Employment in R&D-intensive high-tech industries in Texas

Petroleum and chemicals still distinguish the Texas high-technology sector from its counterparts in other States; but employment growth in Texas has shifted recently, first to civilian durable goods—particularly personal computers—and then, more importantly, to high-tech services

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Since the early 1980s, literally dozens of studies have been published about the geography of high-technology industry in the United States. But because the structure of the industry is constantly evolving, it is often difficult to generalize about the distribution of employment in high technology between and within regions of the United States.[1] California and Massachusetts are often regarded as the preeminent centers of U.S. high-tech industry, but other States have emerged as important locations for new plants and new firms as well. For some time now, Texas has been recognized as a leading center of employment in high technology,[2] yet there have been few attempts to compare the industrial composition of high-tech industry in Texas with that of other States.[3] In this article, we use a definition of "research-and-development (R&D) intensive," as applied to high-tech industries, developed by the Bureau of Labor Statistics in the early 1990s,[4] together with data from the BLS Covered Employment and Wages program (also known as the ES-202 program), to analyze the distinguishing features of Texas-based employment in R&D-intensive high-tech industries relative to that of California, Massachusetts, and, both implicitly and explicitly, the Nation as a whole.

We focus on three aspects of R&D-intensive high-tech industry in Texas relative to the two comparison States and the Nation. First, which industries dominate the composition of employment in Texas R&D-intensive industry? Second, in what ways has Texas employment in this sector changed between 1988 and 1994? Third, what effect have these changes had on Texas' position in the national market hierarchy of R&D-intensive industry? Perhaps our most striking finding is that employment in the R&D-intensive high-tech sector in Texas *increased* during the 6-year interval for which data were available. By contrast, the high-tech sectors in California, Massachusetts, and the Nation all shed employment. But this is a more complex issue than it at first appears. In the remainder of the article, we consider our findings in both the empirical and theoretical context of how R&D-intensive high-tech industries influence the growth and development of regional economies.

High tech and regional economies

For all the attention that high-tech industries receive, their numeric impact on total U.S. employment remains relatively small. In the early 1980s, BLS researchers developed three alternative definitions of high-tech industry and estimated their contribution to total U.S. employment at between 2.8 percent and 13.4 percent.[5] A decade later, another group of BLS researchers introduced two new definitions—"R&D-intensive" high-tech industries and "R&D-moderate" high-tech industries—and estimated employment in the former category at 9.8 percent of total nongovernment and noneducation employment in 1989.[6] More recently, we used the "R&D-intensive" high-tech industry definition and data from the Current Employment Statistics (CES) program to calculate January 1996 employment in such industries at 7.5 percent of all U.S. nonfarm jobs. Table 1 lists these industries and their 1994 employment levels in the Nation, Texas, California, and Massachusetts.

Interest in R&D-intensive industries goes far beyond their contribution to national employment growth, however. Drawing on the work of economists such as Joseph Schumpeter,[7] many theorists view technological innovation as the prime mover in economic development and R&D-intensive industries as the crucial locus of innovation. Through relationships with other industries, technological innovations spawn new generations of products as they diffuse through the economy.[8] In addition, some scholars have argued that R&D-intensive industry's ability to spawn new products and processes generates a synergistic and quite positive combination of effects at the regional and local levels: rapid and self-sustaining employment growth, dense networks of linkages between firms, rapidly expanding markets, and high rates of new-business formation. All of these factors help generate robust economic growth and protect against cyclical downturns in the economy.[9] Thus, it is not simply employment in R&D-intensive industries that is important to regional economies. What is also significant is these industries' role as generators of economic development, more broadly defined.

Given the widely varying composition of regional R&D-intensive industry clusters, how do we evaluate the contribution to regional economic performance of one region's R&D-intensive industries over another's? One way to understand the relationship between the composition of these clusters and qualitative regional economic change is through Raymond Vernon's product and industry life cycle model.[10] Vernon's original version of the model was applied to periods of relatively short duration (6–8 years) and focused narrowly on products alone. Subsequent efforts generalized the model to the development of whole industries and longer periods to account for regional economic change.[11]

As industries go through a life cycle from innovation to growth, maturity, and senescence, each stage or phase has distinct locational requirements. The innovation phase, usually associated with large amounts of R&D, tends to be carried out by firms in "core areas"—usually large metropolitan areas in industrially developed regions—where technical and scientific workers are more readily available. In both the innovation and growth stages, markets for new products or processes expand rapidly, as do rates of employment growth, profits, and new-business formation. Toward the other end of the cycle, the mature phase of production is associated with products that have become standardized or with entire industries whose production processes embody routine technology. Firms in this stage tend to favor lower cost locations in "peripheral areas"—regions in which industrial development has lagged and land and labor costs are low. Rates of market and employment growth for firms in this stage are very low or even negative.

During the 1980s, A. Glasmeier introduced a more complex categorization of space for R&D-intensive industries by adding an intermediate locational phase to the product cycle model: advanced production areas.[12] These areas emerge during the growth phase as firms in core areas relocate in response to increasing costs created by rapid local growth. Unlike peripheral regions, which are dominated by branch plants that assemble standardized products, advanced production areas contain establishments that are stand-alone profit centers in which skilled and semiskilled workers conduct product development and fabricate various components.[13]

The U.S. semiconductor industry illustrates Glasmeier's variation on the product cycle model. Early growth of the industry was concentrated in California's Santa Clara county. As the industry developed, certain phases of the production process were relocated elsewhere. First, the final assembly of semiconductors (a labor-intensive, low-skill phase) was relocated to low-wage sites in Asia and Mexico during the 1960s. Then, in the 1970s and 1980s, high-skilled and advanced production phases of the manufacturing process were moved to other sites in the United States that offered not only an adequate supply of unskilled labor, but also sufficient amenities to appeal to the highly paid technicians, engineers, and other specialists necessary for product-related R&D. These changes shifted all but the highest order R&D functions out of Santa Clara County,[14] and new advanced production areas—for example, in Colorado and Texas—have since experienced high rates of employment growth in semiconductor and related R&D-intensive firms and industries.[15]

The product cycle model has been criticized as a simplistic framework that cannot capture all the complexity of technologically driven regional economic change. Clearly, Texas is a complex case. On the one hand, much of the State's employment base in some R&D-intensive industries (particularly electronics) appears to have arrived from core areas such as California and Massachusetts as an outcome of the advanced production phase of the product cycle. On the other hand, the growth of signature Texas R&D-intensive industries, such as petroleum and petrochemical production, is best attributed to the State's natural resources and economic history, rather than to a life cycle process. In either case, however, the products and processes of industries that are present in any regional economy (whether home grown or imported) at any point in time are unquestionably in different phases of their life cycles. Thus, if contrasts in regional growth and development are at least partly the result of differences in the technical sophisti-

Table 1. Annual average employment in R&D-intensive industries in the United States, Texas, California, and Massachusetts, 1988 and 1994

SIC	Industry name	United States			Texas			California			Massachusetts		
		1988	1994	Percent of 1994 total	1988	1994	Percent of 1994 total	1988	1994	Percent of 1994 total	1988	1994	Percent of 1994 total
	Total	8,471,627	8,355,144	100.0	587,094	627,217	100.0	1,329,962	1,151,593	100.0	374,924	313,398	100.0
131	Crude petroleum and natural gas operations	197,225	161,839	1.9	90,656	78,835	12.6	18,153	14,043	1.2	0	(1)	...
211	Cigarettes	40,872	30,142	.4	(1)	(1)	...	0	0	.0	0	0	.0
281	Industrial inorganic chemicals	134,976	131,797	1.6	7,481	8,459	1.3	7,401	6,424	.6	1,302	738	.2
282	Plastics materials and synthetics	176,657	161,586	1.9	9,704	11,844	1.9	3,411	3,636	.3	4,857	3,318	1.1
283	Drugs	228,694	262,947	3.1	4,849	6,058	1.0	24,062	26,841	2.3	4,075	6,189	2.0
284	Soap, cleaners, and toilet goods	158,749	152,349	1.8	4,703	5,312	.8	15,728	13,773	1.2	2,886	2,118	.7
285	Paints and allied products	63,572	58,049	.7	3,636	3,291	.5	7,510	6,301	.5	1,414	956	.3
286	Industrial organic chemicals	145,803	142,753	1.7	35,347	37,324	6.0	3,652	3,690	.3	417	1,033	.3
287	Agricultural chemicals	52,068	55,046	.7	4,567	3,698	.6	2,976	3,573	.3	98	91	.0
289	Miscellaneous chemical products	101,932	93,464	1.1	7,327	8,292	1.3	8,852	6,701	.6	3,458	3,249	1.0
291	Petroleum refining	123,893	109,011	1.3	26,245	26,126	4.2	24,908	18,650	1.6	(1)	(1)	...
299	Miscellaneous petroleum and coal products	12,104	13,017	.2	1,159	1,005	.2	877	904	.1	409	455	.1
335	Nonferrous rolling and drawing	179,149	166,713	2.0	4,102	6,295	1.0	12,897	9,367	.8	6,522	4,302	1.4
355	Special industry machinery	159,605	154,659	1.9	3,269	3,314	.5	10,696	14,266	1.2	10,794	8,624	2.8
357	Computer and office equipment	465,443	352,904	4.2	22,128	29,688	4.7	92,484	82,845	7.2	54,018	28,668	9.1
362	Electrical industrial apparatus	180,341	156,207	1.9	3,836	4,024	.6	12,780	7,506	.7	6,038	5,144	1.6
366	Communications equipment	273,475	243,500	2.9	21,758	23,649	3.8	32,918	30,229	2.6	23,746	15,734	5.0
367	Electronic components and accessories	619,730	544,893	6.5	64,660	59,757	9.5	150,037	118,369	10.3	38,787	25,509	8.1
371	Motor vehicles and equipment	847,627	898,684	10.8	17,487	16,816	2.7	35,158	32,251	2.8	2,687	1,336	.4
372	Aircraft and parts	678,032	480,037	5.7	55,405	45,087	7.2	164,846	91,904	8.0	10,096	5,888	1.9
376	Guided missiles and space vehicles	209,366	107,773	1.3	15,470	2,083	.3	81,055	36,832	3.2	17,583	11,235	3.6
381	Search and navigation equipment	316,356	182,401	2.2	11,744	8,661	1.4	124,718	61,975	5.4	16,255	10,992	3.5
382	Measuring and controlling devices	325,140	283,634	3.4	10,946	12,312	2.0	70,671	60,188	5.2	28,579	22,475	7.2
384	Medical instruments and supplies	232,983	265,129	3.2	10,931	14,052	2.2	37,255	41,383	3.6	13,447	13,942	4.4
386	Photographic equipment and supplies	110,706	88,308	1.1	579	695	.1	9,759	4,739	.4	10,323	8,660	2.8
737	Computer and data-processing services	662,835	955,095	11.4	47,030	70,196	11.2	99,258	134,682	11.7	36,611	47,517	15.2
871	Engineering and architectural services	724,837	773,775	9.3	50,874	63,993	10.2	102,757	99,693	8.7	31,595	27,182	8.7
873	Research and testing services	505,040	560,245	6.7	23,499	29,347	4.7	85,998	96,568	8.4	25,076	26,000	8.3
874	Management and public relations services	512,310	727,987	8.7	26,514	44,951	7.2	84,239	118,717	10.3	22,980	31,319	10.0
899	Services, n.e.c.[2]	32,107	41,200	.5	1,188	2,053	.3	4,906	5,543	.5	871	724	.2

[1] Data not permitted to be disclosed.
[2] n.e.c. = not elsewhere classified.

SOURCE: Covered Employment and Wages (ES–202) program, Bureau of Labor Statistics.

cation of a given region's industry, then the industry life cycle metaphor is an appropriate way to assess the present and future contributions of Texas R&D-intensive industries to statewide economic performance.

R&D employment in three States

R&D-intensive industries employed 627,217 workers in Texas in 1994, approximately half that of national leader California (1,151,593),[16] and slightly more than twice that of Massachusetts (313,398). (See table 1.) These figures represented 7.5 percent, 13.8 percent, and 3.8 percent, respectively, of all U.S. employment in R&D-intensive industries in 1994, which stood at 8,355,144. Employment in R&D-intensive industries accounted for very similar shares of private employment in Texas (10.0 percent), California (11.0 percent), and Massachusetts (12.7 percent), but this narrow range masked a great deal of variation in the industrial composition of that employment.[17]

Despite falling oil prices and ensuing industry retrenchment during the 1980s, almost one-third of all Texas employment in R&D-intensive high-tech industries was still in petroleum extraction and refining (SIC's 131, 291, and 299) and in the production of chemicals (SIC 28). The largest single R&D-intensive employer in Texas as of 1994 was the crude petroleum and natural gas operations industry (SIC 131), with 78,835 workers. This industry, along with petroleum refining (SIC 291; 26,126) and miscellaneous petroleum and coal products (SIC 299; 1,005), accounted for about 17 percent of all employment in the State's R&D-intensive sector. Data suppression to maintain confidentiality made it difficult to determine the exact magnitude of employment in these industries in Massachusetts, but it was likely a very small share of the R&D-intensive total. In California, petroleum extraction and refining made up slightly less than 3 percent of that total.

Chemicals—in particular, industrial organic chemicals (SIC 286), plastics materials and synthetics (SIC 282), industrial inorganic chemicals (SIC 281), and miscellaneous chemicals (SIC 289)—accounted for another 13.4 percent of total employment in Texas R&D-intensive industries. Like the petroleum-related industries, chemical manufacturing was a relatively minor component of R&D-intensive industry employment in both California (6.2 percent) and Massachusetts (5.6 percent).

Conversely, R&D-intensive service industries—computer and data-processing services (SIC 737), engineering and architectural services (SIC 871), management and public relations services (SIC 874), research and testing services (SIC 873), and services, not elsewhere classified (n.e.c.) (SIC 899)—were central components of employment in all three States' R&D-intensive industry mix. These service industries accounted for an additional one-third (33.6 percent) of the statewide total in Texas. Indeed, in terms of total State R&D-intensive employment, the first four industries listed occupied the second, third, sixth, and ninth ranks, respectively. The one-third share, however, was less than the contribution of services to R&D-intensive high-tech employment in California (39.5 percent) and Massachusetts (42.4 percent).

Slightly more than one-third (36 percent) of the remaining employment in R&D-intensive industries in Texas was in durable goods manufacturing industries. This share was much less than that of either California or Massachusetts, where durable goods made up about half of the high-tech total. Electronic components (SIC 367) and aircraft and parts (SIC 372) were the leading industries in Texas and California. The contribution of the electronic components industry to 1994 R&D-intensive industry employment in Texas was approximately equal to that in California and Massachusetts, with the contribution of aircraft and parts equal to that of California and much greater than that of Massachusetts. But the share of statewide R&D-intensive industry employment was considerably lower in Texas than in the latter two States for other signature R&D-intensive industries—for example, computer

Table 2. Proportional and net shifts in employment in R&D-intensive industries in the United States, Texas, California, and Massachusetts, 1988–94

SIC	Industry name	United States		Texas		California		Massachusetts	
		Percent	Net	Percent	Net	Percent	Net	Percent	Net
	Total	–1.4	–116,483	6.8	40,123	–13.4	–178,369	–16.4	–61,526
131	Crude petroleum and natural gas operations	–17.9	–35,386	–13.0	–11,821	–22.6	–4,110	([1])	([1])
211	Cigarettes	–26.3	–10,730	([1])	([1])	.0	0	.0	0
281	Industrial inorganic chemicals	–2.4	–3,179	13.1	978	–13.2	–977	–43.3	–564
282	Plastics materials and synthetics	–8.5	–15,071	22.1	2,140	6.6	225	–31.7	–1,539
283	Drugs	15.0	34,253	24.9	1,209	11.5	2,779	51.9	2,114
284	Soap, cleaners, and toilet goods	–4.0	–6,400	12.9	609	–12.4	–1,955	–26.6	–768
285	Paints and allied products	–8.7	–5,523	–9.5	–345	–16.1	–1,209	–32.4	–458
286	Industrial organic chemicals	–2.1	–3,050	5.6	1,977	1.0	38	147.7	616
287	Agricultural chemicals	5.7	2,978	–19.0	–869	20.1	597	–7.1	–7
289	Miscellaneous chemical products	–8.3	–8,468	13.2	965	–24.3	–2,151	–6.0	–209
291	Petroleum refining	–12.0	–14,882	–.5	–119	–25.1	–6,258	([1])	([1])
299	Miscellaneous petroleum and coal products	7.5	913	–13.3	–154	3.1	27	11.2	46
335	Nonferrous rolling and drawing	–6.9	–12,436	53.5	2,193	–27.4	–3,530	–34.0	–2,220
355	Special industry machinery	–3.1	–4,946	1.4	45	33.4	3,570	–20.1	–2,170
357	Computer and office equipment	–24.2	–112,539	34.2	7,560	–10.4	–9,639	–46.9	–25,350
362	Electrical industrial apparatus	–13.4	–24,134	4.9	188	–41.3	–5,274	–14.8	–894
366	Communications equipment	–11.0	–29,975	8.7	1,891	–8.2	–2,689	–33.7	–8,012
367	Electronic components and accessories	–12.1	–74,837	–7.6	–4,903	–21.1	–31,668	–34.2	–13,278
371	Motor vehicles and equipment	6.0	51,057	–3.8	–671	–8.3	–2,907	–50.3	–1,351
372	Aircraft and parts	–29.2	–197,995	–18.6	–10,318	–44.2	–72,942	–41.7	–-4,208
376	Guided missiles and space vehicles	–48.5	–101,593	–86.5	–13,387	–54.6	–44,223	–36.1	–6,348
381	Search and navigation equipment	–42.3	–133,955	–26.3	–3,083	–50.3	–62,743	–32.4	–5,263
382	Measuring and controlling devices	–12.8	–41,506	12.5	1,366	–14.8	–10,483	–21.4	–6,104
384	Medical instruments and supplies	13.8	32,146	28.6	3,121	11.1	4,128	3.7	495
386	Photographic equipment and supplies	–20.2	–22,398	20.0	116	–51.4	–5,020	–16.1	–1,663
737	Computer and data-processing services	44.1	292,260	49.3	23,166	35.7	35,424	29.8	10,906
871	Engineering and architectural services	6.8	48,938	25.8	13,119	–3.0	–3,064	–14.0	–4,413
873	Research and testing services	10.9	55,205	24.9	5,848	12.3	10,570	3.7	924
874	Management and public relations services	42.1	215,677	69.5	18,437	40.9	34,478	36.3	8,339
899	Services, n.e.c.[2]	28.3	9,093	72.8	865	13.0	637	–16.9	– 147

[1] Data not permitted to be disclosed.
[2] n.e.c. = not elsewhere classified.

SOURCE: Authors' calculations from data provided by the Covered Employment and Wages (ES-202) program, Bureau of Labor Statistics.

and office equipment (SIC 357), special industry machinery (SIC 355), and the instruments and related products group (SIC's 381, 382, 384, and 386).

Although aircraft and parts was the fifth largest R&D-intensive employer in Texas, defense-dependent R&D-intensive industries[18]—which, in addition to aircraft and parts, included search and navigation equipment (SIC 381) and guided missiles and space vehicles and parts (SIC 376)—were comparatively modest contributors to total Texas R&D-intensive employment. Overall, these industries accounted for 8.9 percent of Texas employment in R&D-intensive industries, a figure essentially equal to Massachusetts' 9 percent, but considerably less than California's 16.6 percent. Texas' share translated into 55,831 jobs in 1994.

Growth of R&D-intensive employment in Texas

At the national level, total U.S. employment in R&D-intensive industries decreased by 1.4 percent between 1988 and 1994. California and Massachusetts followed the national trend, recording employment decreases of 13.4 percent and 16.4 percent, respectively, over the 6-year period. Of the 30 R&D-intensive industries examined in this article, 20 recorded employment losses nationally over the period. (See table 2.) The largest declines were in the defense-dependent industries (SIC's 372, 381, and 376), which fell 29 percent, 42 percent, and 49 percent, respectively. These were followed closely by cigarettes (SIC 211, –26.3 percent), computer and office equipment (–24.2 percent), and photographic equipment and supplies (SIC 386, –20.2 percent). The largest increases were in the services categories, principally computer and data-processing services (44.1 percent), management and public relations (42.1 percent), and services, n.e.c. (28.3 percent). Only one durable goods industry, medical instruments and supplies (SIC 384, 13.8 percent), and one chemical industry, drugs (SIC 283, 15.0 percent), recorded employment growth. Both of these are tied closely to the health care industry.

In sharp contrast, and in spite of a loss of 12,100 workers (10.2 percent) in the oil and gas sector (SIC's 131, 291, and 299), Texas registered a 6.8-percent increase in the number of workers employed in R&D-intensive high-tech industries. This amounted to 40,123 new jobs, or slightly more than 1.1 percent per year between 1988 and 1994. One of the more striking features of this growth was that 12 of the 20 industries that declined nationally grew in Texas. For example, computer and office equipment declined by 24 percent nationally, but increased by 34 percent in Texas, for a net gain of 7,560 workers. Although not particularly well represented in Texas, plastics materials and synthetics, nonferrous rolling and drawing (SIC 335), and photographic equipment and supplies also declined nationally, but grew by more than 20 percent within the State. In contrast, in Massachusetts, only one nationally declining industry—industrial organic chemicals—recorded an increase in employment, and this industry was a very minor contributor to total R&D-intensive employment in the State. Within California, only three nationally declining industries—soap, cleaners, and toilet goods (SIC 284), plastics materials and synthetics, and special industry machinery—recorded growth. Again, none were substantial contributors to total State employment.

Nationally, with the exception of drugs and agricultural chemicals, employment in all three-digit components of the chemicals group declined between 1988 and 1994. The situation was the same in California and Massachusetts, but Texas bucked the trend: the R&D-intensive industries that were most important to the State fared well. Besides the petroleum industries, industrial organic chemicals (the largest chemical industry employer in Texas) grew in spite of a national decline, and four of the other five chemical industries that recorded employment losses at the national level also grew in Texas. Similarly, although the proportion of services to total R&D-intensive employment in Texas is somewhat smaller than in California or Massachusetts, employment growth rates in all five of these increasingly important industries were higher in Texas. In particular, employment in engineering and architectural services increased 26 percent, while declining in both California and Massachusetts.

Nevertheless, despite gains in 8 of the 13 durable goods R&D-intensive industries in Texas, employment declined in high-tech durable goods, as it did nationally and in California and Massachusetts. But the percentage decrements in electronic components and accessories and in aircraft and parts, the two largest R&D-intensive durable goods employers in Texas, were about two-thirds that of the national decline and well under one-half that of each of California and Massachusetts. Similarly, although Texas was less well represented in the instruments group (SIC 38), only one of the four industries in the group—search and navigation equipment—recorded an employment loss in Texas, while two of the other three industries declined nationally and in the two comparison States.

Hierarchy of R&D-intensive industries

Thus far, both in cross section and across time, industry employment in the Texas R&D-intensive high-tech sector is quite different from that in the "core" high-tech States of California and Massachusetts. To evaluate the differences more precisely, we calculated *location quotients* for all three States in both 1988 and 1994. The location quotient measures differences in the concentration of employment in a given industry and region relative to the Nation as a whole. A location quotient greater than 100 indicates that an R&D-intensive industry is more specialized in a given State than in the Nation as a whole. The term "specialized" is often interpreted to mean that the industry produces more of its good or service than is necessary to supply the needs of its home State or region and that it therefore exports a share greater than the national average to external markets. However, this interpretation is problematic because some R&D-intensive high-tech industries are so much more export intensive than others.[19] For example, in fields such as guided missiles and space vehicles, and semiconductors and related devices (SIC 3674, contained in electronic components and accessories), even if there were only a small amount of employment in a given State and a correspondingly low location quotient, *all* of the output might be intended for purchase elsewhere. This issue is made even more poignant by our knowledge that in most R&D-intensive industries over the past several years, output has been increasing while employment has been falling.[20]

In this case, therefore, we calculated the location quotient by first dividing statewide employment in each R&D-intensive industry (for example, in Texas, aircraft and parts) by employment in all R&D-intensive industries in Texas, and so on for each industry and statewide R&D-intensive employment total in Texas and the other two States. An identical ratio was calculated for R&D-intensive industry at the national level, and the State ratio for each industry was divided by the national ratio.[21] While our use of the *total employment in R&D-intensive industries* in the denominators of the State and national ratios is somewhat unorthodox (most researchers simply use *total employment* at the State and national levels), it helps us compare "apples with apples"—that is, Texas producers of R&D-intensive goods and services with their R&D- and export-intensive counterparts throughout the Nation and in California and Massachusetts.[22] Further, by calculating location quotients at the beginning and end of the 1988–94 period, we are able to see how different rates of R&D-intensive industry employment growth at the State *and* national levels affected the degrees of high-tech industry specialization among the three States studied. Also, examining the location quotients at the beginning and end of the 6-year interval indicates whether employment growth in Texas high-tech industries came at the expense of California and Massachusetts, or, for that matter, whether employment in a given R&D-intensive industry was tending to concentrate toward (or away from) any one (or all) of the three States.

Table 3 shows only the industries in which at least one of the three States had location quotients greater than 100 in either 1988 or 1994. We first compare the 1994 location quotients. Not surprisingly, Texas was very highly specialized in crude petroleum and natural gas operations, industrial organic chemicals, and petroleum refining. The magnitudes of the coefficients in these industries indicate the extent to which Texas-based petrochemical industries participate in production for national and even global markets. Texas also was specialized, but to a lesser extent, in miscellaneous petroleum and coal products and miscellaneous chemical products. By contrast, the location quotients for all of these industries were less than 100 in California and Massachusetts, with the exception of petroleum refining in California.

On the other hand, only four durable goods manufactur-

Table 3. Location quotients of selected R&D-intensive industries in Texas, California, and Massachusetts, 1988 and 1994

SIC	Industry name	Texas		California		Massachusetts	
		1988	1994	1988	1994	1988	1994
131	Crude petroleum and natural gas operations	663.3	648.6	58.6	63.0	(1)	(1)
286	Industrial organic chemicals	349.8	348.3	16.0	18.8	6.5	19.3
291	Petroleum refining	305.7	319.3	128.1	124.1	(1)	(1)
367	Electronic components and accessories	150.6	146.1	154.2	157.6	141.4	124.8
299	Miscellaneous petroleum and coal products	138.2	102.9	46.2	50.4	76.4	93.2
287	Agricultural chemicals	126.6	89.5	36.4	47.1	4.3	4.4
372	Aircraft and parts	117.9	125.1	154.9	138.9	33.7	32.7
366	Communications equipment	114.8	129.4	76.7	90.1	196.2	172.3
376	Guided missiles and space vehicles	106.6	25.8	246.6	248.0	189.8	277.9
289	Miscellaneous chemical products	103.7	118.2	55.3	52.0	76.7	92.7
737	Computer and data-processing services	102.4	97.9	95.4	102.3	124.8	132.6
871	Engineering and architectural services	101.3	110.2	90.3	93.5	98.5	93.7
874	Management and public relations services	74.7	82.3	104.7	118.3	101.4	114.7
357	Computer and office equipment	68.6	112.1	126.6	170.3	262.2	216.6
384	Medical instruments and supplies	67.7	70.6	101.9	113.3	130.4	140.2
873	Research and testing services	67.1	69.8	108.5	125.1	112.2	123.7
381	Search and navigation equipment	53.6	63.3	251.1	246.5	116.1	160.7
382	Measuring and controlling devices	48.6	57.8	138.5	154.0	198.6	211.3
355	Special industry machinery	29.6	28.5	42.7	66.9	152.8	148.7
386	Photographic equipment and supplies	7.6	10.5	56.2	38.9	210.7	261.4

[1] Data not permitted to be disclosed.

SOURCE: Authors' calculations from data provided by the Covered Employment and Wages (ES-202) program, Bureau of Labor Statistics.

ing industries in Texas—electronic components and accessories, communications equipment, aircraft and parts, and computer and office equipment—had location quotients above 100 in 1994. All four are widely viewed as strategically important R&D-intensive industries, and Texas location quotients generally fell between the highest and lowest scores of the two comparison States. But both California and Massachusetts were specialized in a number of other durable goods industries: three of the instruments and related products group (SIC's 381, 382, and 384) and guided missiles and space vehicles in both States, and special industry machinery in Massachusetts.

Other things equal, then, most R&D-intensive durable goods manufacturing industries in Texas were less specialized than in California and Massachusetts and, in the national hierarchy of R&D-intensive industries, were less prominent participants in production for external markets.[23] The same could be said for the service industries: of the five such industries, Texas was specialized only in engineering and architectural services, and the degree of specialization was not particularly high, as measured against the two comparison States. Both California and Massachusetts were specialized in three service industries (SIC's 737, 873, and 874). However, in the first of these (computer and data-processing services), the difference between the Texas and California location quotients was so small (97.9 versus 102.3), that the two States were almost equally specialized.

As we might expect, location quotients for 1988 and 1994 indicate that in several industries, differences in proportional shifts in employment at the national and State levels increased the degree of Texas-based R&D-intensive industry specialization. The most significant change was in computers and office equipment, for which the Texas location quotient moved from 68.6 to 112.1. As noted earlier, employment expanded by more than one-third in Texas, but fell by about half in Massachusetts and by lesser, but still considerable, percentages in California and across the Nation. Elsewhere in durable goods, a similar pattern of employment change in communications equipment resulted in a slightly more specialized Texas-based employment concentration. In aircraft and parts production, employment declined in Texas by a smaller percentage than it did in either of the two comparison States or the Nation as a whole, and by 1994, this resulted in a degree of specialization that rivaled California's. In services, Texas' degree of specialization in engineering and architectural services increased over the 6-year interval. The State also increased its location quotients in all four of the instruments industries, but did not become nationally specialized in any. Quotients for medical and surgical instruments and measuring and controlling devices increased in all three States, an indication that the relative weight of employment concentrations in these industries may be moving away from the rest of the Nation and toward Texas, California, and Massachusetts.

Despite some small downward movements in the associated location quotients, Texas maintained its overwhelmingly high level of specialization in the petroleum extraction, industrial organic chemicals, and petroleum-refining industries. The State's specialization in electronic components and accessories also lessened, but not enough to threaten the status of Texas as a national region for the production of these goods. At the other end of the spectrum, one of the few R&D-intensive industries in which employment rose nationally, but fell in Texas, was agricultural chemicals (SIC 287). This shift of employment out of the State—apparently, to California and other parts of the country—resulted in a significant lessening of the industry's degree of employment specialization in Texas. Finally, the relative rates of decline in employment in guided missiles and space vehicles—86.5 percent in Texas, compared with 54.6 percent in Massachusetts and 36 percent in California—were such that Texas became a very minor participant in the manufacture of these products for export between 1988 and 1994.

High-tech contribution to the economy

For some time now, Texas has been an important center of R&D-intensive high-tech industry in the United States. The newest evidence that we bring to bear on this assertion is that, unlike the situation in the two comparison States and the Nation, R&D-intensive industries in Texas have made a positive contribution to State employment growth over the last several years. But as we noted at the outset, this dynamism is more complex than it at first appears. Total employment growth in Texas high-tech industries amounted to only a little more than 40,000, or an average of about 6,700 jobs per year between 1988 and 1994. The aggregate dimensions of employment change in the Texas R&D-intensive sector are therefore less important than the relative concentrations of industry employment (as measured by the location quotient), because the latter identify the indigenous technical specialties that distinguish Texas high-tech industries from their counterparts elsewhere. In turn, a region's specialized industries produce goods and services whose technical sophistication or overall quality make them the commodities "of choice" for customers outside the region. Over the long term, these specialties are likely to be important contributors to State or regional economic performance.

In this sense, although chemicals and petroleum probably will continue to account for only a stable share of jobs in the Texas R&D-intensive sector, their remaining concentrations of employment are still the most important distinguishing feature of the State's high-tech industry. Despite the fact that its natural endowments of onshore oil and gas are dwindling, Texas is the core State in one of the Nation's preeminent chemical-producing regions. Houston and the Texas Gulf

Coast are home to the administrative, research, and production facilities of many of the world's largest petrochemical companies and related support firms. Total employment in the eight chemical industries in Texas increased 8.6 percent (approximately 6,700 jobs) over the 6-year period studied, at the same time that national employment in the chemical industry was essentially static.

Moreover, while the petroleum industry is well into the mature stages of its life cycle, hydrocarbon energy technology will continue to dominate production processes in the advanced industrial world for the foreseeable future. Demand is clearly one spur to technical innovation, and Texas' indigenous specialty in engineering and architectural services—of which the petroleum engineering services industry (in SIC 8711) is a component—is generating new knowledge and equipment that enable petroleum deposits in previously inaccessible waters of the Gulf of Mexico to be exploited. Recent accounts indicate that Houston is now the principal locus of a boom in deepwater oil and gas extraction.[24] This is evidence of technological dynamism linked across two R&D-intensive goods- and service-producing industries in which Texas is specialized.

The historical persistence of the oil and gas share of employment in Texas high-tech industry is at least one reason that durable goods manufacturing, along with services, makes up smaller proportions of R&D-intensive industry employment than in California and Massachusetts. Yet it would be inaccurate to suggest that there are no indigenous segments of high-tech durable goods production in the State or that they have not made significant contributions to the Texas economy. For instance, as the result of a wartime decision by the Federal Government to move a portion of the industry away from vulnerable coastal cities, aircraft and helicopters have been made in the Dallas-Fort Worth area since the early 1940s.[25] And in the 1950s, the invention of the integrated circuit and the invention of the silicon transistor at Texas Instruments fueled considerable employment growth in technology-intensive durable goods manufacturing.[26] Texas Instruments' contribution to the microelectronics revolution was, of course, homegrown, while aircraft production in Texas was imported, but in both cases the State has been a specialized producer in these industries for some time.

One outcome of the recent employment growth scattered across the Texas R&D-intensive durable goods sector was that computers and office equipment took a nationally specialized position alongside the State's electronic components, aircraft, and communications equipment industries. But because the computer and electronics industries were essentially *founded* in States such as California and Massachusetts, and leading firms grew to national and international prominence in those places, Texas is still widely viewed as an "advanced production area," rather than a core region, for high-tech durable goods.[27] This assessment may be outdated, because low taxes and low land and labor costs[28] have positioned Texas to gain employment through the shifting of existing jobs in the computer and electronics industries from other parts of the Nation. These factors will continue to make the State an attractive site for further waves of corporate relocations or new "technical" branch plants. And the R&D-intensive durable goods firms that have moved to or were founded in Austin, Dallas-Fort Worth, and Houston over the last 15 years may yet be able to re-create the self-sustaining rounds of innovation that characterized the growth of firms in places such as California and Massachusetts during the initial years of the microelectronics revolution.

Still, it is important to remember that national employment in R&D-intensive durable goods *declined* over the period examined in this article. The decline is attributable to falling or, at best, stable defense expenditures, automated manufacturing processes that reduce the need for unskilled and semiskilled workers, and the migration of increasingly routinized manufacturing to low-cost offshore locations.[29] These forces are potentially more detrimental to R&D-intensive durable goods employment in Massachusetts and California, where the durable goods industry (and the defense industries that rely on it) constitutes a larger proportion of employment in the R&D-intensive sector, than in Texas. But this is not to say that such forces are absent in Texas: as we (and others) have observed, labor-saving processes developed by R&D-intensive industries cause intraindustry changes, in Texas as well as elsewhere.[30] The category of computers and office equipment provides the most dramatic example of these changes: computing power has continually *increased* over the last two decades, while the price of that power has *decreased*.[31] This has lowered the cost of automating design and manufacturing processes in computers and other civilian high-tech manufacturing, reducing the number of workers required at any output level. The result has been rising output, falling employment, and the likelihood that these trends will continue. The Bureau of Labor Statistics projects annual output in the computer industry to rise by 7.3 percent and annual employment to fall by 2.6 percent between 1994 and 2005.[32]

As products and processes evolve to maturity in firms that migrated to Texas from higher cost locations, the pressure to reduce costs also reduces employment by encouraging more automation or further migration to even lower cost sites—for example, the *maquiladora* manufacturing complexes just south of the Rio Grande. Thus, the State's ability to continue to expand employment in R&D-intensive durable goods may be limited. Furthermore, employment levels may never be high enough for Texas to move from an advanced production area to the status of a core State in this sector of the high-tech market.[33]

Finally, as in California and Massachusetts, R&D-intensive service industries were strongly represented among Texas high-tech industries. Indeed, the five R&D-intensive services posted the largest net employment gain (approximately 61,500) of the four subgroups (oil and gas extraction and refining, chemicals, durable goods, and services) in the Texas R&D-intensive sector. But Texas was nationally specialized only in engineering and architectural services, was slightly below California's marginal level of specialization in computer and data-processing services, and was much further behind in management and public relations and research and testing services. This situation may persist for the same reason that it may be difficult for Texas to become a core State for the production of durable goods in which it is not already specialized: even though some management and research service firms in Texas could be characterized as innovative or in the early growth stages of their life cycles, those in California and Massachusetts may occupy a superior position in the national hierarchy of R&D-intensive service production simply because they entered their markets first.[34] The window of locational opportunity that gave these high-tech service providers their initial lead already may have closed for firms based elsewhere seeking to overtake them.

Nonetheless, in percentage terms, R&D-intensive services grew much faster in Texas than they did nationally or in the two comparison States. This fact, by itself, may indicate that R&D-intensive services (outside of engineering and architectural services) will *not* be consigned to a parochial role in Texas, relative to the nationally specialized high-tech service industries in California and Massachusetts. The overall growth of the Texas economy is likely to continue to generate strong demand for these services in the future,[35] and it also seems likely that R&D-intensive services will make the biggest positive contribution to the statewide change in employment in all R&D-intensive industries in the 1990s. In the process, computer and data-processing services may unseat crude petroleum and natural gas as the largest single R&D-intensive industry in the State.

In one form or another, the latter event has been predicted—and eagerly anticipated—by many observers of the Texas economic scene. If it occurs, it would exemplify a process that often unfolds in regions characterized by technologies that lag behind the leading edge. For example, in the early 1980s, oil and gas extraction dominated the high-tech industry sector in Texas, as did microelectronics in California and Massachusetts. Regions such as Texas can sometimes leapfrog the leading, but maturing, technical specializations, to another generation of machines. The transition from oil to services in Texas high-tech employment would be just such an event: a shift in the State's center of economic gravity from the extraction and secondary processing of resource-based goods to the production of intangible goods, largely skipping the stage in which durable goods manufacturing dominates the landscape.

Overall, then, we see three distinct layers of R&D-intensive industries in Texas, differentiated by the stage each occupies in its life cycle. The petroleum and chemical industries were part of a first generation of R&D-intensive industries. Despite evidence of renewed technological vigor in oil and gas extraction, and the likelihood that these industries will continue to make strong contributions to State product and income flows, both are now quite mature, with limited capacity for employment growth. The second-generation, R&D-intensive durable goods manufacturing industries also may be approaching maturity, even though statewide employment opportunities in such industries may be increasing through the relocation of firms founded elsewhere. Finally, as in California and Massachusetts, Texas employment levels probably will be augmented the most from the expansion of the high-tech service sector, the most recent generation of R&D-intensive industry in the State. □

Footnotes

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[1] See R. P. Oakey and S. Y. Cooper, "High technology industry, agglomeration and the potential for peripherally cited small firms," *Regional Studies*, vol. 23, no. 4, 1989, pp. 347–60; A. Saxenian, "Silicon Valley and Route 128: regional prototypes or historic exceptions?" in M. Castells, ed., *High Technology, Space, and Society* (Beverly Hills, CA, Sage, 1985), pp. 81–105; and A. J. Scott, "The collective order of flexible production agglomerations: lessons for local economic development policy and strategic choice," *Economic Geography*, vol. 69, no. 3, 1992, pp. 219–33, for discussions of the differences that exist among various so-called core high-technology areas, such as Silicon Valley, Route 128 in Massachusetts, and Southern California. It is important to note that, while these areas have enjoyed rapid and self-sustaining rounds of innovation leading to high levels of local employment growth, differences in industrial structure can lead to far less spectacular employment performance elsewhere. For example, R. Miller and M. Cote, in *Growing the Next Silicon Valley*: *A Guide for Successful Regional Planning* (Lexington, MA, Lexington Books, 1987), identified 30 regional clusters of high-technology industry with annual employment growth rates ranging from –1.11 percent to 39 percent.

[2] See R. W. Riche, D. E. Hecker, and J. U. Burgan, "High technology today and tomorrow: a small slice of the employment pie," *Monthly Labor Review*, November 1983, pp. 50–58.

[3] See J. P. Campbell and S. Goodman, *High-technology employment in Texas* (Austin, TX, University of Texas, Bureau of Business Research, 1985); J. P. Campbell, *Comparative High-Tech Industrial Growth: Texas, California, Massachusetts and North Carolina* (Austin, TX, University of Texas, Bureau of Business Research, 1986); and *Defense Transition: Economic Promise for Texas* (Austin, TX, Governor's Office of Economic Transition, 1993), for three such attempts.

[4] P. Hadlock, D. Hecker, and J. Gannon, "High technology employment: another view," *Monthly Labor Review*, July 1991, pp. 26–30, defined R&D-intensive high-technology industries as high-technology industries in which the percentage of workers who spend the majority of their time engaged in R&D activities—as designated by the employer in BLS occupational surveys—was at least 50 percent greater than the average percentage for all industries. This metric generated a list of 30 R&D-intensive high-tech industries that we examine in this article.

[5] Riche, Hecker, and Burgan, "High technology today and tomorrow."

[6] Hadlock, Hecker, and Gannon, "High technology employment."

[7] J. A. Schumpeter, *The Theory of Economic Development* (London,

McGraw =Hill, 1934).

[8] For example, with transistor technology approaching maturity in the 1960s, bipolar integrated logic circuits were introduced. As this technology matured, advances in metal oxide semiconductor technology enabled major breakthroughs to occur in microprocessors and electronic memory. Over time, the end uses of semiconductors have expanded to include radios, televisions, computers, VCR's and a wide variety of other consumer and specialty items. (See G. Colclough and C. Tolbert, II, *Work in the Fast Lane*: *Flexibility, Divisions of Labor, and Inequality in High-Tech Industries* (Albany, NY, State University of New York Press, 1992).

[9] Miller and Cote, *Growing the Next Silicon Valley*; Scott, "The collective order of flexible production agglomerations."

[10] R. Vernon, "International Investment and International Trade in the Product Cycle," *Quarterly Journal of Economic*s, vol. 80, 1966, pp. 190–207.

[11] The product cycle has its corollaries as well: the profit cycle (see A. Markusen, *Profit cycles, oligopoly and regional development* (Cambridge, MA, MIT Press, 1985) and the innovation and manufacturing process cycle (see J. M. Utterback and W. J. Abernathy, "A dynamic model of process and product innovation," *Omega*, vol. 3, 1975, pp. 639–56; and L. Suarez-Villa, "Industrial export enclaves and manufacturing change," *Papers of the Regional Science Association*, vol. 54, 1984, pp. 89–111).

[12] A. Glasmeier, "High-tech industries and the regional division of labor," *Industrial Relations*, vol. 25, 1986, pp. 197–211; and "Factors governing the development of high tech industry agglomerations: a tale of three cities," *Regional Studies*, vol. 22, 1988, pp. 287–301.

[13] See H. Goldstein and E. E. Malizia, "Microelectronics and economic development in North Carolina," in D. Whittington, ed., *High Hopes for High Tech* (Chapel Hill, NC, University of North Carolina Press, 1985), pp. 225–55; and D. Lyons, "Agglomeration Economies among High Technology Firms in Advanced Production Areas: The Case of Denver/Boulder," *Regional Studies*, vol. 29, 1995, pp. 265–78.

[14] A. Saxenian, "The Urban Contradictions of Silicon Valley: regional growth and the restructuring of the semiconductor industry," *International Journal of Urban and Regional Research*, vol. 7, 1983, pp. 237–62.

[15] See D. Lyons, "Agglomeration economies"; and R. Smilor, G. Kozmetsky, and D. Gibson, *Creating the Technopolis: Linking Technology, Commercialization, and Economic Development* (Cambridge, MA, Ballinger, 1988).

[16] Scott, "Collective order of flexible production agglomerations."

[17] Nationally, employment in R&D-intensive industries made up 8.9 percent of all private employment.

[18] Our definition of "defense dependent" includes those industries in which defense-related output represented at least 50 percent of total industry output in 1987, the most recent peak year for U.S. defense expenditures. See Norman Saunders, "Defense spending in the 1990's: the effect of deeper cuts," *Monthly Labor Review*, October 1990, pp. 3–15; and "Employment effects of the rise and fall of defense spending," *Monthly Labor Review*, April 1993, pp. 3–10, for a more detailed explanation of this approach to the classification of defense-dependent industries.

[19] See Niles Hansen, "The Nature and Significance of Network Interactions for Business Performance and Exporting to Mexico: An Analysis of High-Technology Firms in Texas," March 1996, Department of Economics, University of Texas at Austin (mimeo), for recent survey data on the relatively high levels of export intensity of high-tech firms in Texas.

[20] See James C. Franklin, "Industry output and employment projections to 2005," *Monthly Labor Review*, November 1995, pp. 45–59.

[21] Mathematically, the location quotient for any R&D-intensive industry *i* can be expressed as

$$LQ_i = ((e_{ij}/e_i)/(E_{JN}/E_N))\ X\ 100$$

where

e_{ij} = employment in State *i* and R&D-intensive industry *j*;

e_i = total employment in all R&D-intensive industries for State *i*;

E_{JN} = employment in R&D-intensive industry *J* for the Nation *N*; and

E_N = total employment in all R&D-intensive industries for the Nation, *N*.

See Avrom Bendavid-Val, *Regional and Local Economic Analysis for Practitioners* (New York, Praeger, 1991), for a further discussion of interpreting the location quotient and arithmetic variants of the preceding algorithm. See also A. Markusen, P. Hall, and A. Glasmeier, *High Tech America: The what, how, where, and why of the sunrise industries* (Boston, Allen and Unwin, 1986), for an example of the use of the location quotient in looking at variations in R&D-intensive industry employment across States.

[22] Of course, the location quotient suffers from a number of well-documented limitations: it assumes that consumption patterns and labor productivity do not vary geographically, that each industry produces a homogeneous good or set of services across States, and that import flows have no impact on a region. (See Joseph Persky, David Ranney, and Wim Wievel, "Import Substitution and Local Economic Development," *Economic Development Quarterly*, vol. 7, no. 1, 1993, pp. 18–29.) But this is true for almost any conceivable static measure that compares the characteristics of State economies. More problematic are the unavoidable anomalies that our method of calculating location quotients generates. For instance, a small high-tech industry that is the only high-tech industry in a State and that is clearly incapable of meeting all the State's need for the good or service it produces could have a very large location quotient. (An example could be the paints and allied products industry.) Despite these limitations, our location quotient is still useful in the context of a three-State comparison.

[23] Because we only have data for workers on American soil, this is probably an underestimate of the degree of export intensity for some of the Texas-based durable goods industries. The *maquiladora* manufacturing complexes situated on the southern banks of the Rio Grande River in Mexico produce a range of technologically sophisticated products, including electronics (SIC's 362, 366, and 367). While workers in these plants are separated from their counterparts in the Texas-based R&D-intensive sector by the U.S.-Mexico border, the two are intimately linked as the production units of U.S.-owned "twins" from which subassemblies and finished goods are exported back across the river and from there to the rest of the Nation and the world.

[24] See Caleb Solomon, "What's Up in Houston? At Long Last, It's Energy," *The Wall Street Journal*, Jan. 17, 1996, p. T1; Bill Gilmer, *Finding New Ways to Grow*: *Recovery in the Oil Patch*, Federal Reserve Bank of Dallas, Houston Branch, July 1996; and John Sharp (Texas comptroller of public accounts), "The Oil Boom—1990s Style,'' *Fiscal Notes*, April 1996, pp. 7–8.

[25] See William G. Cunningham, *The Aircraft Industry: A Study in Industrial Location* (Los Angeles, Morrison, 1951).

[26] In addition, automobiles have been produced in Dallas-Fort Worth since 1913. (See W. H. Read and J. L. Youtie, "Texas Telecom Corridor," *Economic Development Review*, Summer 1994, pp. 27–31.)

[27] See T. Arnold, "Texas Aerospace, Defense, and Dual-Use Technologies," *Texas* (Dallas, Texas Innovation Network, 1993); Glasmeier, *High Tech America* and "Factors governing the development of high tech industry agglomerations"; Miller and Cote, "Collective order of flexible production agglomerations"; and Read and Youtie, "Texas Telecom Corridor."

[28] D. Ann Petersen and Michelle Thomas, "From Crude Oil to Computer Chips: How Technology is Changing the Texas Economy," *The Southwest Economy* (Federal Reserve Bank of Dallas), vol. 6, pp. 1–5.

[29] See *U.S. Defense-Related Employment Retrenches*, Summary 95–7 (Bureau of Labor Statistics, May 1995); Franklin, "Industry output and employment projections"; and *Occupational Outlook Handbook* (Bureau of Labor Statistics, 1994), p. 394.

[30] See Edward J. Malecki, *Technology and Economic Development*: *The Dynamics of Local, Regional and National Change* (New York, Longman Scientific and Technical, 1991).

[31] This perverse economic logic, known as Moore's law, also holds for other types of consumer electronics manufacturing (for example, cellular phones and pagers); see *Business Week*, Mar. 5, 1995.

[32] Franklin, "Industry output and employment projections."

[33] Scott, "Collective order of flexible production agglomerations."

[34] This is even more notably the case among the software and systems design components of computer and data-processing services in States other than California and Massachusetts—for example, Washington State. (See, for instance, R. A. Chase and D. C. Inveen, *An Economic Assessment of the Wash-*

ington State Software Services Industry (Olympia, WA, Washington State Department of Trade and Economic Development, 1989); P. Haug, "Regional formation of high-technology service industries: the software industry in Washington State," *Environment and Planning A*, vol. 23, 1991, pp. 868–84; and J. Campbell, "Mid-Life Crisis on Route 128," *Regional Review*, vol. 5, no. 3, 1995, pp. 6–11.

[35] C. Miller and H. T. Sanders, *Urban Texas: Politics and Development* (College Station, TX, Texas A&M University Press, 1990).

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