

THE PRODUCT CYCLE AND HIGH TECHNOLOGY INDUSTRY IN NONMETROPOLITAN AREAS, 1976-1980

James P. Miller*

Introduction

Many communities in nonmetropolitan America will face long-term economic decline because of powerful global and technological forces unless they can find new sources of growth. Jobs and incomes have been lost irretrievably in long-established rural industries such as agriculture, forestry, mining, and low-wage, low-technology manufacturing. Survival and growth of rural communities has and will continue to depend on their ability to attract new businesses and industries. The immediate question is: what kinds of new business activity are rural areas most likely to attract? Some policymakers and local officials believe that rural areas should attempt to encourage investment in fast-growing high technology industries because these industries are clean and are perceived to provide stable jobs at high wages.

States and communities are committing an increasingly larger share of their scarce economic development resources to high technology development programs. A recent congressional report (U. S. Congress, 1982) lists 38 programs in 22 states specifically targeted to high-tech industries. Specific programs include joint research and development partnerships among government, industry and universities; physical incubator facilities; venture capital assistance; entrepreneurial job training for workers; technology transfer programs; and tax and regulatory incentives.

To evaluate the potential effectiveness of high-tech industrial development programs, state and local officials need information on how these industries have been performing in rural America in recent years. In particular, they need to know how much employment high-tech firms have been generating in nonmetropolitan areas and whether high-tech firms are up-grading the quality of local jobs and improving the industrial structure of rural economies.

This report examines the degree and manner in which nonmetropolitan areas are participating in the burgeoning national expansion of high technology industries. It focuses on the locational orientation and ownership distribution of employment created by new business establishments during 1976-80. The argument of the report is

simple. It reduces to the proposition, derived from product cycle theory, that relatively few high-tech, manufacturing establishments locate in nonmetropolitan areas and that those that do generally are routine assembly operations owned and controlled by corporations headquartered in other regions.

Review of the Literature on the Product Cycle High-Tech Location

The effect of the product cycle on the locational orientation of high-tech industries has been well-documented in several recent studies.¹ Armington, Odle and Harris (1983), Herzog, Schlottman and Johnson (1986), Markusen, Hall and Glasmeier (1986), Massey and Meegan (1982), Suarez-Villa (1984), Sveikauskas (1979), and Thomas (1975) have shown consistently that firms in the initial stages of product development and innovation, tend to cluster in or near large metropolitan areas where they can find technical and professional workers and support services. Sveikauskas, for example, also has shown that the incidence of new high-tech firms and employment increases with the size of the urban area and the availability of technical and professional workers. Other studies, by Park and Wheeler (1983) and Smith and Barkley (1988), have demonstrated that nonmetropolitan areas have a comparative advantage for only the more standardized portions of the production process in high technology industries, activities that characterize the third phase of the product cycle. As high-tech firms enter the third stage of the product cycle, they transfer their more routine production activities to affiliates in nonmetropolitan areas. The rate at which high tech jobs "filter-down" to nonmetropolitan areas thus depends on where the high-tech firms are in the product cycle. When a large proportion of high-tech industries are entering stage three, employment growth prospects are favorable for nonmetropolitan areas.

As they adjust to the final stage of their product cycles, national corporations have perpetuated a "spatial division of labor" that generally has separated high-skilled, high-wage administrative and innovative jobs in urban areas from low-skilled, low-wage jobs in standardized production activities in outlying areas. Hansen (1979) and Jacobs (1984) observing this trend in the South, particularly in the nonmetropolitan areas of the South, conclude

*Economist, Agricultural and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture

that the region has become a vulnerable branch plant economy. Foreign competition has forced many corporations, especially those with headquarters located outside the South, either to shut down or shift production activities to foreign locations where wages are even lower than in the South. Manufacturing branch operations located in non-metropolitan areas, according to Erickson (1976), are more adversely affected during periods of slumping demand than are metropolitan plants. Parent organizations are likely to curtail production at their marginal fabrication and assembly plants in rural areas before they do in their urban-based operations.

Three recent empirical studies have examined the effect of the product cycle on ownership and the decentralization of high technology industries. Barkley (1988) and Smith and Barkley (1988) found that while nonmetropolitan employment in the high technology sector increased as a result of decentralization, most of the jobs were in routine production branch plants that pay low wages.² High technology manufacturers in the innovative stages of their product cycles were reluctant to shift production activities to nonmetropolitan areas distant from large urban research centers. Malecki (1985), in a study of corporate organization and its effect on high tech location discovered that nearly 60 percent of the employment of new business operations in four high-technology industries (computers, semiconductors, medical instruments and computer programming) was created by corporate branch plants. Branch plants that were nonregionally owned and controlled accounted for nearly 50 percent of the employment. High-tech corporations, according to Malecki, are more inclined to open branches in other regions after they have gone through the initial stages of product development and mass production in the home region. In the third stage of the product cycle, competition in the industry intensifies and firms seek to reduce labor costs by shifting routine production out of the home region to areas in other regions with plentiful low-wage unskilled labor. In the earlier stages of the product cycle, the dispersal of branch plants is more likely to be confined to sites within the same region.

Basic Approach and Data

The descriptive analysis in this article differs from earlier work on high-tech location in three ways. First, it is based on more comprehensive data and focuses on nonmetropolitan counties. Previous studies either have not examined the ownership characteristics of high-tech firms at the county level or have limited the analysis to a single State or region. Barkley (1988), for example, focused on nonmetropolitan counties for the nation as a whole, but did not examine the ownership characteristics

of high tech firms. Second, the study focuses on new, high-tech formations. Data on new installations (and expansions) are more likely to reflect recent location decisions and regional comparative advantage than are data for all establishments that could be biased by location decisions made by older firms in earlier periods under different economic conditions.³ New independent businesses also are more likely to represent the early phase of the industrial product cycle in which innovative and nonstandardized production occurs. Finally, the study compares nonregionally-owned, multi-unit affiliates (branch establishments) with regionally-owned affiliates and independent (locally-owned) establishments. Most of the previous studies of high-tech plant location (cited above) have not focused on ownership and the level of external control by national corporations, and this may limit their usefulness for understanding the rural growth process and for formulating rural industrial policy.

Identifying High-Tech Industries.

"High-tech" is a term commonly used in several contexts in both professional and popular literature. In most previous studies, industries were considered to be high-tech if:

- research and development expenditures were a high percentage of gross sales, and
- scientists, engineers and technicians made up a high percentage of their workforce.

The definition used in this study is based on the work of Armington, Harris and Odle (1983) and Rich, Hecker and Burgan (1983). An industry is classified as "high-technology" if more than 8 percent of its employees are in scientific, engineering and technical occupations and at least 5 percent of them are in scientific and engineering categories, or if expenditures for research and development (R&D) are a relatively large percentage of product sales (twice the average for all industries).⁴ At the 3-digit standard industrial classification (SIC) level, 29 SICs were identified as high-tech industries (Table 1). Of this group, six manufacturing industries and three business service industries were classified as high R&D industries. The rest of the industries in manufacturing (SIC 20-39) and the business services (SIC 73) sectors were judged to be in the "low technology" category.

USEEM Data

The data for new establishments were extracted from a larger data file—U.S. Establishment and Enterprise Microdata (USEEM)—developed by The Brookings Institution under contract with the U.S. Small Business Ad-

Table One
High Technology Industries*

SIC	Industry
131	Crude Petroleum and Natural Gas
132	Natural Gas Liquids
281	Industrial Inorganic Chemicals
282	Plastics Materials, Synthetic Resins and other Man-made Fibers
283**	Drugs
286	Industrial Organic Chemicals
289	Miscellaneous Chemical Products
291	Petroleum Refining
348	Ordnance and Accessories
351	Engines and Turbines
353	Construction/Mining, Machinery and Equipment
356	General Industrial Machinery and Equipment
357**	Office Computing and Accounting Machines
362	Electrical Industrial Apparatus
365	Radio and Television Equipment except Communication Types
366**	Communication Equipment
367**	Electronic Components and Accessories
372**	Aircraft and Parts
376**	Guided Missiles and Parts
381	Engineering, Lab and Science Research Instruments
382	Measuring and Controlling Instruments
383	Optical Instruments and Lenses
384	Surgical, Medical, Dental, Instruments and Supplies
385	Ophthalmic Goods
386	Photographic Equipment and Supplies
387	Watches, Clocks
Business Services:	
737**	Computer and Data Processing Services
739**	Research and Development Labs, Testing Labs
892	Non-commercial Educational and Science Research Organizations
Other (Non-high Technology) Categories:	
Low Technology Manufacturing and Business Services***	
Other Industries	

* This list of 29 high technology industries was derived from a list compiled by The Brookings Institution for a study of high technology industry (Armington, Harris and Odle, 1983). Two criteria were used to select high technology industries at the 3 digit standard industrial classification (SIC) level: the proportion of total industry work force in scientific and technical jobs (e.g., engineers, life and physical scientists, engineering and science technicians, and computer specialists) and the ratio of research and development expenditure to sales.

** This group comprises industries with a ratio of research and development (R&D) expenditures to sales at least twice the average for all industries. The six manufacturing industries were classified as "high R&D" industries by researchers at the Bureau of Labor Statistics (BLS) for a previous study (Burgan, 1985). The three business services industries were added to the BLS list as "high R&D" activities that typically support the manufacturing sector.

*** Refers to all activity in the manufacturing and business services sectors that is not classified, "high technology."

ministration (Armington, Harris and Odle, 1983). The USEEM database contains microdata records on about 1.4 million new client firms of the Dun and Bradstreet credit-rating services between 1976 and 1980.⁵

The file includes nearly all nonfarm businesses with employees. Its principal advantage over census and administrative sources is that the data for each firm are constructed in a corporate "family tree" that allows researchers to identify firm status as an affiliate within a multi-locational corporation with headquarters either in the same census region or with headquarters outside the census region, or as an independent, single-location firm.

One limitation of this study is that the period, 1976-80, may not be sufficiently up-to-date to reflect fully the current locational pattern and ownership structure of high-tech employment. Much of the high-tech growth in nonmetropolitan areas in the late 1970s was energy-related, whereas growth since 1980 has been primarily in defense-related computer manufacturing, data processing services, and consumer electronic products. The pattern of ownership and location in the late 1970s, however, should approximate the pattern in the 1980s. The locational tendencies of different ownership categories of firms are not likely to change much over such a short period.

Location Quotients

Employment location quotients are used in Tables 3 and 5 to measure the locational orientation of various categories of industries. They are based on employment in new establishment formations. Location quotients approximately indicate the level of metropolitan-nonmetropolitan specialization in these industries. A location quotient greater than 1 shows that a group of counties (metropolitan or nonmetropolitan) in a census division specializes in a particular industry category and that it markets (exports) some of the product or service outside the area. A quotient less than 1 suggests that the industry is under-represented in the counties and that the product or service is imported. The main advantage of location quotients is that they prevent the classifying of an area (e.g., the metropolitan portion of New England) as a high tech agglomeration simply because it has a large number of jobs in new high tech formations.⁶

Empirical Results

If it is true, as product cycle theory indicates, that innovative, high-tech industries and firms require urban agglomeration economies in the early stages of growth, then new, high-tech establishments should account for a larger share of the employment created in metropolitan

than nonmetropolitan areas. The tendency for new high-tech establishments to locate in metropolitan areas is evident in Table 2. New high-tech establishments created approximately 1.1 million jobs in 1976-1980, about 8.8 percent of the total employment created by all new establishments in metropolitan areas. In nonmetropolitan areas, the high-tech share was only 5.4 percent. In the more innovative, "high R&D" industries (computer manufacturing and computer software), new establishments created about 5.4 percent of the total employment in metropolitan areas, three times the percentage in nonmetropolitan areas.

Locational Orientation

Metropolitan areas stand out as the preferred location of high-tech industries. As shown by location quotients greater than 1 (Table 3), new jobs created by high-tech industries were more concentrated in metropolitan than in nonmetropolitan counties. In five of the nine U.S. census divisions, the location quotient exceeded 1 in metropolitan areas (and was less than 1 in nonmetropolitan areas), and in two of the remaining four divisions, the location quotient, though less than 1, was higher in metropolitan than in nonmetropolitan areas. High-tech jobs in new establishments were concentrated in nonmetropolitan counties only in the East North Central division where many nonmetropolitan counties are within commuting distance of major metropolitan manufacturing areas.

Innovative, high R&D industries appeared to be even more oriented to metropolitan areas than the broad category of high-tech industry. Location quotients for high R&D industries exceeded those for high-tech as a whole in six of nine census divisions (Table 3). In nonmetropolitan areas, location quotients were less than 1 in all divisions.

Computer manufacturing and software industries showed the strongest tendency among high R&D industries to agglomerate in metropolitan areas. New computer manufacturing establishments tended to locate in metropolitan areas, primarily in the Northeast and West. They were poorly represented in nonmetropolitan areas of every census division except New England, where many nonmetropolitan areas are highly integrated with metropolitan areas.

The computer software industry also is strongly oriented to metropolitan areas but more regionally dispersed than computer manufacturing. Metropolitan location quotients for computer software were greater than one in seven of the nine census divisions.

Low-tech industries showed a stronger tendency to locate in nonmetropolitan than in metropolitan areas. Location quotients for these industries—the category most

Table 2
Employment created by new establishments in selected
groups of industries in metropolitan and nonmetropolitan areas, 1976-80¹

Industry Group ²	Metropolitan		Nonmetropolitan		United States	
	Number	Share	Number	Share	Number	Share
	Thou.	Pct.	Thou.	Pct.	Thou.	Pct.
High Technology	1,144	8.8	195	5.4	1,339	8.1
High R&D	706	5.4	63	1.8	769	4.6
Computer mfg. ³	77	0.6	4	0.1	81	0.5
Computer services ⁴	154	1.2	8	0.2	162	1.0
Other	475	3.6	51	1.5	526	3.1
Low technology	3,033	23.4	931	25.9	3,964	23.9
Other industry ⁵	8,799	67.8	2,462	68.6	11,261	68.0
Total	12,977	100.0	3,588	100.0	16,565	100.0

¹ Detail for number of jobs and shares of jobs may not add exactly to totals due to rounding.

² See Table 1 for industries in each industry group.

³ SIC 357

⁴ SIC 737

⁵ Refers to all other goods- and services-producing industries (3 digit SICs) that are not classified as high- and low-technology industries.

Source: U.S. Establishment and Enterprise Microdata, U.S. Small Business Administration.

likely to include non-innovative, routine production activities—were greater than one in the nonmetropolitan portions of four of the nine census divisions. For metropolitan areas, the location quotients were greater than 1 in only two divisions.

Ownership Structure

The ownership structure of new high-tech establishments in nonmetropolitan areas exhibits two main patterns (Table 4). First, corporate affiliates were the dominant form of new business activity. They accounted for about 88 percent of the jobs in high-tech industries, 80 percent of the jobs in low-tech industries, and 58 percent in other industries. Or put in a more interesting way, locally owned, independent firms, where innovation and new product development are most likely to occur, accounted for only about 11 percent of all jobs created by new high-tech firms in nonmetropolitan areas of the United States. Second, most of the jobs created by new high-tech firms in nonmetropolitan areas were controlled by nonregional corporations. New affiliates with headquarters located outside their census regions accounted for about 58 percent of the jobs created by new, high-tech firms in nonmetropolitan areas, compared with 45 percent in metropolitan areas. Nonregional control of employment was unexpectedly lower in low-tech than in high-tech industries in both

nonmetropolitan (42 percent) and metropolitan (32 percent) areas.

A more detailed account of high-tech ownership in nonmetropolitan areas by census division can be seen in Figure 1. The data indicate that nonregionally-owned affiliates were the primary source of new-high tech employment in five of the nine census divisions. They accounted for 77 percent of the employment in new high-tech establishments in the East South Central States, 72 percent in the South Atlantic States, 68 percent in the East North Central division, 59 percent in the Mountain division and 51 percent in the West North Central division. Regional affiliates were the leading source of jobs in the four regions where high-tech headquarters tend to concentrate—the Mid Atlantic, West South Central, New England and Pacific census divisions.

Industry Differences

Nonmetropolitan areas appeared to have a comparative advantage in high technology industries dependent on natural resources, defense expenditures, low-wage labor or noxious production. Location quotients for the nonmetropolitan portions of the census divisions were consistently greater than 1 in the production of chemical products, petroleum, ordnance, radios and TVs, and electrical apparatus (Table 5).

Table 3
Employment and Location Quotients (LQs) for Employment Created by New Establishments in Selected Groups of Industries, by Census Division, Metropolitan and Nonmetropolitan Counties, 1976-80¹

County and Census Division	Employment by Industry Group ²										Total Employ- ment Number (Thou.)
	High Technology		High R&D		Computer Manufacturing (SIC357)		Computer Services (SIC357)		Low Technology		
	Share %	LQ ³ #	Share %	LQ ⁴ #	Share %	LQ ⁵ #	Share %	LQ ⁶ #	Share %	LQ ⁷ #	
Metropolitan	85.4	1.09	91.8	1.17	94.7	1.21	95.1	1.21	76.6	0.98	12,977
New England	7.8	1.88	8.6	2.05	17.4	4.14	6.7	1.59	4.2	1.00	689
Middle Atlantic	10.7	0.89	12.2	1.03	16.2	1.40	16.7	1.41	13.9	1.18	1962
East North Central	12.9	0.94	10.7	0.78	11.1	0.80	15.8	1.15	16.6	1.21	2008
West North Central	4.8	1.02	5.2	1.11	1.2	0.30	5.6	1.19	3.9	0.83	774
South Atlantic	12.6	1.04	16.2	1.28	5.1	0.40	15.7	1.24	10.2	0.84	2008
East South Central	1.5	0.40	1.2	0.32	0.2	0.50	1.4	0.38	3.4	0.94	612
West South Central	13.5	1.41	9.0	0.94	9.4	1.00	10.1	1.05	8.1	0.84	1593
Mountain	3.3	0.82	4.3	1.07	6.3	1.60	3.6	0.90	2.5	0.62	663
Pacific	18.4	1.26	24.4	1.67	27.8	1.90	19.4	1.33	13.6	0.93	2412
Nonmetropolitan	14.5	0.67	8.2	0.38	5.2	0.24	4.9	0.23	23.4	1.08	3588
New England	0.7	0.88	0.8	1.00	1.0	1.25	0.8	1.00	0.9	1.12	126
Middle Atlantic	1.0	0.77	0.5	0.36	0.3	0.21	0.4	0.29	1.4	1.00	226
East North Central	3.7	1.14	1.4	0.42	0.5	0.15	0.4	0.12	3.8	1.15	543
West North Central	1.2	0.45	0.8	0.31	1.2	0.46	0.3	0.11	2.0	0.77	435
South Atlantic	2.5	0.52	1.8	0.37	0.7	0.14	1.6	0.33	6.7	1.37	806
East South Central	2.0	0.86	1.0	0.43	0.5	0.22	0.2	0.09	3.4	1.47	390
West South Central	2.1	0.77	0.5	0.19	0.1	0.04	0.2	0.08	2.4	0.89	451
Mountain	1.0	0.48	1.0	0.50	0.7	0.35	0.7	0.35	1.3	0.65	334
Pacific	0.3	0.18	0.3	0.18	0.1	0.59	0.3	0.18	1.5	0.88	227
United States	100.0		100.0		100.0		100.0		100.0		16,565

¹ Detail on shares may not add to 100.0 due to rounding.

² See Table 1 for industries in each industry group.

³ Column 1 divided by 11.

⁴ Column 3 divided by 11.

⁵ Column 5 divided by 11.

⁶ Column 7 divided by 11.

⁷ Column 9 divided by 11.

Source: U.S. Establishment and Enterprise Microdata, U.S. Small Business Administration.

Nonregional control of nonmetropolitan-oriented, high-tech industries (at the 3-digit SIC level) clearly is evident in most of the census divisions. In six of the nine census divisions, most of the jobs in a majority of nonmetropolitan-oriented industries (location quotients greater than 1) were created by affiliates with headquarters located outside the census region (Table 5). Nonregional control of nonmetropolitan-oriented industries was particularly apparent in the "Deep South." In the East South Central census division, nonregionally-owned affiliates created

over 90 percent of the jobs in five of the six nonmetropolitan-oriented industries. In the South Atlantic states, nonregional affiliates created 60 percent or more of the jobs in three of the five nonmetropolitan-oriented industries.

By contrast, in New England, over 70 percent of the new jobs in non-metropolitan-oriented, high technology industries were created by regional companies. The proximity of regional headquarters may indicate that rural high tech branch plants are affiliated with firms in the early

Table 4
Employment Created by New Establishments in Selected Groups of Industries, by Ownership Status,
Metropolitan and Nonmetropolitan Areas, 1976-1980

Industry Group and County Type	Affiliates with headquarters						Total
	Independent Establishments ¹		In Census Region ²		Outside Census Region ³		
			Number (Thou.)	Share (%)	Number (Thou.)	Share (%)	Number (Thou.)
	High Technology:						
Metropolitan	136	11.9	489	42.7	519	45.4	1,144
Nonmetropolitan	23	11.8	58	29.7	114	58.5	195
Low Technology:							
Metropolitan	865	28.5	1,189	39.2	979	32.3	3,033
Nonmetropolitan	189	20.3	354	38.0	388	41.7	931
Other Industry:							
Metropolitan	3,241	36.8	3,553	40.4	2,005	22.8	8,799
Nonmetropolitan	1,030	41.8	1,005	40.8	427	17.4	2,462

¹ Single-unit firms.

² Affiliates with firm headquarters located in the same Census region as the affiliate.

³ Affiliates with firm headquarters outside the Census region of the affiliates.

Source: U.S. Establishment and Enterprise Microdata, U.S. Small Business Administration.

stages of their product cycles. Many computer manufacturing and software central offices, e.g., are located in the urban areas of Massachusetts and Connecticut.

nonmetropolitan locations is dependent on natural resources, is defense-related, or labor-intensive, or is involved in noxious production.

Key Findings

- (1) New establishments in high-tech industries accounted for only about 5 percent of all jobs created by all new establishments in nonmetropolitan areas during 1976-80, compared with almost 9 percent of such jobs in metropolitan areas.
- (2) Regional location quotients show that new high-tech establishments were less likely to locate in nonmetropolitan than in metropolitan areas. Establishments with high research and development outlays and large numbers of managerial and technical workers were the least nonmetropolitan-oriented. High-tech activities were most concentrated in metropolitan portions of the New England, the West South Central and Pacific States.
- (3) Most jobs created by new high-tech establishments in nonmetropolitan areas were controlled by nonregional corporations; less than half were so controlled in metropolitan areas.
- (4) Much of the high-tech industry that is drawn to

Conclusions

Policymakers and local officials should not be overly optimistic about near term prospects that nonmetropolitan areas can attract the kind of high technology operations likely to provide high-paying jobs or improve economic linkages in their communities. High-tech firms may not be as footloose as many have been led to believe, particularly when they are in their most innovative stage of development. The analysis reported here has shown that employment created by new high-tech establishments tended to concentrate in metropolitan areas and to cluster in the New England, West South Central and Pacific census divisions during 1976-80.

The lower presence of new high-tech activities in nonmetropolitan than in metropolitan areas, especially of the more innovative (high R&D) activities, and the higher percentage of jobs in new high-tech establishments controlled by absentee (nonregional) corporations are consistent with the product cycle theory of industrial location. High-tech firms, particularly high R&D activities in the

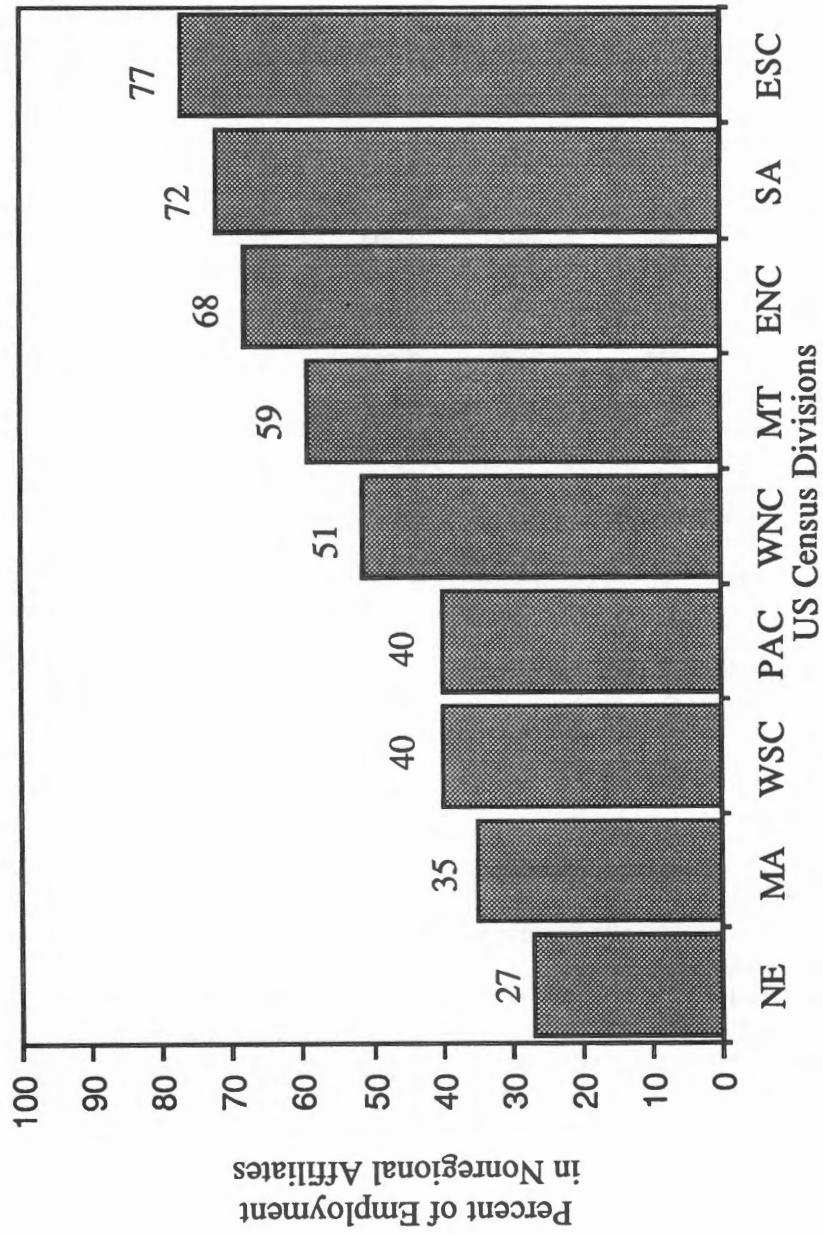


Figure 1. Nonregional Ownership of New High-Tech Formations in Nonmetropolitan Counties, U.S. Census Division, 1976-1980

Table 5
Employment Created by New Establishments in Nonmetropolitan High Technology Industries,
by Ownership Status and Census Division, Nonmetropolitan Counties, 1976-80

Census Division High Technology Industry	Employment Location Quotient	Employment Distribution		
		Independent ¹	Affiliates with Headquarters	
			In Census Region ²	Outside Census Region ³
	No.	Pct.	Pct.	Pct.
New England				
All High Tech Industry	0.88	16	72	12
Engines and Turbines	2.53	0	100	0
Office Computing Machines	1.25	1	99	0
Electronic Components	2.21	23	77	0
Aircraft and Parts	2.72	22	72	6
Optical	4.83	16	84	0
Medical Instruments/Lenses	2.40	16	84	0
Mid Atlantic				
All High Tech Industry	0.77	15	50	35
Natural Gas Liquids	1.59	0	0	100
Misc. Chemical Products	4.69	9	85	6
Electronic Industrial Apparatus	3.86	4	96	0
Radio and TV Equipment	5.24	3	5	92
Medical Instruments	1.56	5	10	85
Watches, Clocks	1.59	5	0	95
East North Central				
All High Tech Industry	1.14	6	26	68
Natural Gas Liquids	1.94	3	97	0
Plastics, Resins, Fibers	1.33	8	37	55
Drugs	1.13	9	1	90
Ordnance	1.37	8	26	66
General Industrial Machinery	6.68	1	10	89
Engineering and Scientific Equipment	1.37	3	77	20
Watches, Clocks	1.94	3	96	1
West North Central				
All High Tech Industry	0.45	13	36	51
Crude Petroleum/Natural Gas	1.19	33	31	36
General Industrial Machinery	1.18	3	21	76
Optical Instruments/Lenses	1.67	2	98	0
Ophthalmic Goods	2.01	5	0	95
South Atlantic				
All High Tech Industry	0.52	8	20	72
Industrial Inorganic Chemicals	1.19	1	55	44
Plastics, Resins, Fibers	2.33	1	14	85
Industrial Organic Chemicals	2.96	3	34	63
Watches, Clocks	3.52	0	0	100

Table 5 (Continued)

Census Division High Technology Industry	Employment Location Quotient	Employment Distribution		
		Independent ¹	Affiliates with Headquarters	
			In Census Region ²	Outside Census Region ³
	No.	Pct.	Pct.	Pct.
East South Central				
All High Tech Industry	0.86	11	12	77
Plastics, Resins, Fibers	3.48	39	39	22
Industrial Organic Chemicals	3.28	2	6	92
Electrical Industrial Apparatus	1.80	5	0	95
Radio and TV Equipment	9.57	0	0	100
Communication Equipment	1.40	2	8	90
Watches, Clocks	1.48	0	1	99
West South Central				
All High Tech Industry	0.77	21	39	40
Crude Petroleum/Natural Gas	5.12	33	35	32
Natural Gas Liquids	4.55	45	20	35
Industrial Organic Chemicals	2.77	4	10	86
Plastics, Resins, Fibers	1.41	1	83	16
Misc. Chemical Products	2.61	2	20	78
Petroleum Refining	2.96	0	62	38
Ordnance	6.47	0	50	50
Construction, Mining Machinery	1.64	25	45	30
Radio and TV Equipment	2.48	100	0	0
Engineering and Scientific Equipment	1.98	0	91	9
Mountain				
All High Tech Industry	0.48	12	29	59
Crude Petroleum	1.96	19	29	52
Ordnance	3.56	3	0	97
Office Computing Machines	1.94	13	38	49
Electric Components	1.85	4	8	88
R&D Labs	1.67	5	54	41
Pacific				
All High Tech Industry	0.18	32	28	40
Industrial Organic Chemicals	2.02	0	100	0
Optical Instruments/Lenses	1.53	43	4	53

¹ Single unit firms.² Affiliates with firm headquarters located in the same Census region as the affiliate.³ Affiliates with firm headquarters located outside the Census region of the affiliate.

Source: U.S. Establishment and Enterprise Microdata, U.S. Small Business Administration

innovative and product development phase, are drawn to metropolitan locations by agglomerative advantages, notably by the availability of professional and technical workers, seed capital, close contacts with customers and suppliers and other high-tech firms. High-tech establishments in nonmetropolitan areas, on the other hand, are more likely to be affiliates of urban-based corporations that have opened routine assembly plants far from where they originated—to avoid high cost of labor, land and other production items. This often occurs after the firm has gone through an initial development stage in the “home region” and after agglomerative advantages have become less important than traditional factor input costs.

The preliminary findings presented in this report suggest that national corporations in high technology industries tend to follow the same pattern as corporations in other industries. They tend eventually to shift their routine production to nonmetropolitan areas and to regions away from the company headquarters.⁷ A large proportion of new high-tech jobs in nonmetropolitan areas was created during the 1976-80 period by new affiliates owned and controlled by corporate headquarters located outside the census region. Because the typical rural “high-tech” operation hires mostly unskilled, low-wage labor, it is likely to have about the same impact on the rural economy as the typical low-wage, routine manufacturing operation that has been attracted to nonmetropolitan areas in the past.

Notes

¹First developed by Raymond Vernon (1966), the product cycle theory holds that products and industries go through a three-phase cycle that begins when new industries emerge with new and innovative products, continues as they expand, and ends once they saturate markets and mature. During the course of the cycle, predictable changes are supposed to occur in company organization, labor requirements, and production location. In the first stage of the cycle, firms are preoccupied with innovating and adapting products for new markets. At this stage they typically are small and independently-owned, and tend to locate in larger metropolitan areas where they can take advantage of large pools of professional and technical labor and a large market for their output. In the second stage, product standardization and mass production begins once the innovative phase is completed. The industry grows rapidly and begins to penetrate new markets. And, according to Thompson (1973), it also begins to disperse production activities to outlying locations to lower cost and capture new markets. In the third stage, industries reach maturity. By this time firms have saturated markets and begin to compete for market shares. The production process requires little of the professional and skilled labor found in metropolitan areas. The

decentralization or “filtering down” of routine production activities away from the home city and region to lower-cost locations in other regions that begin in stage two is completed.

²However, Smith and Barkley (1988) in their survey of high-tech firms in nonmetropolitan areas in the West, also found that non-branch activities (i.e., independent firms) provide significantly higher percentages of professional, technical and skilled jobs than branch establishments, contradicting the product cycle theory.

³Birch (1979) concludes that business start-ups and expansions reveal more about regional comparative advantage than tracking net employment change. Birch, who used Dun and Bradstreet data, shows that most of the variation in growth rates among census divisions over the 1969-76 period was due to differences in job start-up rates and expansion rates and not to variation in the rate of job loss due to closings and contractions.

⁴Industry data alone do not allow researchers to identify truly innovative, high-tech industries engaged in the first stage of product development. Creative entrepreneurs, the most important factor in innovation frequently are excluded from the definition of innovative workers. Scientists, engineers and computer specialists are found primarily on the payrolls of corporate firms. Sveikauskas (1979), however, points out that the inclusion of R&D expenditures improves the classification procedure.

⁵Not all “new client firms” were, in fact, new establishment formations between 1976 and 1980. Some, though not a large proportion by best recent estimates, were older firms that were in existence prior to 1976 and were added to Dun and Bradstreet files as new customers of the credit rating service in the 1976-80 period.

⁶Employment location quotients also have well-known limitations. They do not take into account labor productivity differences among areas; that is, it is possible that a relatively small proportion of the total work force in an area may be employed in a highly productive industry that markets most of its products outside the area. They also do not take into account variation among areas in the local consumption of products or services. And, perhaps of even greater significance, aggregation of employment into broad industry categories and county groups conceal many activities that are exported almost totally.

⁷Additional analysis, however, is needed to determine whether (and to what extent) the more heavily populated nonmetropolitan counties that are adjacent to the larger metropolitan counties are attracting the more sophisticated high R&D, high-tech activities. Smith and Barkley (1988) found that not all high-tech firms in rural counties conform to the product cycle theory. They discovered that high-tech firms in the West, if they were independently owned and operated, tended to be relatively sophisticated in their professional and skilled labor requirements and in the amount of effort they devote to research and development.

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