EXPANSION OF MARKETS AND THE GEOGRAPHIC DISTRIBUTION OF ECONOMIC ACTIVITIES: THE TRENDS IN U. S. REGIONAL MANUFACTURING STRUCTURE, 1860–1987*

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This paper presents evidence on the long-run trends in U. S. regional specialization and localization and examines which model of regional specialization is most consistent with the data. Regional specialization in the United States rose substantially between 1860 and the turn of the twentieth century, flattened out during the interwar years, and then fell substantially and continuously since the 1930s. The analysis of the long-run trends in U. S. regional specialization and localization supports explanations based on production scale economies and the Heckscher-Ohlin model but is inconsistent with explanations based on external economies.

I. INTRODUCTION

The phenomenon of regional specialization has generated considerable interest among economists, geographers, and historians. Ever since Adam Smith's *Wealth of Nations* was published in 1776, regional specialization has been linked with regional development and economic growth [North 1955; Perloff, Dunn, Lampard, and Muth 1960]. With David Ricardo's *Principle of Political Economy and Taxation* in 1817, economists began to develop theories of regional specialization and interregional trade [Ohlin 1933; Krugman 1991b], and after von Thünen's *Isolated State* in 1826, regional scientists developed theories of industrial location [Weber 1929; Lösch 1954]. Yet, despite the considerable interest in the phenomenon of regional specialization, few empirical studies exist that cover the long term. In this paper I present evidence on the long-run trends in U. S. regional specialization and localization and examine the forces that produced them.

Regional specialization may arise as regions exploit their

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comparative advantage, take advantage of economies of scale in production, or both. The Heckscher-Ohlin model predicts that regional specialization will arise as regions produce and export products that are relatively intensive in their abundant resource. The increasing returns model predicts that regional specialization will arise if external economies are significant or if conventional production economies of scale dictate that only a few large plants can satisfy total demand [Krugman 1991b]. I examine which of the three sources of regional specialization—external economies and scale economies in an increasing returns model or resources in a Heckscher-Ohlin model—is most consistent with the long-run trends in U. S. regional specialization and localization.

I find that after a slight decline between 1860 and 1890 U. S. regional specialization rose substantially toward the turn of the twentieth century. The level of regional specialization flattened out during the interwar years but then fell substantially and continuously between the 1930s and 1987. U. S. regions are less specialized today than they were in 1860. I also find that industries, in the aggregate, became more localized as regions became more specialized. Conversely, industries became more dispersed as regions became despecialized. The localization patterns at the industry level, however, exhibit considerable variation. I argue that these long-run trends in regional specialization and localization support explanations based on production scale economies and the Heckscher-Ohlin model but are inconsistent with explanations based on external economies.

II. Data and Measurement

Although detailed statistics on interregional trade for the United States do not exist, sources of information on U. S. regional specialization do. They include the federal *Censuses of Agriculture* and *Manufactures* 1840 to 1987; the *Annual Survey of Manufactures,* 1947 to 1988; the *Agricultural Statistics,* 1937 to 1987; the annual Carload Waybill Statistics, 1954 to 1987; the *Census of Transportation,* 1963 to 1983; and the *County Business Patterns,* 1947 to 1987. Such material has been used extensively in the regional economics literature to construct indexes of regional specialization.

The indexes of regional specialization and localization used here are from Krugman [1991b] and Hoover [1936], respectively.[1] Krugman's index of regional specialization is defined as

$$SI_{jk} = \sum_{i=1}^{n} \left| \frac{E_{ij}}{E_j} - \frac{E_{ik}}{E_k} \right|,$$

where E_{ij} is the level of employment in industry $i = 1, \ldots, n$ for region j and E_j is the total industrial employment for region j and similarly for region k. If the index is equal to zero, then the two regions, j and k, are completely despecialized. If the index is equal to two, then the regions are completely specialized.[2] Hoover's coefficient of localization is based on the location quotient which is defined as

$$L_{ij} = \frac{E_{ij}}{E_{ius}} \Big/ \frac{E_j}{E_{us}},$$

where E_{ij} is employment in industry i for region j, E_j is total employment in region j, E_{ius} is employment in industry i, and E_{us} is total employment in the United States. If the L_{ij} is greater than one, then region j has a higher percentage of industry i compared with its proportion of total industry employment relative to other regions. The localization curve, which is analogous to the Lorenz curve, is then constructed as follows. First, calculate the location quotient for industry i for all regions $j = 1, \ldots, R$. Then rank the regions by their location quotients in descending order, and calculate the cumulative percentage of employment in industry i over the regions (y-axis). Finally, calculate the cumulative percentage of employment in total manufacturing over the regions (x-axis). If the industry is evenly distributed across regions, then the location quotient will be equal to one for all regions, and the localization curve will be a 45-degree line. If the industry is more regionally concentrated, then the localization curve will be more concave. The coefficient of localization, which is analogous to the Gini coefficient, is defined as the area between the 45-degree line

1. See Isard [1960], Hoover [1971], and Ellison and Glaeser [1994] for a discussion of various statistics of regional specialization.

2. Krugman [1991b] uses this index to speculate on the possible path the European nations might take after they integrate in 1992. Krugman divides the United States into four regions so that they are comparable in size to European nations and then calculates the specialization indexes using two-digit SIC employment levels for the United States and Europe for 1947 and 1985. Krugman finds that the United States is more regionally specialized than Europe and speculates that Europe will become more regionally specialized as it becomes more integrated.

and the localization curve divided by the entire triangular area. If the Hoover coefficient is equal to zero, then the industry is completely dispersed across regions. If it is equal to one, then the industry is completely localized in one region.

To apply these indexes, an appropriate regional unit of analysis and the proper level of industry aggregation must be determined. Regional economists often define regions using the homogeneity principle and the functional integration principle [Ullman and Klove 1951]. The homogeneity principle groups regions by similarity of characteristics, whereas the functional integration principle defines regions by the presence of a nucleus and a corresponding area of influence. The census divisions apply the homogeneity principle, whereas the standard metropolitan areas and the census county divisions are examples of functionally integrated areas. These two principles appear useful but are lacking a theoretical framework. The regional unit of analysis is likely to depend on the theoretical framework one adopts. If one uses a model of regional specialization based on external economies, the regional unit should be defined such that the external economies are potentially strong within a region but less so across regions. If one employs the Heckscher-Ohlin framework, factors should be mobile within the region but less so across regions. This paper adopts the standard nine census divisions as regional units of analysis because factors are in general more mobile within the census divisions and because increasing returns are more likely to be captured within the census division.[3]

The definition of industry aggregation also depends on the theoretical framework. If one adopts a model of regional specialization based on external economies, the industry aggregation should be defined such that the external economies are strong within an industry but less so across industries. If one adopts the Heckscher-Ohlin framework, factor intensity of production should be more similar within an industry than across industries. This paper calculates the index of regional specialization using the census definition of the two- and three-digit SIC employment levels

3. According to Ullman and Klove [1951], the census regions were developed around the turn of the twentieth century by Henry Gannet, a geographer of the census, and the considerations that led Gannet to the current definitions apparently are largely lost to history. Other regional units based on the aggregation of states are given by Perloff et al. [1960] and Ullman and Klove. A substantial overlap exists in how the states are grouped between the three definitions. In general, the states within regions are more similar in economic structure as compared with states in other regions.

because factor intensities are more likely to be similar within the SIC categories and because external economies are more likely to be captured within the SIC categories.[4]

III. Regional Integration

Between the nineteenth and twentieth centuries, the United States progressed from being a set of regional economies to becoming an integrated national economy.[5] Although U. S. regions were, to some degree, connected by roads, canals, and railroads, the development of an efficient national railroad network was still in its infancy in 1860.[6] The integration of U. S. regions proceeded rapidly after 1860. The national railroad mileage in operation increased sharply from 30,626 to 166,703 miles between 1860 and 1890. In 1860 railroads were regional systems often with their own particular track gauges—there were at least seven different track gauges in operation with sizes ranging from 4′3″ to 6′0″ [Taylor and Neu 1956]. But by 1890 most railroad lines had converted their tracks to a standard gauge of 4′8.5″.

Major advances in transportation and information transmission technologies further contributed to the lowering of U. S. interregional transportation costs. The size of locomotives more

4. A pertinent issue is whether externalities operate within the more narrowly defined industries such as those distinguished in the three-digit category, which contains approximately 140 industries, as opposed to the relatively broadly defined two-digit category, which contains 20. If the index calculated at the two-digit level indicates low levels of regional specialization but the total manufacturing is concentrated in just a few regions, then externalities are likely to operate across the two-digit level. Similarly, if the index calculated at the three-digit level shows low levels of regional specialization but the index at the two-digit suggests greater regional specialization, then externalities are likely to operate across the three-digit industries but within each of the two-digit categories. Alternatively, if one finds that regions are specialized at the three-digit industries but not at the two-digit industries, then externalities are likely to operate at the narrower industry level. Of course, one would like to disaggregate further to the four-digit and even finer categories, but one must also question the practicality and meaningfulness in taking this process to that extreme. Due to occasional changes in the definitions of industries at the finer levels, a longitudinal study of any substantial length is virtually impossible. Moreover, as one defines industry categories more and more narrowly, regions will become increasingly more specialized by construction. Finding the appropriate level of aggregation is a difficult process, but the two- and three-digit categories seem suitable analytically and policy-wise.

5. The factor price equalization theorem states that, if goods are perfectly mobile across regions, then factor prices will converge across regions even if factors are perfectly immobile. Thus, theory suggests that when goods markets become integrated, factor markets will also become integrated.

6. North [1965] reports the general pattern of inland freight rates for the period between 1784 and 1900. North finds that freight rates fell sharply for roads and rivers beginning in the 1820s, canals beginning in the 1830s, and railroads beginning in the 1850s.

than doubled between 1860 and 1890, increasing their speed and carrying capacity from about 12 miles per hour to a potential 60 miles per hour and from ten tons to twenty tons, respectively [Martin 1992, pp. 19, 61]. Major technological advances and innovations, such as automatic couplers, air brakes, block systems, and improved terminal facilities also accelerated productivity in railroad transportation. As speed, traffic, and length of hauls increased, information technology improved to coordinate the complex system of interregional traffic flow. The telegraph mileage in operation increased exponentially from 50,000 miles to 19,382,000 miles between 1860 and 1890.[7]

An examination of regional convergence in prices suggests that regional integration occurred at different rates for goods and factors markets. Goods market integration seems to have been realized by the latter half of the nineteenth century, capital markets by the early twentieth century, and labor markets by the mid-twentieth century. Goods such as lard, pork, flour, and wheat showed rapid convergence in prices across select regions between 1820 and 1860 [North 1961; Harley 1980]. Interest rates show marked convergence across regions by the early 1900s [Davis 1965]. Although there is evidence for the convergence of wages and earnings by the mid-twentieth century, labor markets remained regionally segmented—especially between North and South—in the late nineteenth and early twentieth centuries [Easterlin 1968; Lebergott 1964; Rosenbloom 1990; Margo and Villaflor 1987; Goldin and Margo 1992].

IV. Regional Specialization in Manufacturing, 1860 to 1987

The index of regional specialization is calculated using nine census divisions and two-digit manufacturing employment levels to establish the long-run trends in U. S. regional specialization. In order to test whether the results are sensitive to how the regions or products are defined, the index of regional specialization is also calculated using states (at the two-digit level) and three-digit manufacturing employment (using census divisions).[8]

7. Chandler [1977] sees the organizational, accounting, and statistical innovations that were invented by railroad managers during the 1840–1850s and widely adopted by the 1880s as perhaps the most important catalysts for regional integration. Also see Yates [1989].

8. The robustness of the index is also tested using the agriculture and service sectors as control groups in Appendix 1.

The index of regional specialization, calculated using census divisions and two-digit SIC employment levels, indicates that the degree of regional specialization rose between 1860 and World War I after a slight decline between 1860 and 1890. The level of regional specialization reached its peak during the interwar years before falling continuously and substantially through 1987. Although the latter trend toward regional despecialization in manufacturing has been noted by a number of writers, its continuous pattern has not yet been fully appreciated.[9] The aggregate index of specialization for 1860, 1880, and 1890 is 0.69, 0.63 and 0.61, respectively. It increases to 0.75 in 1900, and then reaches a plateau of 0.89, 0.86, and 0.87 for 1914, 1927, and 1939, respectively. The index then falls until 1987 when its value is 0.45. The index of specialization suggests that the extent of regional specialization was around 35 percent in 1860, increased to about 43 percent in 1927 and 1939, and then fell to 23 percent in 1987 (see Table I and Figure I).[10] Moreover, the movements in the aggregate index, averaged over the 36 biregional indexes, are not caused by changes in a subset of regions. If each of the biregional indexes is examined over time (see Table I), the aggregate pattern is replicated in most biregional comparisons. In general, each region becomes more specialized compared with any other region between 1860 and the turn of the twentieth century and becomes less specialized compared with any other region toward the latter half of the twentieth century.

The qualitative pattern of regional specialization found at the two-digit level using census divisions seems robust to how regions and products are defined. The level of regional specialization at the state level using two-digit manufacturing is higher than at the census division level, but the overall trends are similar. The extent of regional specialization at the state level for years 1880, 1927, 1967, and 1987 is 0.90, 1.16, 0.94, and 0.75, respectively. As with the census division levels, the level of regional specialization rises

9. The trend toward regional despecialization has been noted by Fuchs [1962], Hoover [1971], and Krugman [1991b] among others. This trend has also been noticed by geographers. Scott [1988] writes, "Indeed, one of the most spectacular developments in the urban and economic geography of the United States and the world system over the last four or five decades has been a pervasive dispersal of much industrial capacity." Related to the locational dispersal of manufacturing activity is the relative decline of large metropolitan areas. Scott finds that between 1970 and 1980, metropolitan areas with populations of 5 million or more grew at about 3.4 percent on average, whereas those with a population between 100,000 and 250,000 grew at about 17.9 percent on average.

10. If the index of regional specialization is equal to 2, then the extent of regional specialization is 100 percent. If it is equal to 0, then the extent of specialization is 0 percent.

TABLE I

INDEX OF REGIONAL SPECIALIZATION: MANUFACTURING, 1860–1987
(CONSTRUCTED USING TWO-DIGIT SIC INDUSTRIES)

1860	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PC
NE	—	0.70	1.04	1.05	1.09	0.90	0.95	—	—
MA	—	—	0.70	0.72	0.80	0.54	0.76	—	—
ENC	—	—	—	0.39	0.83	0.55	0.33	—	—
WNC	—	—	—	—	0.67	0.32	0.38	—	—
SA	—	—	—	—	—	0.47	0.87	—	—
ESC	—	—	—	—	—	—	0.51	—	—
WSC	—	—	—	—	—	—	—	—	—
MT	—	—	—	—	—	—	—	—	—

Average = 0.69

1880	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PC
NE	—	0.62	0.99	1.00	0.95	0.97	1.14	1.02	0.87
MA	—	—	0.57	0.69	0.59	0.60	0.87	0.84	0.65
ENC	—	—	—	0.26	0.50	0.34	0.51	0.48	0.35
WNC	—	—	—	—	0.51	0.32	0.38	0.35	0.29
SA	—	—	—	—	—	0.39	0.60	0.66	0.41
ESC	—	—	—	—	—	—	0.44	0.46	0.37
WSC	—	—	—	—	—	—	—	0.35	0.45
MT	—	—	—	—	—	—	—	—	0.40

Average = 0.59

1890	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PC
NE	—	0.65	0.97	1.06	0.88	0.95	1.02	1.15	1.04
MA	—	—	0.55	0.73	0.53	0.52	0.66	0.82	0.67
ENC	—	—	—	0.35	0.52	0.37	0.49	0.42	0.31
WNC	—	—	—	—	0.54	0.51	0.48	0.30	0.23
SA	—	—	—	—	—	0.39	0.41	0.61	0.52
ESC	—	—	—	—	—	—	0.29	0.50	0.37
WSC	—	—	—	—	—	—	—	0.57	0.31
MT	—	—	—	—	—	—	—	—	0.42

Average = 0.59

1900	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PC
NE	—	0.63	0.83	1.00	0.83	0.97	1.20	1.16	1.04
MA	—	—	0.43	0.65	0.89	0.66	1.00	0.85	0.79
ENC	—	—	—	0.42	0.97	0.60	0.74	0.64	0.52
WNC	—	—	—	—	1.01	0.67	0.50	0.63	0.41
SA	—	—	—	—	—	0.56	0.91	1.03	0.87
ESC	—	—	—	—	—	—	0.47	0.70	0.44
WSC	—	—	—	—	—	—	—	0.80	0.31
MT	—	—	—	—	—	—	—	—	0.76

Average = 0.75

TABLE I
(CONTINUED)

1914	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PC
NE	—	0.74	0.97	1.10	0.85	1.17	1.47	1.52	0.76
MA	—	—	0.54	0.80	0.79	0.89	1.24	1.18	0.66
ENC	—	—	—	0.49	0.93	0.86	1.02	0.90	0.82
WNC	—	—	—	—	0.89	0.84	0.83	0.86	1.02
SA	—	—	—	—	—	0.53	0.88	0.98	0.72
ESC	—	—	—	—	—	—	0.48	0.67	0.78
WSC	—	—	—	—	—	—	—	0.72	1.11
MT	—	—	—	—	—	—	—	—	1.06

Average = 0.89

1927	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PC
NE	—	0.69	1.87	1.01	0.74	1.01	1.39	1.51	1.22
MA	—	—	0.55	0.73	0.83	0.75	1.12	1.21	0.95
ENC	—	—	—	0.62	1.06	0.90	1.02	0.92	0.86
WNC	—	—	—	—	1.05	0.96	0.80	0.76	0.62
SA	—	—	—	—	—	0.56	0.95	1.14	0.93
ESC	—	—	—	—	—	—	0.54	0.63	0.59
WSC	—	—	—	—	—	—	—	0.52	0.31
MT	—	—	—	—	—	—	—	—	0.48

Average = 0.86

1939	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PC
NE	—	0.67	0.84	0.84	0.75	0.76	1.17	1.47	1.11
MA	—	—	0.62	0.69	0.87	0.65	1.00	1.17	0.95
ENC	—	—	—	0.78	1.09	0.91	1.01	1.09	0.81
WNC	—	—	—	—	1.07	0.96	0.74	0.82	0.66
SA	—	—	—	—	—	0.44	0.93	1.22	1.01
ESC	—	—	—	—	—	—	0.74	0.91	0.80
WSC	—	—	—	—	—	—	—	0.65	0.47
MT	—	—	—	—	—	—	—	—	0.70

Average = 0.87

1947	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PC
NE	—	0.61	0.72	0.74	0.81	0.79	1.08	1.46	1.01
MA	—	—	0.58	0.59	0.85	0.64	0.87	1.22	0.80
ENC	—	—	—	0.66	1.05	0.87	0.96	1.19	0.65
WNC	—	—	—	—	0.94	0.82	0.61	0.93	0.58
SA	—	—	—	—	—	0.42	0.74	1.19	0.83
ESC	—	—	—	—	—	—	0.56	0.87	0.62
WSC	—	—	—	—	—	—	—	0.71	0.39
MT	—	—	—	—	—	—	—	—	0.81

Average = 0.81

TABLE I

(CONTINUED)

1958	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PC
NE	—	0.47	0.57	0.60	0.81	0.69	0.78	0.97	0.72
MA	—	—	0.49	0.56	0.76	0.47	0.70	0.79	0.70
ENC	—	—	—	0.50	0.93	0.87	0.66	0.79	0.57
WNC	—	—	—	—	0.86	0.75	0.47	0.57	0.50
SA	—	—	—	—	—	0.40	0.64	0.91	0.80
ESC	—	—	—	—	—	—	0.54	0.75	0.66
WSC	—	—	—	—	—	—	—	0.59	0.49
MT	—	—	—	—	—	—	—	—	0.59

Average = 0.66

1967	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PC
NE	—	0.44	0.49	0.51	0.81	0.70	0.62	0.70	0.55
MA	—	—	0.48	0.52	0.66	0.42	0.53	0.55	0.57
ENC	—	—	—	0.39	0.90	0.73	0.55	0.55	0.46
WNC	—	—	—	—	0.79	0.71	0.40	0.40	0.39
SA	—	—	—	—	—	0.39	0.58	0.84	0.79
ESC	—	—	—	—	—	—	0.48	0.70	0.65
WSC	—	—	—	—	—	—	—	0.49	0.37
MT	—	—	—	—	—	—	—	—	0.42

Average = 0.57

1977	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PC
NE	—	0.43	0.48	0.45	0.76	0.59	0.51	0.52	0.47
MA	—	—	0.50	0.49	0.56	0.36	0.42	0.43	0.50
ENC	—	—	—	0.34	0.82	0.62	0.47	0.57	0.40
WNC	—	—	—	—	0.74	0.59	0.36	0.36	0.37
SA	—	—	—	—	—	0.36	0.53	0.75	0.68
ESC	—	—	—	—	—	—	0.36	0.58	0.52
WSC	—	—	—	—	—	—	—	0.42	0.37
MT	—	—	—	—	—	—	—	—	0.31

Average = 0.50

1987	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PC
NE	—	0.39	0.45	0.40	0.63	0.59	0.45	0.38	0.35
MA	—	—	0.51	0.45	0.41	0.39	0.36	0.37	0.41
ENC	—	—	—	0.31	0.64	0.57	0.42	0.52	0.43
WNC	—	—	—	—	0.57	0.57	0.29	0.32	0.35
SA	—	—	—	—	—	0.28	0.40	0.57	0.49
ESC	—	—	—	—	—	—	0.42	0.56	0.49
WSC	—	—	—	—	—	—	—	0.33	0.31
MT	—	—	—	—	—	—	—	—	0.26

Average = 0.43

The specialization index is calculated using employment data from the U. S. *Census of Manufactures*. See Appendix 3 for sources. (NE = New England, MA = Middle Atlantic, ENC = East North Central, WNC = West North Central, SA = South Atlantic, ESC = East South Central, WSC = West South Central, MT = Mountain, and PC = Pacific.)

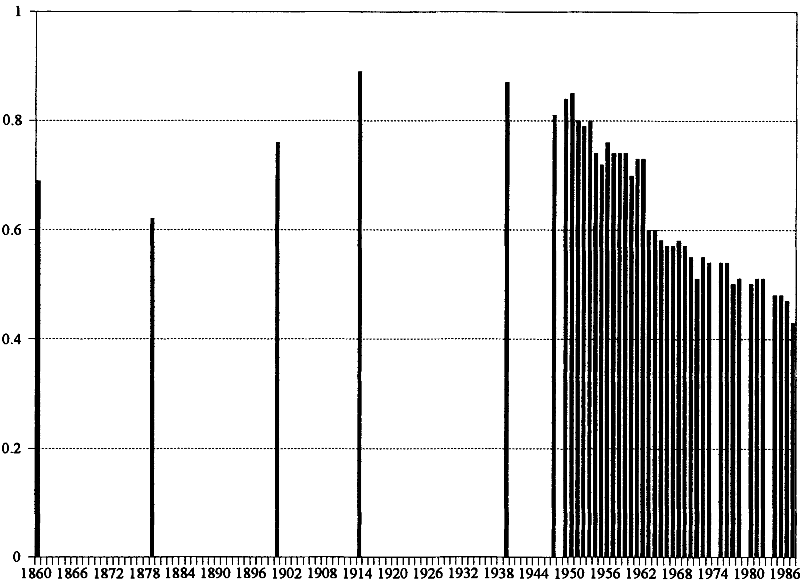

FIGURE I
Index of Regional Specialization: Manufacturing, 1860–1987
The specialization index is calculated using employment data from the U. S. *Census of Manufactures*. See Appendix 3 for sources.

between 1880 and the turn of the twentieth century and then falls between the interwar years and 1987. The level of regional specialization at the census division level using three-digit manufacturing is higher than at the two-digit level, but the time trend correlates well with the two-digit index between 1947 and 1987. The extent of specialization indicated by the regional specialization index at the two-digit level for census years 1947, 1954, 1958, 1963, 1967, and 1987 was 40.5, 37.0, 37.0, 30.0, 28.5, and 21.5 percent, respectively. The comparable measure of specialization at the three-digit level for corresponding years was 51.5, 46.3, 49.6, 44.8, 41.5, and 34.4 percent, respectively (see Table II).[11] It is not surprising that the level of regional specialization at the three-digit level was somewhat higher than at the two-digit level. As products are defined more narrowly, the extent of regional specialization naturally increases by construction. Whether the jump in the specialization index from the two-digit to the three-digit level is an

11. Comparable indexes at the three-digit level prior to 1947 are difficult to construct and hence are unavailable. See Appendix 2 for notes on the reliability of the index constructed at the three-digit level.

TABLE II

INDEX OF REGIONAL SPECIALIZATION: MANUFACTURING, 1947–1987

(CONSTRUCTED USING THREE-DIGIT SIC INDUSTRIES)

1947	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PC
NE	—	0.81	0.95	1.07	1.24	1.36	1.44	1.52	1.30
MA	—	—	0.73	0.91	1.14	1.19	1.32	1.40	1.12
ENC	—	—	—	0.78	1.26	1.21	1.31	1.35	1.11
WNC	—	—	—	—	1.07	1.08	0.98	0.93	0.90
SA	—	—	—	—	—	0.52	0.66	0.94	0.77
ESC	—	—	—	—	—	—	0.69	0.90	0.87
WSC	—	—	—	—	—	—	—	0.70	0.76
MT	—	—	—	—	—	—	—	—	0.77

Average = 1.029

1954	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PC
NE	—	0.69	0.84	0.96	1.09	1.14	1.17	1.39	1.06
MA	—	—	0.65	0.83	0.90	0.96	1.10	1.29	0.96
ENC	—	—	—	0.78	1.04	1.00	1.09	1.22	0.94
WNC	—	—	—	—	0.96	0.97	0.76	0.94	0.77
SA	—	—	—	—	—	0.46	0.65	0.98	0.84
ESC	—	—	—	—	—	—	0.71	0.97	0.91
WSC	—	—	—	—	—	—	—	0.67	0.75
MT	—	—	—	—	—	—	—	—	0.87

Average = 0.925

1958	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PC
NE	—	0.69	0.93	0.99	1.16	1.12	1.19	1.39	1.12
MA	—	—	0.72	0.89	1.02	1.00	1.10	1.31	1.05
ENC	—	—	—	0.76	1.15	0.99	1.04	1.20	1.05
WNC	—	—	—	—	1.11	1.00	0.87	0.93	0.86
SA	—	—	—	—	—	0.55	0.81	1.20	1.08
ESC	—	—	—	—	—	—	0.75	1.14	1.05
WSC	—	—	—	—	—	—	—	0.76	0.90
MT	—	—	—	—	—	—	—	—	0.83

Average = 0.991

1963	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PC
NE	—	0.66	0.84	0.84	1.02	1.04	1.00	1.23	0.95
MA	—	—	0.66	0.76	0.87	0.89	0.97	1.21	0.93
ENC	—	—	—	0.73	1.04	0.92	0.95	1.20	1.01
WNC	—	—	—	—	0.96	0.89	0.68	0.82	0.80
SA	—	—	—	—	—	0.56	0.74	1.11	0.97
ESC	—	—	—	—	—	—	0.72	1.11	1.03
WSC	—	—	—	—	—	—	—	0.73	0.80
MT	—	—	—	—	—	—	—	—	0.62

Average = 0.895

TABLE II
(CONTINUED)

1967	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PC
NE	—	0.64	0.82	0.81	0.97	0.99	0.94	1.02	0.90
MA	—	—	0.63	0.73	0.82	0.80	0.89	0.98	0.80
ENC	—	—	—	0.70	1.03	0.88	0.91	1.02	0.88
WNC	—	—	—	—	0.94	0.85	0.60	0.71	0.72
SA	—	—	—	—	—	0.57	0.75	1.02	0.90
ESC	—	—	—	—	—	—	0.72	1.00	0.90
WSC	—	—	—	—	—	—	—	0.64	0.71
MT	—	—	—	—	—	—	—	—	0.68
Average = 0.830									
1987	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PC
NE	—	0.52	0.72	0.70	0.80	0.86	0.74	0.69	0.59
MA	—	—	0.59	0.57	0.65	0.69	0.61	0.75	0.61
ENC	—	—	—	0.57	0.85	0.77	0.76	0.95	0.82
WNC	—	—	—	—	0.74	0.73	0.52	0.69	0.69
SA	—	—	—	—	—	0.52	0.57	0.83	0.70
ESC	—	—	—	—	—	—	0.63	0.92	0.81
WSC	—	—	—	—	—	—	—	0.63	0.57
MT	—	—	—	—	—	—	—	—	0.45
Average = 0.688									

The specialization index is calculated using employment data from the U. S. *Census of Manufactures*. See Appendix 3 for sources. (NE = New England, MA = Middle Atlantic, ENC = East North Central, WNC = West North Central, SA = South Atlantic, ESC = East South Central, WSC = West South Central, MT = Mountain, and PC = Pacific.)

artifact of disaggregation or reflects stronger externalities at the three-digit level is difficult to know. The degree of regional specialization at the three-digit level, however, has declined since 1947 as well. The only difference is that the rate of decline in the specialization index at the three-digit level is slightly lower than at the two-digit level. Between 1947 and 1987 the index at the two-digit level declined by 46.9 percent, whereas it declined by 32.2 percent at the three-digit level.

V. LOCALIZATION IN MANUFACTURING, 1860 TO 1987

Hoover's coefficient of localization is calculated at the two-digit manufacturing employment level to establish long-run trends in the localization of industries. The localization index uses variation in regional concentration for a given industry, whereas the regional specialization index uses variation in industry structure for any pair of regions. The two indexes are complementary as they provide different statistics using the same information. The localization index provides data on the evolution of each industry, whereas the regional specialization index provides data on the development of regional manufacturing structure.

The aggregate index of localization indicates that industries became more localized as regions became more specialized. Conversely, industries became more dispersed as regions became despecialized. To derive an aggregate index of localization, Hoover's coefficient of localization is calculated at the two-digit SIC industry level and then averaged across the twenty industries. The unweighted average of the coefficient of localization is 0.265 in 1860. It decreases in value to 0.243 in 1900, increases in value to 0.307 and 0.327 in 1927 and 1947, respectively, and then decreases in value to 0.259 in 1987. If the more relevant weighted average is used, Hoover's coefficient of localization peaks earlier and declines at a faster rate: the weighted average is 0.273 in 1860; it peaks at 0.316 in 1927; and then falls sharply to 0.197 in 1987 (see Figure II).

The localization indexes at the industry level, however, show significant variations in long-run trends. The overall trend, it appears, was driven by approximately half of the industries, and these industries (except for lumber and wood) became relatively more important in terms of employment over time. The industries characterized by the rising and falling trend in localization are lumber and wood, rubber and plastic, fabricated metal, nonelectrical machinery, electrical machinery, transportation equipment, instruments, and miscellaneous industries. The remaining industries did not follow the overall pattern. Some, such as tobacco, textiles, and apparel, to a lesser extent, became more regionally localized throughout the entire period. Other industries, such as food, paper, printing and publishing, and chemicals, became more regionally dispersed from 1860 to 1947 and then remained at that level through 1987. Still other industries, such as furniture and fixtures, and primary metal, exhibited little change in localization throughout the entire period (see Table III).

The localization patterns across industries at various points in time are also informative. In 1860 the most localized industries were tobacco, lumber and wood, and chemicals, while the least

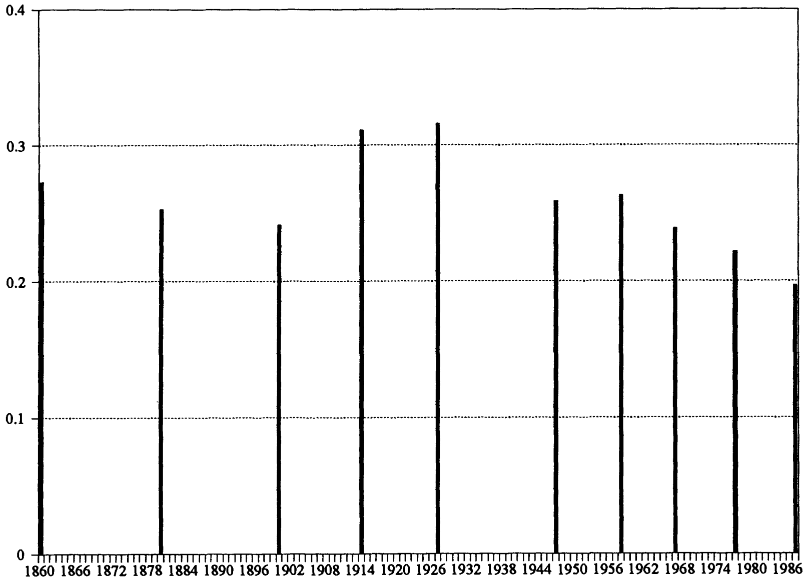

FIGURE II
Hoover's Coefficient of Localization: Manufacturing, 1860–1987
Hoover's coefficient of localization is calculated using employment data from the U. S. *Census of Manufactures*. See Appendix 3 for sources.

localized industries were fabricated metal, transportation, nonelectrical machinery, furniture and fixtures, and stone, clay and glass. In 1927 the most localized were lumber and wood, textiles, tobacco, petroleum and coal, and rubber and plastic, whereas the least localized were stone, clay and glass, and printing and publishing. The most localized in 1987 were tobacco and textiles, and the least localized were electrical machinery, paper, printing and publishing, rubber and plastic, stone, clay and glass, fabricated metal, nonelectrical machinery, chemicals, and food (see Table III).[12]

VI. TESTING MODELS OF REGIONAL SPECIALIZATION AND LOCALIZATION

The regional economies of the United States between 1860 and 1987 present an ideal case study for examining models of regional

12. Ellison and Glaeser [1994] report similar findings for 1987.

TABLE III
HOOVER'S COEFFICIENT OF LOCALIZATION: MANUFACTURING, 1860–1987

Industries	1860	1880	1900	1914	1927	1947	1967	1987
20 Food	0.322	0.311	0.215	0.231	0.249	0.260	0.196	0.153
21 Tobacco	0.630	0.385	0.276	0.303	0.455	0.719	0.730	0.776
22 Textiles	0.357	0.401	0.452	0.443	0.497	0.575	0.653	0.707
23 Apparel	0.249	0.218	0.217	0.307	0.284	0.338	0.360	0.351
24 Lumber & wood	0.418	0.263	0.369	0.486	0.566	0.559	0.451	0.259
25 Furniture & fixtures	0.167	0.246	0.238	0.255	0.211	0.189	0.223	0.210
26 Paper	0.221	0.286	0.249	0.235	0.211	0.088	0.061	0.094
27 Printing & publishing	0.253	0.144	0.151	0.154	0.132	0.139	0.122	0.116
28 Chemicals	0.414	0.242	0.381	0.334	0.279	0.204	0.198	0.185
29 Petroleum & coal	0.257	0.165	0.189	0.214	0.434	0.442	0.461	0.373
30 Rubber & plastics	0.284	0.497	0.532	0.373	0.454	0.438	0.215	0.124
31 Leather	0.224	0.229	0.230	0.371	0.357	0.373	0.422	0.330
32 Stone, clay & glass	0.194	0.191	0.095	0.166	0.105	0.106	0.083	0.137
33 Primary metal	0.216	0.200	0.235	0.256	0.256	0.210	0.224	0.247
34 Fabricated metal	0.092	0.123	0.210	0.324	0.248	0.167	0.164	0.162
35 Machinery	0.113	0.084	0.015	0.241	0.236	0.276	0.233	0.149
36 Electrical machinery	—	0.239	—	0.222	0.238	0.227	0.123	0.087
37 Transportation	0.105	0.240	0.219	0.300	0.296	0.309	0.238	0.203
38 Instruments	0.289	0.155	0.244	0.288	0.372	0.577	0.292	0.274
39 Miscellaneous	0.232	0.248	0.218	0.220	0.250	0.340	0.240	0.244
Unweighted average	0.265	0.243	0.256	0.286	0.307	0.327	0.284	0.259
Weighted average	0.273	0.253	0.242	0.311	0.316	0.259	0.239	0.197

Hoover's coefficient of localization is calculated using employment data from the U. S. *Census of Manufactures*. See Appendix 3 for sources.

specialization. From 1860 to 1914 the United States went from being a predominantly agrarian economy to being the leading industrial producer in the world.[13] Regional political barriers that often complicate international studies are absent in U. S. regional studies due to the constitutional prohibitions against interstate tariffs. This section examines the three major hypotheses of regional specialization—external economies and scale economies in an increasing returns model or resources in a Heckscher-Ohlin

13. Marshall [1920, p. 274] writes, "One of the most striking movements towards the specialization of a country's industries, which history records, is the rapid increase of the nonagricultural population of England in recent times." In the United States in 1860, 52.93 percent of the labor force was employed in agriculture and 13.77 percent in manufacturing. By 1960 the figures were 8.06 percent for agriculture and 23.15 percent for manufacturing. (See *Historical Statistics of the United States,* series D167–181.)

framework—to determine which is the most consistent with long-run regional specialization and localization trends.

A. External Economies

Because external economies typically leave no paper trail, they are difficult to measure directly. Consequently, geographers and economists have used the extent of regional specialization and localization as indirect evidence for the existence and significance of externalities.[14] The dynamic trends and cross-sectional industry localization patterns provide clues for the importance of this single factor.

Marshallian externalities—labor market pooling and technological spillovers—are expected to be positively correlated with levels of intensities in research and development, information, skilled workers, and rates of technological innovations. Industries with these characteristics are often termed the high-tech industries.[15] If localization is caused by external economies, then high-tech industries should be more localized than low-tech industries [Krugman 1991b]. The dynamic trends and cross-sectional industry localization patterns, however, seem to be negatively correlated with measures associated with high-tech industries.[16] First, de-

14. For example, Ullman [1958, p. 196] writes: "Concentration within countries is the rule. This fact may signal the operation of a general localization principle in man's use of the earth: initial location advantages at a critical stage of change become magnified in the course of development. Geographic differentiation starts out as a matter of homeopathic doses of mild concentration and winds up as a system of massive localization based on a wide range of internal and external economies of scale... This concentration in practice takes the form of an area of concentration in many countries as in the American manufacturing belt." More recently, Krugman [1991b, p. 5] writes, "Step back and ask, what is the most striking feature of the geography of economic activity? The short answer is surely *concentration*... This geographic concentration of production is clearly evidence of the pervasive influence of some kind of increasing returns." Also see Marshall [1920]; Pred [1966]; Henderson [1988]; Krugman [1991a]; Glaeser, Kallal, Scheinkman, and Shleifer [1992]; Ciccone and Hall [1993]; and Ellison and Glaeser [1994].

15. Markusen, Hall and Glasmeier [1986] define high-tech industries on the basis of a greater than average proportion of engineers and scientists in the industry's labor force. Also see Mowery and Rosenberg [1989].

16. Mowery and Rosenberg [1989] find that research intensity for all industries (scientific personnel per 1000 wage earners) rose between 1921 and 1946 from 0.56 to 3.98. They also find that the research intensities of tobacco and textiles were consistently among the lowest in manufacturing between 1921 and 1946. In 1946 the research intensities in tobacco and textiles were 0.65 and 0.38, respectively, whereas the average research intensity for all industries was 3.98. The last fundamental technical change in the tobacco and textiles industries occurred toward the end of the nineteenth century with the invention of the Bonsack cigarette machine and the Northrup loom, respectively [Alderfer and Michl 1957]. Between 1956 and 1987 research and development per worker in manufacturing has increased from $1.26 thousand per worker to $4.23 thousand per worker (in

spite the rising trends in the intensities in research and development, information, and skilled workers in manufacturing between World War II and 1987, the level of regional specialization in manufacturing fell rather than rose over the period.[17] Second, skill intensity, research and development, and rates of technological innovations for the tobacco and textiles industries fell, while those for machinery, electrical machinery, and transportation rose. Yet localization levels for the former rose over time but fell for the latter industries. Third, in 1987 localization levels for high-tech industries are comparably lower than low-tech industries such as tobacco and textiles.[18] In sum, contrary to claims made by Krugman [1991b], the historical trends in U. S. regional specialization raise doubts about whether geographic concentration provides evidence for the significance of external economies.

B. Scale Economies and Resources in a Heckscher-Ohlin Framework

Unlike external economies, resources and scale economies can be measured directly (see Tables IV and V). Raw material intensity

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1982 dollars). Over this period, research and development intensity is consistently much higher in chemicals, machinery, electrical machinery, transportation, and instruments [*Historical Statistics,* series W144–160 and U. S. National Science Foundation's *Research and Development in Industry*]. If we use the percentage of census production workers as a proxy for the importance of unskilled workers, then the tobacco and textiles industries consistently had one of the highest percentages of unskilled workers. On the other hand, printing, chemicals, machinery, electrical machinery, transportation, and instruments consistently had the highest proportion of nonproduction workers. A similar picture emerges from wage rates in these industries.

17. Alternatively, one might argue that between 1860 and the turn of the twentieth century, externalities occurred within industries causing regions to become more specialized at the two-digit level, but that since the mid-twentieth century, externalities became more significant across the two-digit categories rather than within, causing regions to become despecialized at the two- and three-digit levels. If this explanation is correct, then one would expect aggregate manufacturing activity to become more concentrated in areas such as the manufacturing belt. To the contrary, the evidence suggests that the aggregate manufacturing activity has become more dispersed since World War II. Also see Glaeser, Kallal, Scheinkman, and Shleifer [1992], who argue that city despecialization at the two-digit industry level between 1956 and 1987 is consistent with the idea that knowledge spillovers across industries are more important than knowledge spillovers within industries.

18. Krugman [1991b] also finds that the most localized industries at the three-digit level are the textiles industries while the least localized are the high-tech industries. Krugman argues, however, that the localization of high-tech industries are biased downward by disclosure laws and classification problems. In this paper the localization index is calculated at the two-digit level so that the disclosure laws come into effect much less frequently. Ellison and Glaeser [1994] also report that in 1987 localization is highest in tobacco and textiles and lowest in machinery, electrical machinery, and transportation.

TABLE IV
MANUFACTURING PLANT SIZE, 1880–1987

Industries	1880	1900	1920	1927	1947	1967	1987
20 Food	8.7	8.1	10.0	16.3	34.1	50.7	50.0
21 Tobacco	11.3	8.9	15.3	65.4	103.1	228.0	238.7
22 Textiles	81.8	123.5	148.3	158.3	151.0	131.2	94.8
23 Apparel	29.2	26.4	28.1	29.4	36.0	51.4	39.3
24 Lumber & wood	6.9	17.4	18.5	43.4	24.4	15.1	17.1
25 Furniture & fixtures	11.3	46.3	42.8	50.8	41.8	42.5	35.2
26 Paper	33.0	52.2	86.2	86.3	110.7	108.5	74.0
27 Printing & publishing	17.3	11.9	11.1	20.7	24.6	27.1	12.9
28 Chemicals	13.7	16.7	20.0	40.5	62.5	71.3	38.5
29 Petroleum & coal	43.4	60.0	107.2	179.8	147.4	75.5	34.2
30 Rubber & plastics	—	404.1	967.5	327.5	295.9	80.1	44.1
31 Leather	8.7	32.0	46.1	80.1	72.2	89.3	49.6
32 Stone, clay & glass	14.7	21.9	48.4	45.5	39.6	37.9	25.0
33 Primary metal	158.0	252.5	432.6	—	211.9	187.4	81.3
34 Fabricated metal	11.1	34.4	40.0	—	57.7	48.9	29.9
35 Machinery	21.3	48.4	71.7	—	86.7	49.2	21.9
36 Electrical machinery	—	—	—	175.3	200.5	175.1	62.8
37 Transportation	12.4	10.9	9.8	—	317.3	245.1	115.0
38 Instruments	32.4	36.9	51.2	—	94.0	88.5	49.3
39 Miscellaneous	16.6	22.3	27.8	—	32.7	30.1	16.4
Production workers	10.8	22.7	42.0	41.8	49.5	44.9	33.2
All employees	—	—	—	48.4	59.4	62.1	51.4

Plant size is defined as the *Census of Manufactures'* production workers divided by the number of establishments. Data for years 1880 to 1920 are from O'Brien [1988].

TABLE V
DESCRIPTIVE STATISTICS OF LOCALIZATION REGRESSION VARIABLES

	Mean [Standard deviation]					
Variable	1880	1914	1947	1967	1987	All
Localization	0.243	0.286	0.327	0.284	0.259	0.280
	[0.11]	[0.08]	[0.18]	[0.17]	[0.18]	[0.15]
Plant size	33.24	61.99	90.50	91.65	56.50	66.77
	[38.4]	[60.1]	[71.2]	[66.0]	[49.4]	[62.6]
Raw material intensity	1.457	1.240	1.268	1.154	1.276	1.279
	[0.95]	[0.73]	[0.69]	[0.58]	[1.16]	[0.85]

Localization is Hoover's coefficient of localization from Table III, and plant size (production workers divided by the number of establishments) is from Table IV. Cost of raw materials and value added from the *Census of Manufactures* are used to calculate raw material intensity (cost of raw materials divided by value added).

(cost of raw materials divided by value added from the *Census of Manufactures*) is used as a measure of the importance of resources (RESOURCE),[19] and average plant size by production workers is used as a measure of scale economies (SCALE).[20] Industries intensive in resources should be more localized given that resources are relatively immobile, and industries characterized by large plant sizes should be more localized since fewer plants are needed to satisfy the national demand.[21]

To test whether localization can be explained by scale economies or the Heckscher-Ohlin model, a panel data set on twenty industries and five time periods (1880, 1914, 1947, 1967, and 1987) has been constructed. The panel structure is then used in a regression of localization on measures of scale economies and resources:

$$(1)\quad \text{LOCALIZATION}_{it} = \beta_0 + \beta_1\text{SCALE}_{it} + \beta_2\text{RESOURCE}_{it} + \alpha_i + \upsilon_t + \epsilon_{it},$$

where α_i is the industry-specific effect and υ_t is the year-specific effect.[22] A fixed-effects model, using the least squares dummy-variable approach, is used to account for effects specific to indi-

19. The raw material intensity variable lumps together all the different types of resource inputs. As a result, the Heckscher-Ohlin model is not given a completely fair representation. To examine to what extent the regional distribution of manufacturing activities are explained by resources, Kim [1995] estimates the Heckscher-Ohlin-Vanek model for each of the twenty two-digit manufacturing industries against twelve factor endowments (agriculture and fisheries, raw tobacco, cotton, timber, cattle, petroleum, and four types of minerals: chemical, stone, fuel, and metal) for 1880, 1900, 1967, and 1987. The results are consistent with the Heckscher-Ohlin-Vanek model for food, tobacco, textiles, lumber and wood, furniture, paper, printing and publishing, chemical, petroleum and coal, leather, stone, clay and glass, and primary metal in varying degrees. The estimates are less successful with apparel, rubber and plastic, fabricated metal, machinery, electrical machinery, and transportation. While the latter result might be interpreted as evidence for some kind of increasing returns, the matter of interpretation is much more complicated by foreign trade in raw materials and final products, recycling, and the use of a significant amount of semi-manufactured inputs in these latter industries.

20. Scherer [1980, pp. 81–150] distinguishes three types of economies of scale in production: product-specific, plant-specific, and multi-plant economies. Given the complex nature of scale economies, no single measure is likely to capture all aspects of scale economies. Plant size is likely to capture certain aspects of product and plant-specific economies but not other aspects. Thus, the results must be interpreted with some caution. Alternative measures of economies of scale such as minimum efficient scale and output per establishment also pose problems for this study. Even if output per establishment increases, there may be no tendency for localization if the size of market increases faster than the output per establishment [Scherer 1980, p. 98; Sands 1961; Weiss 1972].

21. The causal relationship between scale economies and localization has been investigated by a number of writers such as Florence [1948], Krugman [1991b], and Ellison and Glaeser [1994].

22. I am grateful to an anonymous referee for suggesting this regression.

TABLE VI
ESTIMATES OF THE DETERMINANTS OF INDUSTRY LOCALIZATION

Independent variables	(1)	(2)	(3)	(4)
Plant size	0.830	0.773	0.805	0.659
	(0.222)	(0.241)	(0.209)	(0.238)
Raw material intensity	0.0372	0.0380	0.0480	0.0488
	(0.0164)	(0.0168)	(0.0188)	(0.0190)
Industry dummies	no	no	yes	yes
Time dummies	no	yes	no	yes
R^2	0.17	0.18	0.71	0.72
No. of observations	100	100	100	100

Localization is Hoover's coefficient of localization from Table III, and plant size (production workers divided by the number of establishments) is from Table IV. Cost of raw materials and value added from the *Census of Manufactures* are used to calculate raw material intensity (cost of raw materials divided by value added). The plant size variable was divided by 10^3. Standard errors are in parentheses.

vidual cross-sectional units that stay constant over time and for effects specific to each time period that are constant for all cross-sectional units. The industry-specific and year-specific transportation costs are captured by their respective dummy variables.

The results in Table VI provide empirical support for models of regional specialization based on scale economies and resource use. The coefficients on plant size and raw material intensity are both significant, the elasticities at the means are 0.157 and 0.223, respectively, the R^2 is 0.72, and the coefficients are robust to different specifications of dummy variables. The R^2 increases from 0.12 to 0.72 when industry dummy variables are included, suggesting the importance of transportation costs for localization.[23] On the other hand, the R^2 changes only slightly when time dummy variables are included. The hypothesis of identical industry effects is rejected at the 1 percent level (equation (3)), whereas a similar hypothesis concerning time effects cannot be rejected (equation (2)).

The descriptive data in Table V suggest that plant size or scale economies explain more of the time series variation, whereas raw material intensity and transportation costs explain more of the cross-section variation. The mean values of plant size and localization are correlated over time but not across industries (see Tables

23. There is substantial industry variation in transportation costs. For example, value per ton is highest for instruments at $11,000 per ton and is lowest for stone, clay and glass at $55 per ton. It is not surprising that only 29.1 percent of instruments is shipped to its own census region as compared with 88.9 percent of stone, clay and glass products (see *Census of Transportation* [1977]).

III and IV), whereas the opposite seems true of raw material intensity and localization. This conjecture is supported when the least squares estimator is decomposed into a within-units estimator and a between-units estimator for equation (3) which specifies industry dummy variables but excludes time dummy variables [Greene 1993, pp. 465–73]. The results indicate that 74.2 percent of the variation explained by plant size is within-units and the remaining 25.8 percent is explained by between-units. Conversely, 20.3 percent of the variation explained by raw material intensity is within-units, and the remaining 79.7 percent is explained by between-units. Thus, most of the explanatory power of plant size comes from variations in each industry over time, while most of the explanatory power of raw material intensity comes from variations across industries. However, when the decomposition of within-units is carried out for equation (4), which contains both industry and time dummy variables, the within-units variation explained by plant size falls significantly from 74.3 percent to 29 percent but remains unchanged for raw material intensity. These results suggest the existence of a correlation between year-specific transportation costs and plant size [Scherer 1980, pp. 88–89].

The historical trends in U. S. regional specialization can be explained jointly by models based on scale economies and resources. As transportation costs fell between 1860 and the turn of the twentieth century, firms adopted large-scale production methods that were intensive in relatively immobile resources and energy sources. The rise in scale and the use of immobile resources caused regions to become more specialized. As factors became increasingly more mobile and as technological innovations favored the development of substitutes, recycling, and less resource-intensive methods over the twentieth century, regional resource differences diminished. The growing similarity of regional factor endowments and the fall in scale economies caused regions to become despecialized between World War II and today.

Energy consumption provides an illustrative example. As sources of energy changed from water and wood fuel to coal between the nineteenth and early twentieth century, the geographic mobility of energy relative to that of final goods decreased. As petroleum, natural gas, and electricity replaced coal over the twentieth century, however, the geographic mobility of energy increased. In addition, electricity is a processed form of energy that can be generated by many primary sources as well as by solar and nuclear means. Thus, despite the diversity of U. S. regional primary energy supplies, regional differences in final energy supplies are considerably lower [Duchesneau 1972]. Another example relates to the changes in the structural materials in manufacturing. When markets were regional, the basic structural material in the United States was wood which was widely available. As markets expanded, the structural materials changed from wood to iron and steel which were highly intensive in coal, ore, and limestone. These resources, unlike wood, were highly concentrated in certain regions and were costly to transport. Over time, however, many substitutes for wood and steel have been developed from light metals, alloys, plastics, and plywood, each of which can be produced from many different resources. The final illustration involves the development in the paper industry. The early paper industry served local markets by using widely available inputs, such as straw, rag, waste paper, and manila stock. As markets expanded, technological innovations favored the use of a more resource-intensive technology, namely the use of wood pulp, since it permitted a greater scale of operation. Over time, advances in mechanical and chemical pulping technologies have increased the number of tree varieties that could be used for producing paper, thereby reducing the regional differences in the supply of inputs.

VII. CONCLUSION

As the regional economies of the United States integrated to form a national economy between the nineteenth and early twentieth centuries, regional specialization rose substantially, reached a peak during the interwar years, and then has fallen substantially and continuously since the 1930s. Over the same period, industries became more localized when regions became more specialized. Conversely, industries became more dispersed as regions despecialized.

The evidence presented here supports the hypothesis that changes in resource use and in scale economies, rather than external economies, explain the long-run trends in U. S. regional specialization and localization. The panel regression on localization finds that scale economies explain industry localization over time, whereas resource intensity explains localization patterns across industries. The data, however, provide little support for the importance of external economies. The industry localization patterns are negatively correlated with characteristics associated with external economies. Accordingly, an indication of geographic concentration cannot be naively interpreted as evidence for the significance of external economies.

The review of the data also raises doubts as to whether the phenomenon of increasing returns has become more important over time. While average plant size is a significant explanatory variable in the panel regression on industry localization, this figure has fallen rather than risen since the 1940s. Perhaps more important is that as factors of production became increasingly more mobile relative to final goods since the mid-twentieth century, the level of U. S. regional specialization fell. This development is consistent with the Heckscher-Ohlin model and a decreased significance of increasing returns. Thus, despite the serious inroads made in recent years by models based on increasing returns against the standard neoclassical Heckscher-Ohlin model, empirical analysis based on the long-run trends in U. S. regional specialization cautions against this shift in the tide.

Appendix 1: Regional Specialization in Agriculture and Services

The two sectors, agriculture and services, are used as control groups to confirm the robustness of the index of regional specialization. This paper finds that the extent of regional specialization in agriculture was much higher than in manufacturing and increased throughout the years between 1870 and 1987. The extent of regional specialization in services was much lower than in agriculture and manufacturing and stayed low during the period between 1947 and 1986. Unlike manufacturing whose inputs are often mobile, agricultural production is tied to immobile inputs, namely fertile land, so that regional specialization in agriculture is expected to be much higher. On the other hand, services usually require that production and consumption occur in the same location, so that regional specialization is expected to be much lower. The averaged index of regional specialization, calculated for various agricultural products using the value of production, is 0.98 in 1870, 1.10 in 1900, and 1.25 in 1987.[24] The extent of regional specialization increased throughout the period from around 49 percent in 1870 to 55 percent in 1900 and to 62.5 percent in 1987. The averaged index of regional specialization for the service sector,

24. Agricultural products in our study consist of wheat, barley, corn, oats, rye, cotton, tobacco, and vegetables.

calculated at the two-digit SIC employment level, was 0.19 in 1947, 0.24 in 1967, 0.23 in 1977 and 0.22 in 1986.[25] The extent of regional specialization was 9.5 percent in 1947 and 11 percent in 1986.

APPENDIX 2: NOTES ON THE CONSTRUCTION OF THE INDEX OF REGIONAL SPECIALIZATION USING THE THREE-DIGIT SIC CATEGORY

Several problems arise when Krugman's index of regional specialization is constructed using the three-digit SIC category as opposed to the two-digit category. Due to changes in the definitions of industries from time to time, historical comparability is hampered. Moreover, disclosure laws come into effect more frequently at the three-digit level as compared with the two-digit level, resulting in higher occurrences of missing data points. When confidentiality of data becomes a problem, the order of priority in disclosure is as follows: regions, states, SMSAs, two-digit, three-digit, and four-digit SIC groups. Data from 1947 to 1967 are taken from reported regional values. Data from 1972 are constructed from state values. Due to confidentiality laws, five categories are used when actual data could not be disclosed: 150 to 249, 250 to 499, 500 to 999, 1000 to 2499, and 2500 or more. The midpoint of these estimates are used. The percentage levels covered by the published values at the three-digit category by region is given below.

	NE	MA	ENC	WNC	SA	ESC	WSC	MT	PC
1947	90.5	93.3	92.5	92.5	55.2	71.9	82.4	70.1	81.1
1954	97.1	97.4	97.2	96.9	72.5	85.7	92.0	83.4	91.4
1958	97.2	96.1	88.7	90.4	85.0	90.0	83.9	78.2	85.4
1963	97.4	97.6	97.7	97.2	91.1	93.7	97.1	87.7	93.7
1967	97.4	97.4	98.3	99.5	99.7	99.1	100	91.7	81.8
1987	89.9	97.0	97.9	90.8	94.5	98.1	96.0	89.5	96.8

APPENDIX 3: SOURCE NOTES

A. Manufactures: Data for 1860 and 1900 is from Niemi [1974]. Niemi used the 1963 Census definitions to categorize

25. Services in this study consist of hotel and other lodgings (70); personal services (72); business services (73); auto repair, services, and garages (75); miscellaneous repair services (76); motion pictures (78); amusement and recreational services (79); health services (80); legal services (81); educational services (82); social services (83); museums and botanical zoological gardens (84); membership organizations (86); and miscellaneous services (89).

manufacturing industries by value added and employment levels at the two-digit SIC level. Because Niemi omitted the Mountain and Pacific regions, I have categorized data for these two regions for 1900. Data for years 1880, 1914, and 1927 were categorized at the two-digit level using the 1972 census definitions and Niemi's product list. Easterlin [1957] also has data for 1880. Data for 1890 are from Fenichel [1979] who omitted miscellaneous manufacturing. For 1939, "production workers" rather than "all employees" is used. The categorized data for 1939, from the 1947 *Census of Manufactures,* do not report all employees. For all other years, data are from the *Census of Manufactures* or the *Annual Survey of Manufactures.*

B. Agriculture: For reasons of historical comparability, the following agricultural products are used: wheat, barley, corn, oats, rye, cotton, tobacco, and vegetables. Data from 1840 to the early 1930s are from the censuses of agriculture. Data from 1939 to 1987 are from *Agricultural Statistics.* Data prior to 1900 are only given in gross output form such as bushels and pounds. Hence, prices from the *Historical Statistics of the United States* are used to convert output into value terms for 1870 and 1880. Due to the difficulty of obtaining regional agricultural prices, it is assumed that prices are equal across the regions. Beginning in 1900, the values of agricultural products are provided, and the values are obtained by using regional prices based on each state.

C. Services: *County Business Patterns.*

D. Energy: Schurr and Netschert [1960] and the *Annual Energy Book.*

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