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METROPOLITAN HIGH-TECHNOLOGY INDUSTRY GROWTH IN THE MID 1970'S: CAN EVERYONE HAVE A SLICE OF THE HIGH-TECH PIE?

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A. Introduction: Can Everyone Have A Slice of the High-Technology Pie?

The enthusiasm surrounding high-technology (high-tech) industries is in part a response to the prospect of future employment growth and to the expectation that these industries will form the basis of self-sustaining local/regional economies. Currently, however, states and communities compete for high-tech employment with only a vague understanding of the forces governing the diffusion of high-tech development. All too often they use scarce public revenues to attract these industries with little assurance of long-run returns on such investment.

Most of these state and local efforts assume that high-tech industries are dependable job generators. They operate as if high-tech industries are highly mobile and can as easily be drawn to older central city areas as to newer Sunbelt suburban industrial parks. Often, they are premised on the belief that high-tech facilities draw other activities around them and set off sustained economic growth (Office of Technology Assessment, 1983). In addition, high-tech operations are often assumed in economic development plans to be dominated by small businesses and thus to share the innovative characteristics and strong growth potential ascribed to small firms (Markusen, Weiss, 1984).

To date, however, insufficient evidence has been presented on the actual performance of high-tech industries as generators of regional economic development. In this article, we examine empirically four simple hypotheses about high-tech industry locational behavior: (1) high-tech manufacturing industries are uniformly substantial job generators; (2) high-tech employment growth occurs in both older industrial areas as well as newly developing sites; (3) high-tech industries show the same or higher rates of small business incidence than do manufacturing industries as a whole; (4) high-tech plants are frequently found in tandem with plants in other high-tech sectors. Preliminary results of a year long study of high-tech industry growth and location tendencies (Glasmeier, Hall, Markusen, 1983a) cast some light on these issues.

B. Defining High Technology Industries

The definition of high-technology industry is controversial (Glasmeier, Markusen, Hall, 1983c). In most popular literature, any industry related to electronics or information-processing is referred to as "high-tech". When the discussion ventures beyond this popular definition, three measures typically are used to define these industries: degree of product sophistication, employment growth rates, and R&D as a percent of sales. There are serious problems with each.

The first measure, sophistication of product, relies on subjective judgement in choosing industries from the Standard Industrial Classification Manual (SIC) (Vinson, 1979). As such, it identifies the most obvious industries such as computers fairly well, but overlooks those such as biogenetics that are newly emerging, and others that are of a process-nature such as crystal-growth technology.

The second measure, employment growth, though objective, lacks precision and comparability. For example, it is unable to distinguish between newly emerging industries and other fast-growing consumer industries, such as household furnishings; and it overlooks more mature industries such as chemicals as well as more capital-intensive industries such as petroleum refining which, on the basis of R&D expenditures and occupational structure, could be considered high-tech. It also eliminates many defense-related industries because of their sporadic growth record, such as guided missiles and space vehicles.

The third measure, R&D as a percent of sales, has similar limitations based on the way it is calculated. Industries identified by this measure are likely to be new and in the early stages of the product life cycle. Industries with comparatively low rankings are those such as chemicals and even computers which have huge sales figures as the denominator of the measure (TMA, 1982). At a more fundamental level, this measure assumes R&D activities are homogeneous across all industries. As Gold (1979) points out, R&D levels vary across industries, firms, and products, making inter-industry comparisons difficult. Some of the apparent variation is based on the orientation of the research: product differentiation versus new product development. Other factors limiting comparisons include: the method of accounting for R&D expenditures, and differences among firm development strategies.

In our analysis we sought a criterion that would be systematic and comprehensive in defining high-tech industries. One consistent characteristic which can be applied systematically across all industries is the degree of technical skill employed within them. More importantly, occupational composition measures the capacity within an industry to apply scientific and engineering skills to the development of products and processes.

In our research, high-tech industries were identified as those where engineers, engineering technicians, computer scientists, mathematicians and life scientists comprise a greater proportion of total employment than the average for all manufacturing. Using the 1980 Occupational Employment Statistics Survey (OES), 29 industries were identified as high-technology. The OES provides detailed occupational profiles for all industries at a three-digit SIC level. These twenty-nine industry groupings were expanded to include their 4-digit components, bringing the total number of industries analyzed to 100.

As with the three previous definitions, using three-digit occupational data has analytical limitations. Using the three-digit OES survey assumes that the four-digit counterpart product groups use comparable levels of scientific, engineering and technical personnel. A similar aggregation problem also plagues R&D expenditure statistics comprehensively available only at a three-digit level. Despite these limitations, researchers have increasingly preferred definitions of high-tech based on occupational data (Vinson, 1979; Brookings, 1983; Bureau of Labor Statistics (BLS), 1983; BusinessWeek, 1983).

But among occupationally-based definitions, there remains disagreements in lists of industries considered high-tech. These differences result from the percentage of scientific and technical personnel selected as a cut-off point to identify high-tech industries.

We used the national manufacturing industry average for engineering, scientific and technical personnel. We prefer the manufacturing average for two reasons. The first is that our analysis concentrates on manufacturing industries. Second, we chose the average with the intention of testing different groupings of industries as part of our ongoing research.

Differences among alternative lists of high-tech industries primarily result from the inclusion of sectors other than manufacturing and from the choice of cutoff criteria. Vinson's criteria is similar to ours with two exceptions: he included services and he used the durable manufacturing industry average as the cut-off point (Vinson, 1983). On the basis of these differences his list includes 8 fewer three-digit industries than ours. Brookings used Vinson's definition but further excluded eight four-digit business service industries (1983, p.25). Their list includes eighty-eight four digit industries. The strict definition proposed by the BLS includes just 6 industries; the more liberal one based on R&D statistics and occupational profiles includes 28 three-digit industries. With the exception of the highly selective BLS definition, the individual three-digit industry groupings are quite similar.

The real problem, of course, is that "high-tech" connotes different industrial features to different interested parties. We believe that an occupational definition comes closest to capturing the multiplicity of connotations important to planners. Our choice is reinforced by the fact that alternative data bases are less reliable and bear similar aggregation problems. Additional research based on sectoral and production characteristics is one possible avenue for overcoming some of the more troublesome definitional difficulties.

C. High Tech Locational Data

Using the 1972 and 1977 unpublished Census of Manufacturers Plant Location data, we compiled county-level four-digit industry tallies of manufacturing plants by employment size category (Glasmeier, Markusen, Hall, 1983b). Combining this with published employment data, we estimated industry employment levels. Cross-checking with published national industry employment and plant totals confirmed the stability of our results: estimates across all 100 industries showed less than one percent variation between the published and estimated employment counts; individual industry employment estimates varied by less than 10%.

The time period analyzed is important to consider on two counts. First, the starting point, 1972, reflects the early decline of the Viet Nam War effort; therefore, defense-related manufacturing employment was likely to have been depressed. Second, in the intervening period the United States experienced a serious recession (1975-76) and was just emerging from its worst affects by 1977. Despite the limitations of the time period, it does provide an opportunity to study high-tech employment growth without the influence of high levels of defense spending. Nevertheless, pre-1972 and post-1977 data would add substantially to our analysis. Unfortunately, changes in industry classifications that occurred in 1972 limit analysis of earlier data (1963 and 1967); more recent data will not be available from the Census until late 1984.

To explore the hypotheses about high-tech growth and location behavior, we used the 264 Standard Metropolitan Statistical Areas, (SMSA) as defined in 1977 for the spatial unit of analysis. Distinctions among SMSA's were made based on their central-city status. Metropolitan (metros) areas which have a major urban center, for example New York, Chicago, San Francisco, were considered big-city SMSA's. Metros that have recently achieved SMSA status or are suburbs of big-city metros, and were designated metros because of population size irrespective of economic maturity, were considered suburban adjacent metro areas.

D. High Technology Industry Growth

In 1977, high-technology industries represented 12% of all manufacturing business establishments, contributing 5,140,000 jobs or 26% of all manufacturing employment (Census of Manufacturers 1972, 1977). Over the five year period studied, the 100 high-tech industries grew by eight percent, while general manufacturing grew by only three percent.

This growth rate, though impressive, was not consistent across the 100 industries (Table I). Thirty-four out of the 100 industries studied actually lost employment and 4 failed to grow at the manufacturing average. Losses and gains varied from the dismal 65 percent decline in SIC's 3483 and 3769, the Munitions and Guided Missile Industries, to the dramatic 110 percent increase in SIC 3795, Tanks and Tank Components.

Nor was there consistent growth within three-digit industry groupings. Industry groups such as Office, Computing, and Accounting Machines, including Computers, grew only slightly

TABLE 1
High Technology Industries Growth Performance, 1972-1977

SIC#	Industry Name	1977 No. of Jobs	No. of Plants 1977	Net New Jobs 72-77	Net New Plants 72-77	% Job Change	Plant Change
2812	Alkalies and Chlorine	11831	49	-1500	1	-11.28	-.02
2813	Industrial Gases	7332	562	-2100	59	-21.88	.12
2816	Inorganic Pigments	12003	106	-700	-8	-7.03	.07
2819	Ind.Inorganic Chem.Nec.	78192	564	15000	180	23.51	.47
2821	Plastic Materials, Syn.Resins	57111	397	2400	74	4.38	.23
2822	Synthetic Rubber	11538	63	-1800	4	-15.25	.07
2823	Cellulosic Man-Made Fibers	16224	25	-1100	7	-6.43	.39
2824	Syn.Organic Fibers, Ex Cellul	74067	66	-4200	5	-5.13	.08
2831	Biological Products	18498	310	5600	128	55.45	.70
2833	Med.Chem.Botanical Prod.	15730	177	6600	37	84.62	.26
2834	Pharmaceutical Preparations	126445	756	14400	0	12.86	0
2841	Soap,Other Detergents	32621	638	600	3	1.90	.005
2842	Spec.Cleaning,Polishing Prep.	22941	1022	-3000	-84	-11.95	-.08
2843	Surface Active Finishing Agents	6851	175	-300	-3	-4.35	-.02
2844	Perfumes,Cosmetics,Toilet Prep.	50775	693	2700	48	5.60	.07
2851	Paints,Varnishes,Lacquers,Enam.	61343	1579	4500	-19	-6.83	-.01
2861	Gum,Wood Chem.	4717	119	-1100	-20	-18.64	-.14
2865	Cyclic Crudes,Intermediates,Dyes	35499	191	7500	17	26.60	.10
2869	Ind.Organic Chem.Nec.	112426	569	9900	56	9.67	.11
2873	Nitrogenous Fertilizers	12443	152	2700	79	28.72	1.08
2874	Phosphatic Fertilizers	15704	91	-500	-54	-3.36	-.36
2875	Fertilizers,Mixing Only	12401	673	1000	46	8.77	.07
2879	Pesticides,Agr.Chem.Nec.	15131	409	2800	21	22.95	.05
2891	Adhesives,Sealants	16647	573	1800	110	12.08	.25
2892	Explosives	11546	97	-6300	5	-33.87	.05
2893	Printing Ink	10106	446	500	40	5.21	.10
2895	Carbon Black	2601	31	-400	-6	-13.79	-.16
2899	Chem,Chem.Prep.,Nec.	35382	1639	-1800	34	-4.85	.02
2911	Petroleum Refining	102398	349	46000	26	45.63	.08
3031	Reclaimed Rubber	1008	21	0	1	0	.05
3482	Small Arms Ammunition	12199	65	-3600	3	-25.90	.05
3483	Ammunition,Ex Small Arms,Nec.	20589	81	-36000	-14	-65.57	-.15
3484	Small Arms	17495	112	1400	30	8.70	.37
3489	Ordnance,Accessories,Nec.	19042	89	-1000	13	-4.07	.17
3511	Steam,Gas,Hydraulic Turbines	40971	83	-5400	8	-11.69	.11
3519	Internal Combustion Engines,Nec.	88804	232	18900	54	27.04	.30
3531	Construction Mach. Equipt.	155129	922	21500	175	16.0	.23
3532	Mining Mach.,Equipt.	31312	344	10100	104	47.4	.43
3533	Oil Field Mach.,Equipt.	58469	478	22700	163	63.2	.52
3534	Elevators,Moving Stairways	10214	152	-4800	-2	32.0	-.01
3535	Conveyors,Conveying Equipt.	32926	616	5700	124	20.9	.25
3536	Hoists,Ind.Cranes,Monorail Syst.	15820	242	-500	54	-3.06	.29
3537	Ind,Trks,Tractors,Trailers,Stackers	28383	475	3000	95	11.62	.25
3541	Mach.Tools,Metal Cutting Types	59432	919	7000	25	13.33	.03
3542	Mach.Tools,Metal Forming Types	23154	429	-400	46	-1.66	.12
3544	Spec.Dyes,Die Sets,Jigs Fix.,Ind.Molds	106175	7152	7800	536	7.97	.08
3545	Mach.Tool Accesories,Measur.Devices	54177	1412	7400	181	15.84	.15
3546	Power Driven Hand Tools	27667	124	4600	36	19.9	.41
3547	Rolling Mill Mach.,Equipt.	8529	63	-2500	16	-24.03	.34
3549	Metalworking Mach.,Nec.	19086	534	5800	141	42.6	.36
3561	Pumps,Pumping Equipt.	63025	613	7500	54	13.51	.10
3562	Ball,Roller Bearings	50286	149	-300	14	-.59	.10
3563	Air,Gas Compressors	31916	175	9100	91	39.74	1.08
3564	Blowers,Exhaust,Ventil. Fans	28415	482	4500	86	19.15	.22
3565	Ind.Patterns	9352	1002	800	-19	9.41	-.02
3566	Speed Chgers,Ind,High Drives,Gears	24572	327	-200	-19	12.44	-.05
3567	Ind.Process Furnaces,Ovens	16260	327	1600	61	11.76	.23
3568	Mech.Power Transmission Equipt.Nec.	32564	226	4800	71	17.33	.46

SIC#	Industry Name	1977 No. of Jobs	No. of Plants 1977	Net New Jobs 72-77	Net New Plants 72-77	% Job Change	Plant Change
3569	General Ind.Mach.Equipt.Nec.	58621	1646	20500	746	55.41	.83
3573	Electronic Comput.Equipt.	192510	932	47900	332	33.08	.55
3574	Calc.Acc.Mach.Ex Elec.Compt.Equipt.	15474	64	-5400	-15	-24.0	-.19
3576	Scales,Balances,Ex Lab.	6738	103	400	6	5.97	.06
3579	Office Mach.,Nec.	42398	218	7900	3	22.90	.01
3612	Power,Distr.Special Transformers	43360	279	-3500	63	-7.48	.29
3613	Switchgear,Switchboard Apparatus	72211	668	2800	100	4.05	.18
3621	Motors,Generators	96951	447	6600	22	7.31	.05
3622	Industrial Controls	56408	726	4100	143	7.99	.24
3623	Welding Apparatus,Electric	17409	176	2000	10	12.90	.01
3624	Carbon,Graphite Products	12086	74	800	2	7.08	.03
3629	Elec.Ind.Apparatus,Nec.	16490	223	4300	35	-16.32	.14
3651	Radio,TV Receiv.Sets,Ex Comm.Types	74639	581	-11900	211	-13.76	.57
3652	Phono Records,Pre-Recorded MagTape	23131	709	2800	142	13.79	.25
3661	Telephone,Telegraph Apparatus	124345	264	-10000	62	-7.44	.31
3662	Radio TV Transmit,Signal,Detect.Equipt.	333006	2121	14900	350	4.67	.20
3671	Cathode Ray Tubes,Nec.	36808	146	-9202	-8	-.20	-.05
3674	Semiconductors,Related Devices	114011	545	16400	219	16.80	.67
3675	Electronic Capacitors	28647	118	1300	5	4.71	.04
3676	Resistors for Electronic App.	24918	101	800	5	3.90	.06
3677	Resistors,Electric Apparatus	22424	294	-3500	54	-14.46	.22
3678	Connectors,Electronic Appls.	26020	133	7900	42	43.65	.46
3679	Electronic Components,Nec.	125998	3118	25400	1276	25.27	.69
3721	Aircraft	222805	176	-9100	8	-3.93	.05
3724	Aircraft Engines,Parts	106222	269	1400	37	1.34	.16
3728	Aircraft Parts,Auxiliary Equipt.,Nec.	101900	728	-200	34	-.20	.05
3743	Railroad Equipt.	56396	201	5500	38	10.83	.23
3761	Guided Miss.,Space Veh.	93933	40	-24400	29	-20.61	.42
3764	Guided Miss.,Space Veh.Propul.Units	17011	26	-2200	-3	-10.58	-.10
3769	Guided Miss.,Space Veh.Parts Nec.	10189	42	-13700	-6	-65.55	-.13
3795	Tanks,Tank Components	12122	24	6500	2	110.0	.09
3811	Eng,Lab,Scientific,Research Inst.	42178	786	5697	47	.16	.06
3822	Auto,Controls Reg.Resid,Comm.Env.Appl.	39076	201	8300	70	27.04	.53
3823	Ind.Instr.Measure,Display	46480	426	9900	239	30.62	.128
3824	Fluid Meters,Counting Devices	16032	111	7100	50	80.68	.82
3825	Instr.Measuring,Testing Elec.Elec.Sigs.	66622	671	11800	26	21.57	.04
3829	Measuring,Controlling Devices,Nec.	32175	670	7700	77	31.30	.13
3832	Optical Instru.,Lenses	29883	545	11200	51	59.57	.10
3841	Surgical,Medical Inst.Apparatus	43206	651	8700	145	25.22	.29
3842	Orthopedic,Prosthetic,Surgical Appl.	53967	1154	10000	284	22.78	.33
3843	Dental Equipt,Supplies	16673	550	3900	121	31.45	.28
3861	Photographic Equipt,Supplies	111568	780	15700	156	16.35	.25

faster than the high-tech average. The substantial 33.6 percent growth in computers was nearly offset by the 24 percent decline in calculating and accounting machines. This example suggests that four-digit industries within the same three-digit grouping may act as substitutes for one another. The regional implications of such divergent growth rates depend upon the extent to which production of individual products occurs in the same or different locations.

On the basis of aggregate statistics, then, sub-sectors within high-tech industries over the period studied were not uniform job generators. In addition, our research suggests that there is a high degree of product substitution and a rapid rate of obsolescence inherent in high-tech industries (Glasmeier, Hall, Markusen, 1983c). Public policy proposals aimed at picking "winning" industries, or even industry groups, are therefore likely to produce uneven results.

E. Metropolitan High Tech Industry Growth

Twenty-two states have some type of development program geared to attract and maintain high-tech industries (Office of Technology Assessment, 1983). States in every region see high-tech industries as a solution to their unemployment problems as well as key instruments for the repair and expansion of their economic base. To what extent does the growth of high-tech employment and plants over the period studied support this enthusiasm?

Eight-six of the 264 SMSA's studied lost high tech employment during the mid 1970's and the regional distribution of these metropolitan employment losers contains a few surprises. Twenty-six (27 percent) out of ninety-seven Southern metro areas lost employment; twenty-eight (37 percent) of the seventy-five Midwestern metros also lost employment. Half, or twenty-three of the forty-six Northeastern metropolitan areas were net employment losers, while only eleven (25 percent) of forty-four Western metro areas lost jobs. Thus, contrary to popular belief, the Sunbelt is not immune to high-tech job shifts.

While our analysis includes all 264 Standard Metropolitan Statistical Areas as defined in 1977, here we present only the results of the top ten employment and plant gainers and losers. Although this shorthand picture is only a partial presentation of on-going research, significantly, both high-tech employment and plant winners and losers comprise more than forty percent of the total high-tech industry change over the period studied.

1. Metropolitan High Technology Employment Gains and Losses

In general,losing metro areas consisted of older big-city SMSA's. Winners, on the other hand, tended to be newer, adjacent suburban metropolitan communities (Table II). This pattern is not unlike that of total manufacturing decentralization which has occurred over the last several decades (Walker, 1976).

Using a loose four region breakdown which places the Plains states in the Midwest and Texas in the South, a number of interesting findings emerge. While overall the Northeast fared better than the Midwest in terms of high-tech job loss, five of the ten largest losers were Northeastern metropolitan areas; New York state alone lost 14,000 jobs in the New York City and Syracuse metros. Even two mature Sunbelt big-city SMSA's, Miami and Los Angeles, were among the top ten losers despite substantial gains in their surrounding suburban areas.

The top ten winners closely resemble what are popularly thought of as high-tech centers. The San Jose SMSA, home of "Silicon Valley", and the Boston SMSA, home of "Route 128", together accounted for 11% of the total metro high-tech gains. The top 10 job gainers were collectively responsible for 41% of high-tech employment growth.

TABLE II
The Top Ten Metropolitan Employment Winners and Losers, 1972-1977

Winners		*Losers*	
Metro Area	Net Employment	Metro Area	Net Employment
San Jose, CA	31909	New York, NY	-8975
Anaheim, CA	30612	Philadelphia, PA	-8586
Houston, TX	18932	Cleveland, OH	-8170
San Diego, CA	16782	Miami, FL	-6584
Boston, MA	15173	Syracuse, NY	-5521
Dallas, TX	12067	Baltimore, MD	-4245
Worcester, MA	9893	Jersey City, NJ	-4062
Oklahoma City, OK	8363	Parksburg, WV-OH	-3664
Lakeland, FL	8132	Los Angeles, CA	-3220
Phoenix, AZ	7976	Decatur, IL	-3130
Median gain	248	Median loss	740

2. Metropolitan High Tech Plant Gains and Losses

If big-city metro areas have been overlooked by high-tech job growth, they have not lost out entirely in the growth of new plants (Table III). The 6691 new high-tech plants established in the mid 1970's were more evenly distributed across both regions and types of metropolitan communities than employment growth.

TABLE III

The Top Ten Net Plant Winners and Losers, 1972-1977

Winners		*Losers*	
Metro Area	Net Plants	Metro Area	Net Plants
Anaheim, CA	464	New York, NY	-159
Los Angeles, CA	367	Jersey City, NJ	-17
San Jose, CA	339	Elmira, NY	-9
Dallas, TX	276	Muncie, IN	-9
Chicago, IL	224	Albany-Schnectady, NY	-7
Houston, TX	204	Port Arthur, TX	-7
Boston, MA	191	E. Lansing, MI	-7
Minneapolis, MN	158	Wilmington, DE	-6
San Francisco, CA	151	Johnstown, PA	-5
Detroit, MI	145	Kokomo, IN	-5
Median gain	9		

Net changes in high-tech plant location offer an approximate measure of the location of new high-tech growth. Although there is a strong resemblance between places with significant net plant change and those with significant net employment change, there are also several anomalies. Metropolitan plant gainers, like their employment counterpart, accounted for a substantial portion of all new plants created in the mid 1970's. The top ten locations accounted for 38% of all new plants; the top twenty contributed 64%. This pattern of plant growth suggests that although 81% of the 264 metropolitan areas gained at least one plant, the majority of new plant growth was highly concentrated in a few locations.

Of the top ten plant gainers, however, only half ranked as well in employment growth (Anaheim, San Jose, Dallas, Houston, and Boston). Los Angeles, at the other end of the extreme, was the ninth largest job loser even though it was the second largest plant gainer. This suggests that Los Angeles may still be hosting the growth of small, innovative, experimental or specialty high-tech establishments while losing out in the competition to maintain larger scale, more standardized manufacturing operations. In Chicago, also, smaller average size plants accounted for higher plant gain than job gain.

Plant losers, with few exceptions, resemble job losers. New York state shows the biggest loss with three of the state's ten metro areas, New York, Albany-Schenectady, and Elmira, losing a total of 175 plants. Among this group the magnitude of plant loss differs dramatically: the New York city metro area lost 159 plants, almost 10 times as many as the next loser, Jersey City, with 17. In three of the four regions, the Midwest, South, and Northeast, the number of metropolitan plant losers were almost equal (10-12); the West, on the other hand, lost plants in only one metropolitan area.

In summary, then, this evidence suggests high-tech industries alone are not likely to bring salvation to declining central cities. In fact, the substantial concentration of both new jobs and plants suggests that the beneficiaries of high-tech employment growth are, with a few exceptions, likely to be suburban communities primarily located in the western United States.

F. High Technology Industry Structure: The Role of Ownership and Plant Size Characteristics

Firm formation in high-tech sectors differs substantially from that of the general manufacturing establishment population (Brookings, 1983). Our research indicates that high-tech industries have substantially larger manufacturing plants than manufacturing industries in general. In 1977, high-tech average plant employment was 114 as compared with the all manufacturing average of 54. A study by the Brookings Institution also showed that high-tech industry average plant size substantially exceeded the manufacturing average. Furthermore, according to this study based on Dunn and Bradstreet data, 58% of the jobs in all industries are in multi-establishment firms, whereas almost 90% of the jobs in high-tech industries are of this form. A high degree of absentee-ownership coupled with plants of greater than average size suggests a somewhat different pattern of economic development than is popularly associated with innovative activities.

G. Metropolitan High Technology Industry Dominance

Given the form of ownership and the average establishment size of high-technology industries, we explored the extent to which metropolitan high-tech employment was distributed among the industries studied. As part of this effort we calculated a measure of industry dominance using estimated employment and industry incidence across SMSA's. Dominant industries are defined as those four-digit sectors accounting for the largest proportion of employment in all high-tech industries within SMSA's.

Our results indicate that high-tech employment is concentrated in one industry in a substantial portion of the metro areas studied. In 1972, one industry accounted for at least 50% of all high-tech employment in 86 (34%) SMSA's. Some 30 metropolitan areas had greater than 70% of their estimated high-tech employment concentrated in one industry. The number of SMSA's dominated by one industry declined slightly in 1977 to 75, although the number of SMSA's with greater than 70% of their employment concentrated in one industry actually increased slightly. On the basis of this indicator it is clear that in 30% of the metro areas in both 1972 and 1977, one 4-digit industry accounted for the greatest proportion of areal high-tech employment.

With few exceptions, metro areas exhibiting highly concentrated high-tech employment were located outside both central cities and sub-state regional metropolitan centers. A large number of these metros are non-adjacent SMSA's, with an additional group lying outside but in close proximity to regional metro centers. Over 50% of these SMSA's were located in the South, with Texas (11), Florida(8), and Virginia (5) having the highest proportion of SMSA's dominated by large single industry establishments.

Austin (TX) and Tucson (AZ), were two SMSA's popularly thought of as a high-tech centers that had more than 50% of their estimated high-tech employment concentrated in one industry. In Austin, nine plants in SIC 3662, Radio, TV, Transmitting Signal Devices and Equipment accounted for 53% of estimated high-tech jobs. Tucson's dominant industry was SIC 3761 Guided Missiles; one plant accounted for an 74% of high-tech employment. Melbourne-Titusville (FL), a metro area heavily dependent on high-tech industries had more than 70% of its high-tech employment concentrated in ten plants in one industry, SIC 3761, Guided Missiles. And finally, Seattle (WA), well-known as the home of Boeing Aircraft Corporation, had 53% of its estimated high-tech employment concentrated in five plants in SIC 2721, Aircraft.

Conclusions

During the mid 1970's high-technology industries were not uniform job generators. Nor was the growth of high-tech employment in the mid 1970's distributed evenly across metropolitan areas. Instead, high-tech employment growth was heavily concentrated in a select number of largely suburban metropolitan areas. High tech average plant size and ownership characteristics differed substantially from manufacturing in general. In a significant percentage of the metropolitan areas studied, high-tech employment was concentrated in one or a few industries.

These findings suggest that any public policy which indiscriminately targets high-tech industries is a questionable economic development strategy. A number of high-tech industries are also declining industries. Even if it were possible to attract a plant of a fast growing industry, there is no guarantee it would still be creating new jobs five years from now.

Similarly, high-tech industries in and of themselves are not likely to be the solution for older industrial metropolitan economies. As our research shows, the bulk of new high-tech job growth in the mid 1970's occurred in suburban metropolitan areas. While attempts to create high-tech research and development centers may prove successful in selected areas, investing in the technical and professional components of high-tech industries is not likely to result in the creation of a substantial number of new jobs for low-skilled inner-city residents. Unless policies are aimed at employment opportunities which match local skills, new jobs will go to new immigrants, and the existing allocation of jobs will largely be unchanged.

High-tech employment is also concentrated in multi-establishment enterprises with larger than average size plants. This suggests that high-tech employment and plants are often dependent on outside corporate investment decisions. If the goal is to inspire the development of locally-based innovative potential, then a more appropriate target would be locally/regionally based firms.

To conclude, economic development strategies which focus on one set of industries to the exclusion of more traditional employment sources may ultimately be trading off one set of dependent conditions for another. Chances are good that communities with strong economic bases will prove attractive to high-tech industries regardless of the incentives they might offer. Clearly, any policy attempting to attract high-tech will need to be carefully targeted in order to match the needs and assets of the local community.

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