast, most previous studies use data only for metropolitan areas because the survey data that must be used in order to focus on individual workers are available only for metropolitan areas and States. However, use of the CEA's means that it is not possible to match the characteristics of individual workers with their earnings. Consequently, the variables representing individual characteristics do not have as much explanatory power as in previous studies.

The remainder of this section describes the variables used in estimating the regression model.

Worker characteristics.—Four variables representing worker characteristics are used in this analysis. The first two, the proportion of the working-age population (persons 25 years or older) without a high school education and the proportion with a college degree, relate directly to the educational attainment of workers. The other two variables, the percentage of the CEA's population that is nonwhite and the percentage of the CEA's civilian workforce that is female, are included because previous studies of individual workers have shown these two variables to be significantly related to a worker's wages.

Table 1 shows that high-earnings CEA's have a slightly better educated work force than other CEA's.[20] The average proportion of working-age adults without a high school education ranged

16. For example, Beeson, in "Amenities and Regional Differences," used three broad industries (manufacturing, government, and construction) to represent industry mix.

17. For example, see the discussion in Olivier Jean Blanchard and Lawrence F. Katz, "Regional Evolutions," *Brookings Papers on Economic Activity* 1 (1992).

18. This is called wait unemployment; see Blanchard and Katz, "Regional Evolutions," 30.

19. See appendix A for a more detailed discussion of agglomeration and industry clustering.

20. The data are from USA *Counties, 1996* [CD-ROM] (Washington, DC: Bureau of the Census, May 1997).

from 22.7 percent in high-earnings CEA's to 29.7 percent in low-earnings CEA's. The proportion of working-age adults with a college education showed a relatively stronger contrast: 21.0 percent in high-earnings CEA's, compared with 15.1 percent for low-earnings CEA's. The proportion of total population that is nonwhite declines from the top quintile to the middle quintile and then increases from the middle quintile to the bottom quintile. The proportion of the workforce that is female shows little or no systematic variation among the five quintile averages.

Regional amenities.—Because economic theory gives little guidance on which amenity variables should be included in this type of study, many different amenity variables have been used in previous studies. The amenity variables included in this study, representing five pure amenities and two produced amenities, were chosen based on the availability of data for all CEA's and on the results of previous studies. The pure amenities are cooling-degree days, average January temperature, average July temperature, average annual precipitation, and average elevation.[21] Of these variables, only average elevation exhibits a systematic relationship with the average manufacturing earnings by quintile.

The produced-amenity variables are average number of serious crimes per 10,000 population and average commuting time. The quintile with the highest average manufacturing earnings per job had the highest crime rate, and the lowest quintile had the lowest crime rate. The average length of commute declined with quintile, with the highest quintile having the longest average commuting time.

Demand factors.—The six variables representing demand factors are industry mix, manufacturing's share of total jobs, the unemployment rate, population, population density, and the share of manufacturing jobs in industry clusters. The industry-mix variable is constructed in the following way. First, average wages and salaries per job by manufacturing industry at the national level is calculated using data on employment and on wages and salaries for four-digit Standard Industrial Classification (SIC) industries.[22] The earnings-per-job estimates from BEA's regional accounts are not used, because these estimates are available only for two-digit SIC industries.

Second, for each CEA, the number of jobs in each manufacturing industry is multiplied by the national-average rate for wages and salaries per job in that industry. The results are summed to arrive at an estimate of what total manufacturing wages and salaries would have been for the CEA if the national-average rate for each industry were paid. This estimate is divided by total manufacturing jobs in the CEA to arrive at an estimate of average wages and salaries per job at national-average rates (henceforth called the industry-mix wages and salaries per job).

Table 1 shows that high-earnings CEA's have higher average industry-mix wages and salaries than low-earnings CEA's. However, the range in industry-mix wages and salaries between high- and low-earnings CEA's is much narrower than the range in earnings per job, indicating that industry mix does not explain all the regional variation in earnings per job.

Manufacturing's share of total jobs in a CEA is included to account for the industry composition of the overall CEA economy and is similar to the industry-mix variables used in previous studies. Manufacturing industries employed a larger share of the labor force in high-earnings CEA's than in low-earnings CEA's: 25 percent of total jobs in high-earnings CEA's compared with 15 percent in low-earnings CEA's.

The unemployment rate is included to account for imbalances in labor supply and demand. The average unemployment rate increases from a low of 5.3 percent in high-earnings CEA's to a high of 6.3 percent in low-earnings CEA's.

The remaining three variables are intended to measure the effects of agglomeration on manufacturing earnings per job. Following relatively standard practice, population is used to

21. A cooling-degree day is a day in which the average temperature is one degree above the reference temperature of 65 degrees. Cooling degree days are commonly used in studies of regional wage variation as a broad measure of climate throughout the year, while average January and July temperatures are included to account for seasonal extremes. The data for cooling degree days, average annual rainfall, serious crimes per 10,000 people, and average commuting time are from the Bureau of the Census' *USA Counties, 1996*. Average January and July temperatures and average elevation were calculated from historical climate data from the U.S. Historical Climatology Network, National Oceanic and Atmospheric Administration.

22. The data used in constructing the industry-mix variable are based on special internal tabulations of data provided by the Bureau of Labor Statistics (BLS) for BEA's use in constructing its regional accounts. The data are summarized by county and by four-digit SIC industry on form ES–202 by the State employment security agencies (ESA's). Each quarter, the ESA's send these data to BLS, which edits the data and makes the tabulations available to BEA. The summarized data are from quarterly State unemployment insurance (UI) contribution reports, which are filed with an ESA by the employers in the industries that are covered by, and subject to, that State's UI laws. Under most of these laws, wages and salaries include bonuses, tips, and the cash value of meals and lodging provided by the employer—that is, pay-in-kind. Unlike the earnings-per-job data, these data do not cover proprietors. For more information, see Bureau of Economic Analysis, *State Personal Income, 1929–93*, M–8—M–21; and Bureau of Economic Analysis (BEA), *Regional Economic Information System, 1969–96* [CD-ROM] (Washington, DC: BEA, May 1998).

account for urbanization economies.[23] As expected, high-earnings CEA's were more populous than low-earnings CEA's: High-earnings CEA's had an average population of 1,414,700, compared with an average of 289,600 for low-earnings CEA's. In order to account for the wide range in both population and geographic size of CEA's, population per square mile is also included; as expected, high-earnings CEA's had substantially higher average population density than low-earnings CEA's.

Localization economies are represented by the share of CEA manufacturing employment in an industry cluster, where clusters were identified using the local Moran statistic.[24] As table 1 shows, high-earnings CEA's have a substantially higher proportion of manufacturing jobs in clusters than low-earnings CEA's: For high-earnings CEA's, the average is 48.9 percent; for low-earnings CEA's, it is only 6.2 percent.

The final group of variables included in the regression are dummy variables representing the location of each CEA in terms of the eight BEA regions. These variables are included to account for differences unaccounted for by the other variables but that are systematically related to the broad geographic location of each CEA.

CEA characteristics associated with manufacturing earnings per job

Table 2 summarizes the regression results, presenting only the variables that were statistically significant (for more detailed results, see appendix C). The third column shows the value of the estimated coefficient for each explanatory variable. These coefficients indicate the change in average manufacturing earnings per job in a CEA that would be associated with a one-unit change in the row variable, holding all other variables constant. For example, an increase of 1 percentage point in the proportion of the working-age population with at least a college degree is associated with an increase of $192 in average manufacturing earnings per job. Because the dependent variables are measured in different units, the estimated coefficients do not provide a good basis for comparison.

One way to assess the relative effects of the dependent variables is to calculate elasticities from the regression coefficients. An elasticity shows the percent change in one variable that is associated with a 1-percent change in another variable. The elasticities of average manufacturing earnings per job with respect to the explanatory variables, evaluated at the average values of the explanatory variables, are presented in the fourth column. Industry mix has by far the largest elasticity: A 1-percent change in industry-mix wages and salaries is associated with a 2.3-percent change in average manufacturing earnings per job. However, even though the elasticities are in the same units (percent), comparisons may be misleading because some of the explanatory variables have a much larger range (difference between the highest and lowest value) than others. Consequently, a 1-percent change in a variable with a small range represents a much larger proportionate change than does a 1-percent change in a variable with a large range. For example, a 1-percent increase in the industry-mix wages and

23. Many researchers use population and population density in studies of agglomeration economies, though some researchers have criticized their use. For a discussion, see Ronald Moomaw, "Is Population Scale a Worthless Surrogate for Business Agglomeration Economies?" *Regional Science and Urban Economics* 13 (1983): 525–545.

24. See appendix B for a discussion of the process of identifying clusters using the local Moran statistic.

Table 2.—Summary of Regression Results

Explanatory variables	Units	Coefficient	Elasticity	Beta coefficient
		Dollars	Percent	Dollars
Worker characteristics:				
Percentage of workforce with college degree	Percent	192	0.089	1,030
Percentage of workforce that did not finish high school	Percent	–148	–.103	–1,050
Percentage of population that is nonwhite	Percent	100	.041	1,170
Regional amenities:				
Average January temperature	Degrees	–120	–.106	–1,540
Average elevation	Hundreds of feet	–100	–.029	–1,340
Crime rate	Rate × 100	329	.044	710
Demand factors:				
Industry-mix wages and salaries	Thousands of dollars	2,452	2.333	5,380
Manufacturing share of total jobs	Percent	273	.141	2,680
Population	Thousands	917	.317	890
Population density	People per square mile	1	.005	570
Percentage of manufacturing jobs in clusters	Percent	24	.016	760

salaries for a CEA with the all-CEA average is equal to 2.7 percent of its total range while a 1-percent change in the proportion of manufacturing jobs in clusters for a CEA with the all-CEA average is equal to only 0.3 percent of this variable's total range.

To account for these very different variances, "beta coefficients" were calculated. Beta coefficients indicate the effect that a change of 1 standard deviation in an explanatory variable has on the dependent variable, in this case manufacturing earnings per job.[25] The beta coefficients are presented in the fifth column, in dollars of manufacturing earnings per job.

Worker characteristics.—Both education variables were statistically significant and had the expected signs. The coefficient of 0.192 on the percent of the working-age population with a college degree indicates that an increase of 1 percentage point in this proportion is associated with a $192 increase in average manufacturing earnings per job, while a 1-percent increase in the percent of the work-age population that did not complete high school is associated with a $148 decrease in average manufacturing earnings per job. However, the positive association between manufacturing earnings per job and the percent of the labor force that is nonwhite is the opposite of what other studies have found.

The beta coefficients indicate relatively larger effects than the estimated coefficients. For instance, a 1-standard-deviation increase in the college proportion would be associated with a $1,030 increase in average manufacturing earnings per job, compared with a $1,050 decrease for a 1-standard-deviation increase in the proportion of the working-age population without a high school education.

Regional amenities.—The results on regional amenities, consistent with previous studies, indicates that warmer climates are associated with lower earnings per job. Average January temperature and average elevation are the two pure amenities that were statistically significant. A higher average January temperature is associated with lower average manufacturing earnings per job ($120 lower for a 1-degree increase and $1,540 for a 1-standard-deviation increase). A 100-foot increase in average elevation is associated with a $100 decrease in manufacturing earnings per job, while a 1-standard-deviation increase is associated with a $1,340 decrease.

As expected, higher crime rates are associated with higher earnings per job. A 1-percentage-point increase in the crime rate is associated with a $329 increase in average manufacturing earnings per job, and a 1-standard-deviation increase in the crime rate is associated with a $710 increase.

Demand factors.—The results of this study, unlike those of studies of individual workers, indicate that industry mix is the factor most strongly associated with average manufacturing earnings per job. The regression coefficient on the industry-mix variable indicates that a $1,000 increase in industry-mix wages and salaries would be associated with a $2,452 increase in manufacturing earnings per job. The associated elasticity is 2.3, and the beta coefficient indicates that a 1-standard-deviation increase in industry-mix wages and salaries would be associated with a $5,380 increase in manufacturing earnings per job.

The regression coefficients for all the other demand factors except the unemployment rate were also statistically significant. The population variables indicate that larger, more densely populated CEA's have higher earnings per job, even after accounting for other factors. Manufacturing earnings per job are also higher in CEA's in which manufacturing accounts for a large share of total jobs. A 1-percentage-point increase in the share of manufacturing jobs is associated with a $273 increase in manufacturing earnings per job, while a 1-standard-deviation increase is associated with a $2,680 increase in earnings per job. Industry clusters are also associated with higher average earnings per job; a 1-percentage-point increase in the share is associated with a $24 increase in earnings per job, while a 1-standard-deviation increase is associated with a $760 increase in earnings per job.

Regional effects.—None of the regional dummy variables were statistically significant, indicating that no statistically significant regional variation remains after accounting for the other variables included in the regression analysis.

Appendix A: Agglomeration and industry clusters

Agglomerations exist for a variety of reasons. Establishments may cluster near input suppliers to reduce the transportation costs associated with acquiring inputs or near customers to reduce

25. The standard deviation is the most widely used statistical measure of the variation of a variable. A variable has a large standard deviation if many observations are much greater or much smaller than the average value. A variable has a small standard deviation if all observations are close to the average value. For more information about beta coefficients, see Robert Pindyck and Daniel Rubinfeld, *Econometric Models and Economic Forecasts* (New York: McGraw-Hill Book Company, 1976).

transportation costs related to the distribution of their products to customers. Establishments may also locate in clusters if establishments located in clusters are more productive than establishments outside of clusters. Productivity will be higher in clusters if there are external economies associated with clustering or "clustering-related externalities," which are factors that are beyond the control of the establishment but that affect the productivity of capital, labor, or both. To the extent that clustering-related externalities raise output per worker, clustering will affect the regional variation in earnings per job because of the positive relationship between productivity and earnings.

Economists distinguish two types of clustering-related externalities: Those associated with the size and diversity of the local economy, called urbanization economies, and those associated with the clustering of similar industries, called localization economies.

Urbanization economies raise the productivity of establishments because a large local economy will tend to have a large, diverse labor force and a wide range of services and input suppliers. The availability of a diverse labor force raises average labor productivity by increasing the likelihood that the demands for different types of labor can readily be satisfied from the local labor market. A large local market makes it possible for input suppliers to specialize, raising overall productivity.[26]

Localization economies raise productivity in at least two ways. First, the local labor market for an industry cluster is more likely to have a pool of workers with specialized skills than would the labor market for a relatively isolated establishment. The larger pool of skilled labor increases the likelihood that an establishment in the cluster will be able to hire workers with exactly the needed skills, when the workers are needed. The better matching of workers and jobs results in higher average labor productivity, all other things being equal. In addition, recent research indicates that the higher the quality of the overall labor force, the faster workers gain skills they need.[27] To the extent this is true, workers in clusters will be more skilled and hence more productive than otherwise similar workers not in clusters.

Second, establishments located in clusters are likely to have better access to information about markets and technology than are establishments located in relative isolation because of what are called "knowledge spillovers" from nearby establishments. The term "knowledge spillover" refers to the spread from one firm or establishment to another of information about technology or markets. For example, suppose a firm develops an improved method of producing a particular product. A knowledge spillover occurs when other firms find out about the new method and use it to improve their production process. Because many knowledge spillovers occur informally—for example, when workers employed by the innovating firm take jobs at other firms—they are more likely to occur among establishments located in clusters than among isolated establishments.

When knowledge spillovers occur, innovations spread among establishments, raising the productivity of both capital and labor throughout the cluster. Commonly cited examples of this type of clustering are the computer and related establishments in the Silicon Valley of California and the Route 128 corridor in Massachusetts, the financial district in New York City, and carpet manufacturers in Dalton, Georgia.

Appendix B: Measuring clusters

The concept of an industry cluster involves the establishments' proximity to one another, while the concept of agglomeration economies involves both proximity and the extent to which establishments are affected by nearby establishments. The local Moran statistic, or "local Moran," which measures whether "neighbors" of a given spatial unit have higher or lower values than would be expected from a random distribution of values, was used to measure the proximity of establishments.[28] The local Moran for a given industry is calculated using the following formula:

$$LM_i = \frac{(x_i - \overline{x})}{\sum_j (x_j - \overline{x})^2} \sum_j w_{i,j}(x_j - \overline{x})$$

where LM_i is the local Moran for county i; x_i and x_j are the number of establishments in counties i and j, respectively; $\overline{x}$ is the mean

26. See John M. Quigly, "Urban Diversity and Economic Growth," *Journal of Economic Perspectives* 12 (Spring 1998): 127–138 and Francisco L. Rivera-Batiz, "Increasing Returns, Monopolistic Competition, and Agglomeration Economies in Consumption and Production," *Regional Science and Urban Economics* 18 (1988): 125–153.

27. E.L. Glaeser and D.C. Maré, "Cities and Skills," NBER Working Paper No. 4728 (1994) and Robert Gibbs and G. Andrew Bernat, Jr., "Rural Industry Clusters Raise Local Earnings," *Rural Development Perspectives* 12 (1998): 18–25.

28. For more information on the local Moran statistic, see Luc Anselin, "Local Indicators of Spatial Association—LISA," *Geographical Analysis* 2 (1995): 93–115.

number of establishments for all counties; and w is the spatial weights matrix. A spatial weights matrix has a row and a column for each county. If two counties are "neighbors," defined as having geographic centers 100 miles or less apart, the corresponding element of w is equal to one. If the counties are not neighbors, the element of w is zero. The spatial weights matrix used in calculating the local Moran is normalized so that the sum of each row is equal to one.

Table 3.—Regression Results

	Coefficient	t-value	p-value
Intercept	–56.7383	–4.0292	0.0001
Worker characteristics:			
Percentage of workforce with college degree	.1917	2.8613	.0045
Percentage of workforce that did not finish high school	–.1478	–2.2074	.0280
Percentage of population that is nonwhite	.0999	3.3221	.0010
Percentage of the labor force that is female	–.3162	–1.5984	.1109
Regional amenities:			
Cooling degree days	–.0151	–.4611	.6450
Average January temperature	–.1195	–2.4387	.0153
Average July temperature	.0011	1.5413	.1242
Average precipitation	.0143	.1504	.8806
Average elevation	–.0010	–3.4438	.0006
Average commuting time	.1366	1.2415	.2153
Crime rate	.3287	2.6279	.0090
Demand factors:			
Unemployment rate	.1922	1.6706	.0958
Population	.9169	3.1349	.0019
Population density	.0007	2.2330	.0262
Manufacturing share of total jobs	.2728	8.7338	0
Percentage of manufacturing jobs in clusters	.0242	2.3127	.0214
Industry-mix wages and salaries	2.4519	18.6565	0
Regional dummy variables:			
New England	–.3153	–.2342	.8149
Mideast	1.6486	1.8048	.0720
Southeast	–.8418	–.7048	.4815
Plains	–.8653	–.8432	.3998
Southwest	–.8136	–.6279	.5305
Rocky Mountain	–.3311	–.2109	.8331
Far West	1.1051	.7611	.4472

Measuring the extent to which nearby establishments affect each other is a more difficult task because there are so many ways this can occur. Input-output accounts show which industries are closely linked in terms of input purchases, but as yet no satisfactory measure has been developed that combines this information with a measure of spatial proximity.

The cluster variable used in the regression was constructed in the following way. First, the local Moran was calculated for each county and industry. If the local Moran for a given county and industry was statistically significant, then the county was considered part of a cluster for that industry, and all jobs in the county for that industry were considered to be in the cluster. Second, the total number of jobs in clusters in all counties within a given CEA were summed. Third, this sum was divided by the number of manufacturing jobs in the CEA to yield the share of total manufacturing jobs for that CEA that are in clusters.

Appendix C: Regression results

The regression equation was estimated using ordinary least squares. The adjusted R-squared was 0.83, and the F-statistic was 71.1, which is significant at the 1-percent level. One regional dummy variable—for the Great Lakes region—is omitted, as required for regressions with dummy variables. Even though many of these variables are interrelated, standard tests indicated that the results were not significantly affected by either multicollinearity or spatial autocorrelation, two commonly encountered problems with this type of regression analysis. The results of the regression are summarized in table 3.