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Trends in Employment, the Number of Establishments, and Workers Per Establishment in Biopharmaceutical Industries in Massachusetts and the U.S.

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Introduction

Knowledge of the magnitude and sources of employment change in a state's industries over time is critical for both economic development and workforce development policymaking and planning. Employment in an industry can grow over time due to an increase in the number of economic establishments within the industry, to a rise in average employment per establishment, or to some combination of the above two factors. Annual data from the U.S. Census Bureau's County Business Patterns (CBP) allow us to identify trends in employment, payrolls, and the number of establishments within industrial sectors. The CBP published data cover all major and sub-sector NAICS industries at the national, state and local level.[1] An economic establishment is defined by the U.S. Census Bureau as a physical facility producing goods and services that is located in a fixed geographic location.[2] For each industry, information on the number of establishments by employment size class is also provided. In this research brief, we will identify and assess trends in both the number of establishments and in average employment per establishment for biopharmaceutical industries in Massachusetts and compare the state's trends with those for the U.S. over the 1998 to 2004 period.

Our definition of biopharmaceutical industries includes the following set of industries: pharmaceutical and medicine manufacturing, medical instruments and supplies manufacturing, and research and development in physical, scientific, and biological services. There were 1,142 biopharmaceutical industry establishments in Massachusetts in 2004, representing an increase from 1,020 in 1998 and 1,062 in 2001. In relative terms, the number of establishments in biopharmaceutical industries increased by 12 percent between 1998 and 2004 (Table 1). The establishment growth rate for Massachusetts in these industries was above average for the state as a whole, but was only three-fourths as high as that for the entire nation during the same time period (16%).[3] Between 2001 and 2004, biopharmaceutical industries in Massachusetts experienced a 7.5 percent increase in the number of establishments versus a growth rate of nearly 10 percent for the entire nation. Massachusetts' share of the national number of establishments in biopharmaceutical industries declined modestly from 4.3% to 4.1% over this six-year period (See Chart 1).

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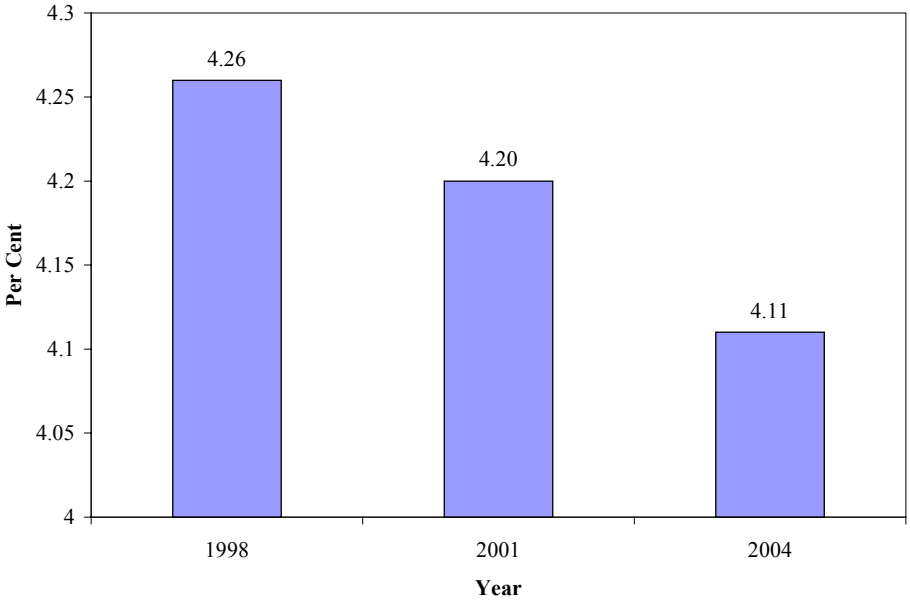
[1] The NAICS acronym refers to the North American Industry Classification System used to assign industry codes to each economic establishment.
[2] Many of the large and medium-sized firms in the biopharmaceutical industry have multiple economic establishments across and within states.
[3] According to estimates from CBP, the number of private, economic establishments in the state increased by 8,000 or slightly under 5% between 1998 and 2004.

Table 1:
Trends in the Number of Economic Establishments in Biopharmaceutical Industries in Massachusetts and the U.S., 1998-2004

Area	Number of Establishments			Percent Change		
Massachusetts	1998	2001	2004	1998-2001	2001-2004	1998-2004
Pharmaceutical and Medicine Manufacturing	70	82	72	17.1	-12.2	2.9
Medical Instrument and Supplies Manufacturing	357	339	312	-5.0	-8.0	-12.6
Research and Development in Physical, Engineering, and Biological Services	593	641	758	8.1	18.3	27.8
All Biopharmaceutical Industries	1,020	1,062	1,142	4.1	7.5	12.0
United States						
Pharmaceutical and Medicine Manufacturing	1,812	1,825	1,833	0.7	0.4	1.2
Medical Instrument and Supplies Manufacturing	12,469	12,151	12,139	-2.6	-0.1	-2.6
Research and Development in Physical, Scientific, and Biological Services	9,650	11,299	13,780	17.1	22.0	42.8
All Biopharmaceutical Industries	23,931	25,275	27,752	5.6	9.8	16.0

Source: County Business Patterns (CBP), U.S. Census Bureau, authors' tabulations.

Chart 1:
Massachusetts' Share of All Establishments in Biopharmaceutical Industries of The U.S., 1998, 2001, and 2004

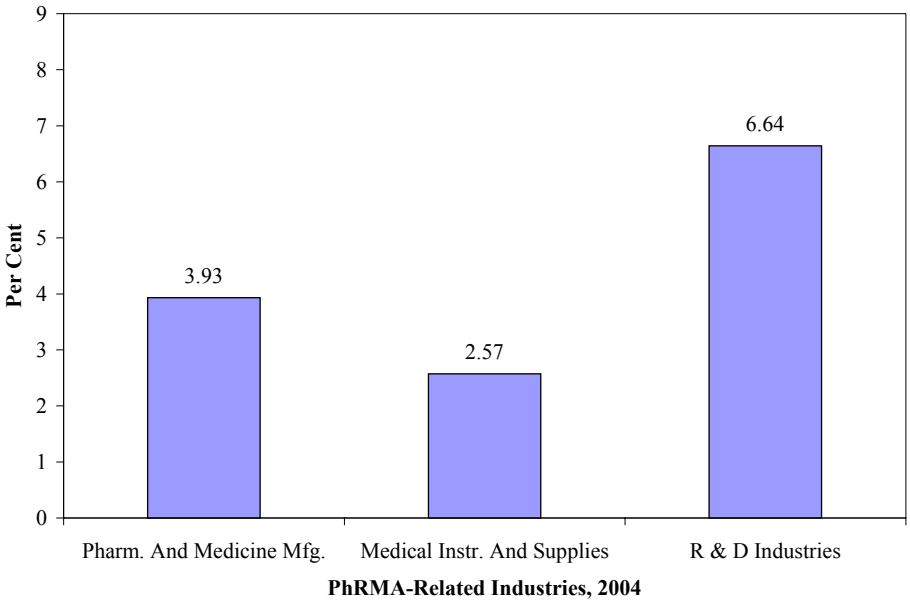


Growth patterns in the number of economic establishments over the 1998-2004 period varied widely across key industrial segments of the biopharmaceutical sector. The medical instrument and supplies manufacturing industries were the only biopharmaceutical sector in Massachusetts experiencing a substantial decline in the number of establishments over the six-year period. A similar growth pattern was prevalent in the U.S. too, but the decline in the number of national establishments in the medical instruments and supplies industry took place at a much more modest pace. The number of establishments involved in medical instrument and supplies manufacturing in Massachusetts declined from 357 in 1998 to 339 in 2001 and even further to 312 in 2004, an overall decline of 13 percent between 1998-2004. The national number of establishments in this industry declined by only 2.6 percent over the same time period. The number of establishments in pharmaceutical and medicine manufacturing industries in Massachusetts increased from 70 to 72 between 1998 and 2004. The number of establishments in this particular industry in our state grew by 17% over the 1998-2001 period, but then declined by 12% between 2001 and 2004. However, the Massachusetts' establishment growth rate of nearly 3% in pharmaceutical and medicine manufacturing industries over the entire time period was slightly higher than that of the nation (1.2%).

The largest increase in the number of establishments in biopharmaceutical industries in Massachusetts occurred in the research and development in physical, engineering and biological services' industries. The number of establishments in this research and development services industry increased sharply from 593 in 1998 to 869 in 2004, an absolute gain of 165 establishments representing a relative increase of 28 percent. However, the growth rate in the number of establishments in Massachusetts in this biopharmaceutical sector was lower than the growth rate of establishments in the same set of industries in the U.S. (43% versus 28%).

In 2004, Massachusetts was home for a varying proportion of national economic establishments in these three key segments of the biopharmaceutical sector. Only 2.6% of national establishments in the medical instruments and supplies industries were located in Massachusetts during that year versus nearly 4.0% of establishments in the pharmaceutical and medicine manufacturing industry and 6.6% of all establishments in the research and development services industries (Chart 2).

Chart 2:
Massachusetts' Share of the National Number of Establishments in Selected Segments of Biopharmaceutical Industries, 2004



The Distribution of Establishments in Biopharmaceutical Industries of Massachusetts by Size Class in 1998 and 2004

The U.S. Census Bureau's County Business Patterns (CBP) data allow us to identify the number of establishments by employment size for each NAICS industry in Massachusetts and the U.S. Table 2 displays information on the distribution of biopharmaceutical establishments in Massachusetts and the U.S. by their employment size class in 1998 and 2004. Establishments can be classified into one of the following nine employment size class categories:

- 1-4
- 5-9
- 10-19
- 20-49
- 50-99
- 100-249
- 250-499
- 500-999
- 1000+

For purposes of our analysis, we will classify an establishment as "small" if it employs under 20 workers, as "medium-sized" if it employs between 20 and 249 workers, and as "large" if it employs more than 250 employees.[4]

[4] Different economic researchers and business organizations often use quite different definitions in classifying establishments by size class. For example, the Small Business Administration defines a business as "small" if it has under 500 employees. Over 98 percent of establishments in the U.S. in 2004 would have been classified as "small" under this definition.

In Massachusetts, nearly 39 percent of biopharmaceutical establishments in 2004 had only 1-4 employees compared to 48 percent for the entire U.S. Overall, 67% of the establishments in biopharmaceutical industries in Massachusetts and 77 percent in the U.S. had fewer than 20 employees in 2004; thus, they would have been classified as "small" establishments. Some researchers have argued that smaller firms in this particular sector are more innovative and productive than their bigger counterparts.

Another 29 percent of the biopharmaceutical establishments in Massachusetts would have been classified as "medium-sized" with somewhere between 20 and 249 employees, and the remaining 3.5 percent would have been classified as "large" establishments. A similar percent (3.1%) of U.S. establishments in biopharmaceutical industries would have been classified as large employers in 2004. The share of Massachusetts-based, biopharmaceutical establishments that were classified as large (with more than 250 employees) has been rising over time, increasing from 2.7 percent in 1998 to 3.5 percent in 2004.

The distribution of establishments by employment size class varied across the three biopharmaceutical industries. In Massachusetts, less than half of all establishments (46%) in pharmaceutical and medicine manufacturing industries in 2004 had fewer than 20 employees versus 69 percent of those in both medical instrument and supplies manufacturing and in research and development in physical, engineering and biological research service industries.

A higher share (10%) of the establishments in pharmaceutical and medicine manufacturing industries in Massachusetts were large establishments than in the other two biopharmaceutical industries where only 2 to 3 percent of the establishments employed 250 or more workers. The Research and Development Services industry (NAICS 54171), however, contained a considerably greater number of establishments than pharmaceutical and medicine manufacturing industries. Thus, the actual number of large establishments was greater in the NAICS 54171 industry than in NAICS 3254 (26 versus 7 establishments).

Table 2:
Distribution of Establishments in Biopharmaceutical Industries by Employment Size Class, Massachusetts and the U.S., 1998 and 2004

	NAICS 3254		NAICS 3391		NAICS 54171		All Biopharmaceutical	
Area/Employment Size	1998	2004	1998	2004	1998	2004	1998	2004
Massachusetts								
1-4	25.7	15.3	42.0	39.7	42.8	40.8	41.4	38.9
5-9	11.4	18.1	16.2	16.7	15.3	14.5	15.4	15.3
10-19	8.6	12.5	13.7	12.2	13.3	13.6	13.1	13.1
Less than 20	***45.7***	***45.8***	***72.0***	***68.6***	***71.5***	***68.9***	***69.9***	***67.3***
20-49	21.4	15.3	12.9	14.1	13.7	14.4	13.9	14.4
50-99	11.4	11.1	7.3	8.3	8.3	9.9	8.1	9.5
100-249	10.0	18.1	5.0	6.7	5.1	3.4	5.4	5.3
250-499	5.7	4.2	1.7	1.0	0.7	1.8	1.4	1.8
500-999	4.3	2.8	0.8	1.3	0.5	0.9	0.9	1.1
1000 or more	1.4	2.8	0.3	0.0	0.3	0.7	0.4	0.6
United States								
1-4	25.6	23.7	55.0	52.8	50.7	48.0	51.0	48.5
5-9	12.6	12.0	18.0	18.2	16.1	15.0	16.8	16.2
10-19	13.7	12.2	10.9	11.4	12.7	12.2	11.8	11.8
Less than 20	***51.9***	***47.8***	***83.9***	***82.4***	***79.4***	***75.3***	***79.7***	***76.6***
20-49	18.4	18.8	8.1	9.0	10.7	11.6	9.9	10.9
50-99	9.8	9.5	3.5	3.6	4.7	6.0	4.5	5.2
100-249	10.2	11.9	2.5	3.0	3.5	4.1	3.5	4.2
250-499	5.1	6.3	1.2	1.2	1.0	1.6	1.4	1.7
500-999	2.5	3.4	0.5	0.5	0.4	0.8	0.6	0.9
1000 or more	2.2	2.1	0.3	0.3	0.3	0.6	0.4	0.5

Source: County Business Pattern Data (CBP), U.S. Census Bureau, authors' tabulations.

The Average Number of Workers Per Establishment in Biopharmaceutical Industries of Massachusetts

Estimates of the number of employed workers, both full-time and part-time, in biopharmaceutical industries of Massachusetts can be combined with data on the number of economic establishments to estimate the mean number of workers per establishment for all biopharmaceutical industries combined and for individual industries.[5] The following types of questions can be answered with these data.

What was the average level of employment per establishment in biopharmaceutical industries of Massachusetts and how did the average employment levels of biopharmaceutical

[5] The employment counts from the CBP surveys include corporate executives on the payrolls of these firms and persons on paid vacation/sick leave.

firms compare with those of establishments in other major industries in our state? Has average employment in these biopharmaceutical establishments experienced any growth in Massachusetts over the 1998-2004 period? How has growth of average employment in biopharmaceutical establishments in Massachusetts compared with that of other industries? To answer these questions, we divided total employment in each of these industries by the number of establishments for calendar years 1998, 2001 and 2004. The results are displayed in Tables 3, 4, and 5.

Table 3 displays the rankings of major industries by average employment per establishment in Massachusetts in 2004, and Table 4 displays trends in average employment per biopharmaceutical establishment in Massachusetts and the U.S. over the 1998-2004 time period. The average employment size of establishments in Massachusetts' biopharmaceutical industries was 45 in 2004. For all private sector industries in the state, average employment per establishment was only 17. To place these findings in comparative perspective, we also compared biopharmaceutical industries' average employment per establishment with those of 19 other major industries in Massachusetts in 2004. Among the 20 major industries, the average employment per establishment in Massachusetts was third highest in biopharmaceutical industries. (Table 3). The two industrial sectors with a higher average employment per establishment were management of companies & enterprises with 83 employees per establishment and educational services with 74 employees per establishment.

Table 3:
Ranking of Major Private Sector Industries by Their Average Employment Per Establishment in Massachusetts, 2004

Rank	Industry	Average Employment Per Establishment
1	Management of companies & enterprises	83
2	Educational services	74
3	***Biopharmaceutical Industries***	45
4	Utilities	43
5	Manufacturing	36
6	Health care and social assistance	28
7	Information	27
8	Finance & insurance	22
9	Transportation & warehousing	22
10	Admin, support, waste mgt, remediation services	20
11	Wholesale trade	16
12	Accommodation & food services	16
13	Arts, entertainment & recreation	15
14	Retail trade	14
15	Mining	13
16	Professional, scientific & technical services	11
17	Real estate & rental & leasing	7
18	Other services (except public administration)	7
19	Construction	7
20	Forestry, fishing, hunting, and agriculture support	3
	All Industries	17

Source: County Business Patterns (CBP), U.S. Census Bureau, authors' tabulations.

Average (mean) employment in biopharmaceutical establishments in Massachusetts has been trending upward in recent years, rising from 40 workers per establishment in 1998 to 41 in 2000 and to 45 in 2004, an increase of 5 workers per establishment or 12.5%. Massachusetts' trends in average establishment employment in biopharmaceutical industries were in close accord with the entire U.S over the same time period. Average employment per establishment in the U.S. increased from 33 to 41 over this six year period, a relative gain of 24%. Average employment per establishment grew in both time periods in the U.S. The growth rate of average employment in biopharmaceutical industries in Massachusetts between 1998-2001 period was lower than that of the entire nation for the same set of industries.

Table 4:
Trends in the Mean Number of Workers Per Establishment in Biopharmaceutical Industries of Massachusetts and the U.S., 1998-2004

Area	Number of Workers Per Establishment			Percent Change		
	1998	2001	2004	1998-2001	2001-2004	1998-2004
Massachusetts						
Pharmaceutical and Medicine Manufacturing	113	100	122	-11.6	21.8	7.6
Medical Instrument and Supplies Manufacturing	37	34	36	-7.2	4.4	-3.1
Research and Development in Physical, Scientific, and Biological Services	33	37	42	13.4	13.8	29.0
All Biopharmaceutical Industries	40	41	45	2.5	9.7	12.5
United States						
Pharmaceutical and Medicine Manufacturing	120	128	134	6.8	5.0	12.1
Medical Instrument and Supplies Manufacturing	24	25	25	5.6	1.5	7.2
Research and Development in Physical, Engineering, and Biological Services	29	30	43	6.7	40.0	49.4
All Biopharmaceutical Industries	33	35	41	6.1	17.1	24.2

Source: County Business Patterns (CBP), U.S. Census Bureau, authors' tabulations.

The three biopharmaceutical industries in Massachusetts were characterized by large differences in average employment per establishment and by the growth rates of average employment per establishment over the 1998-2004 period. The pharmaceutical/medicine manufacturing industries were characterized by a considerably higher average employment per establishment in both 1998 and 2004. Average employment during 2004 in establishments in pharmaceutical and medicine manufacturing industries of Massachusetts was 122 versus only 42 workers in research and development service industries and 36 workers per establishment in medical instruments and supplies manufacturing. A similar set of average employment size patterns prevailed for these industries in the U.S., with pharmaceutical manufacturing establishments employing more than five times as many workers as establishments in medical instrument and supplies manufacturing (134 vs. 25).

Growth trends in average employment per establishment also varied widely across the three biopharmaceutical industries over the 1998-2004 time period (Table 4). Average

employment per establishment in pharmaceutical and medicine manufacturing industries of the state increased from 113 to 122 or by nearly 8 percent during the 1998-2004 period in Massachusetts whereas average employment per establishment in medical instrument and supplies manufacturing declined modestly from 37 to 36 employees over the same time period. In Massachusetts, the research and development in physical, engineering and biological services industry experienced substantial growth in average employment per establishment, rising from a mean of 33 workers to 42 workers by 2004. What was unique in this particular industry in both Massachusetts and the U.S. was that the high growth rate in the number of establishments was accompanied by above average growth in average employment per establishment. Massachusetts' growth rate of 29 percent in average employment per establishment in this industry was accompanied by a 28 percent increase in the number of establishments. Very similar developments took place across the nation for this industry. The R & D services industry nationally also experienced very strong growth in both the number of establishments and average employment per establishment over the 1998-2004 period.

How did growth in average employment per establishment in Massachusetts' biopharmaceutical industries compare to the growth rates of average employment per establishment in all other major industries of the state between during 2001-2004? Table 5 compares and ranks growth rates in average employment per establishment in biopharmaceutical industries with 17 other major private industries in the state. The near 10 percent growth rate in average employment per establishment in biopharmaceutical industries of Massachusetts ranked second highest among these 18 industries. Only management of companies and enterprises experienced a higher growth rate (10.2%) between 2001-2004. Overall, average employment per establishment in private sector industries declined from 18 to 17 during this time period, representing a relative decline of 4%.

Table 5:
Growth Rates of Employment Per Establishment in 18 Major Private Sector Industries of Massachusetts, 2001-2004 (Ranked by Growth Rates in Descending Order)

Industry	2001	2004	Absolute Change	Relative Change
Management of companies & enterprises	75	83	8	10.2
Biopharmaceutical Industries	***41***	***45***	***4***	***9.7***
Retail trade	14	14	0	3.5
Transportation & warehousing	21	22	1	3.1
Health care and social assistance	27	28	1	2.9
Educational services	75	74	-1	-1.6
Accommodation & food services	16	16	0	-1.8
Other services (except public administration)	7	7	0	-2.6
Wholesale trade	17	16	-1	-4.0
Real estate & rental & leasing	8	7	-1	-6.6
Finance & insurance	24	22	-2	-8.9
Admin, support, waste mgt, remediation services	22	20	-2	-9.3
Arts, entertainment & recreation	17	15	-2	-10.9
Professional, scientific & technical services	12	11	-1	-11.4
Construction	8	7	-1	-12.7
Utilities	52	43	-9	-17.1
Information	33	27	-6	-17.3
Manufacturing	43	36	-8	-17.8
All Industries	18	17	-1	-4.0

Source: County Business Patterns (CBP), U.S. Census Bureau, authors' tabulations.

Summary of Key Findings

Overall, the biopharmaceutical industries of Massachusetts performed comparatively quite well in generating both more establishments operating in the state over the 1998-2004 period and increasing the average number of employees per establishment. The number of establishments in all biopharmaceutical industries of the state increased by 12 percent over the 1998-2004 period and by nearly 8 percent during the 2001-2004 period when the state was experiencing very substantial job losses and the number of private sector establishments was unchanged.

While two-thirds of all establishments in biopharmaceutical industries had under 20 employees in 2004, average (mean) employment per establishment was 45, the third highest among the 20 major industrial sectors of the state.[6] Over the 1998-2004 time period, the mean number of workers per establishment in biopharmaceutical industries in our state increased

[6] Mean employment per establishment in biopharmaceutical industries was 45 versus a median of approximately 7. The much higher value of the mean relative to the median indicates a substantial skewness in the distribution of establishments on the right hand tail. There are a small number of establishments (1.7% of all biopharmaceutical establishments) that employed 500 or more workers in 2004.

from 40 to 45, a gain of 12.5%, with most of this gain taking place between 2001-2004. Mean employment per establishment in biopharmaceutical industries in Massachusetts rose by nearly 10% between 2001 and 2004 while mean employment per private sector establishment across the state declined by 4 percent over the same time period. The expansion of employment in this sector is particularly important given the heavy export-orientation of the products and services produced by the industry and the high output and employment multipliers, which will be the focus of a future research paper in this series.