Employment and wage outcomes for North Carolina's high-tech workers

North Carolina's employment surge in "high-tech" industries has captured many economic planners' focus; these industries may provide high-paying employment to workers in declining industries, such as textiles, furniture, and apparel

Robert Bowles

During the 1990s, North Carolina experienced a large employment increase in certain industries classified as high-tech. As a result, many economic planners have focused on these industries as a means of providing high-paying employment to workers displaced from declining industries, such as textiles, furniture, and apparel.

From what industries are new high-tech employees drawn? How large are the replacement wages of these workers?[1] The answers to these questions provide valuable insights to State planners who decide which industries receive subsidies and to those who evaluate the success of such programs. In addition, results could be used as a comparison to the results obtained from economic simulation software, which are used in many economic impact studies.[2]

How data were obtained

The methodology involved choosing growing companies in key high-tech industries that had considerable employment in North Carolina in 2000. What are "high-tech" companies? There is no official definition. In general, these are companies that utilize the latest technology in their production or are involved in creating new technology. They have variously been chosen based on the percentage of research and development spending, the proportion of scientists and researchers employed, number of new patents, and so forth. This article uses the three-digit Standard Industrial Classification (SIC) industries highlighted by Paul Hadlock and others in 1991.[3]

The employer data are from the North Carolina Quarterly Census of Employment and Wages (QCEW) program. Also known as the ES–202, this program is a cooperative effort between the Bureau of Labor Statistics and each State. The QCEW data also are linked longitudinally from 1990 through the most recently available quarter, providing a comprehensive and accurate source of business employment and wage data. The employer-reported wage records, which also come from the ES-202, list each employee and total wages paid during the quarter. Combining these existing administrative files with the longitudinal QCEW allows accurate and comprehensive analyses by industry and county for most employers.

From the list of 30 high-tech three-digit SIC industries noted in Hadlock and others, 11 manufacturing industries with a presence in North Carolina were chosen.[4] From the State's longitudinal QCEW, individual companies that had employment increases from the first quarter of 1999 to the third quarter of 2000 were chosen. (The third quarter of 2000 was chosen as a reference period because the current economic downturn hit many of these industries beginning in the latter half of 2000. It also provides an opportunity to see which of the workers hired in this period were laid off in subsequent periods.) Choosing only companies with large net increases in employment produces the most relevant sample for the purposes of this analysis.

For each company chosen, the unemployment insurance (UI) account number was matched to the State's wage records database to obtain the identification numbers of workers employed at

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that company. Then, each worker's wage record history (back to the fourth quarter of 1992 and forward to the fourth quarter of 2002) could be retrieved. Those workers who obtained employment in the high-tech companies during the second quarter of 1999 were selected, and their wage and employment histories were analyzed for this report. Data were initially retrieved for all four quarters of 1999. However, for ease of exposition only, one quarter was chosen for this report. Henceforth, the second quarter of 1999 is referred to as the *hire quarter*.

Company characteristics

As stated previously, North Carolina has significant employment in 11 high-technology manufacturing industries. Table 1 shows the total employment in North Carolina and average annual wages for each of these industries in the second quarter of 1999.

Among all manufacturing employment in the second quarter of 1999, these industries represented 19 percent of total manufacturing employment in North Carolina. The quarterly average wage of the high-tech companies was 142 percent of the average wage for all manufacturing workers in the State.

From the 11 industries, 169 individual companies were chosen based on an increase in the number of jobs between the first quarter of 1999 and the first quarter of 2000. (Originally, there were 170 companies selected, but one of these companies has been deleted because of its relatively large share of employment, which may have led to violations of confidentiality.) These companies are henceforth referred to as the *high-tech sample*. This section shows some of the characteristics of these companies, based on data from the longitudinal QCEW for the second quarter of 1999. In order to protect confidentiality, the companies were aggregated to the two-digit SIC-defined industries. In addition, it is important to distinguish between worksites and companies, as a given company may have several worksites, some of them in different industries.

Table 2 shows the number of companies (actually, worksites) in each two-digit SIC industry, the employment levels, and average wages for the second quarter of 1999.

Of the 169 companies, only 154 had positive employment during the quarter. Many of these companies had multiple worksites. Although it is possible to distinguish between these worksites in the QCEW longitudinal database, it is not

Table 1. Selected high-tech industry employment and wages in North Carolina, 2nd quarter 1999

SIC Code	Industry description	Total employment	Average quarterly wage
20–39	Manufacturing	802,500	$8,400
282	Plastics materials and synthetic fibers	13,600	10,700
283	Drugs	18,100	13,000
335	Rolling, drawing and extruding of nonferrous metals	12,400	9,800
355	Special industry machinery	7,600	9,100
357	Computer and office equipment	20,000	16,700
362	Electrical industrial apparatus	11,800	8,500
366	Communications equipment	14,900	15,400
367	Electronic components and accessories	10,500	9,900
371	Motor vehicles and motor vehicle equipment	31,100	9,700
382	Laboratory instruments	6,900	18,000
384	Medical instruments	6,300	7,900

Table 2. Employment and wages of hire sample, by 2-digit SIC

SIC code	Industry description	Number of worksites	Total Employment	Average quarterly wage
28	Chemicals and allied products	41	24,908	$12,493
33	Primary metal industries	47	8,843	9,889
35	Industrial and commercial machinery and computer equipment	18	1,918	10,981
36	Electronic and other electrical equipment and components, except computer equipment	57	23,593	13,188
37	Transportation equipment	34	16,603	10,181
38	Measuring, analyzing and controlling instruments; photographic, medical and optical goods; watches and clocks	32	5,252	20,099
50	Wholesale trade—durable goods	64	887	15,689

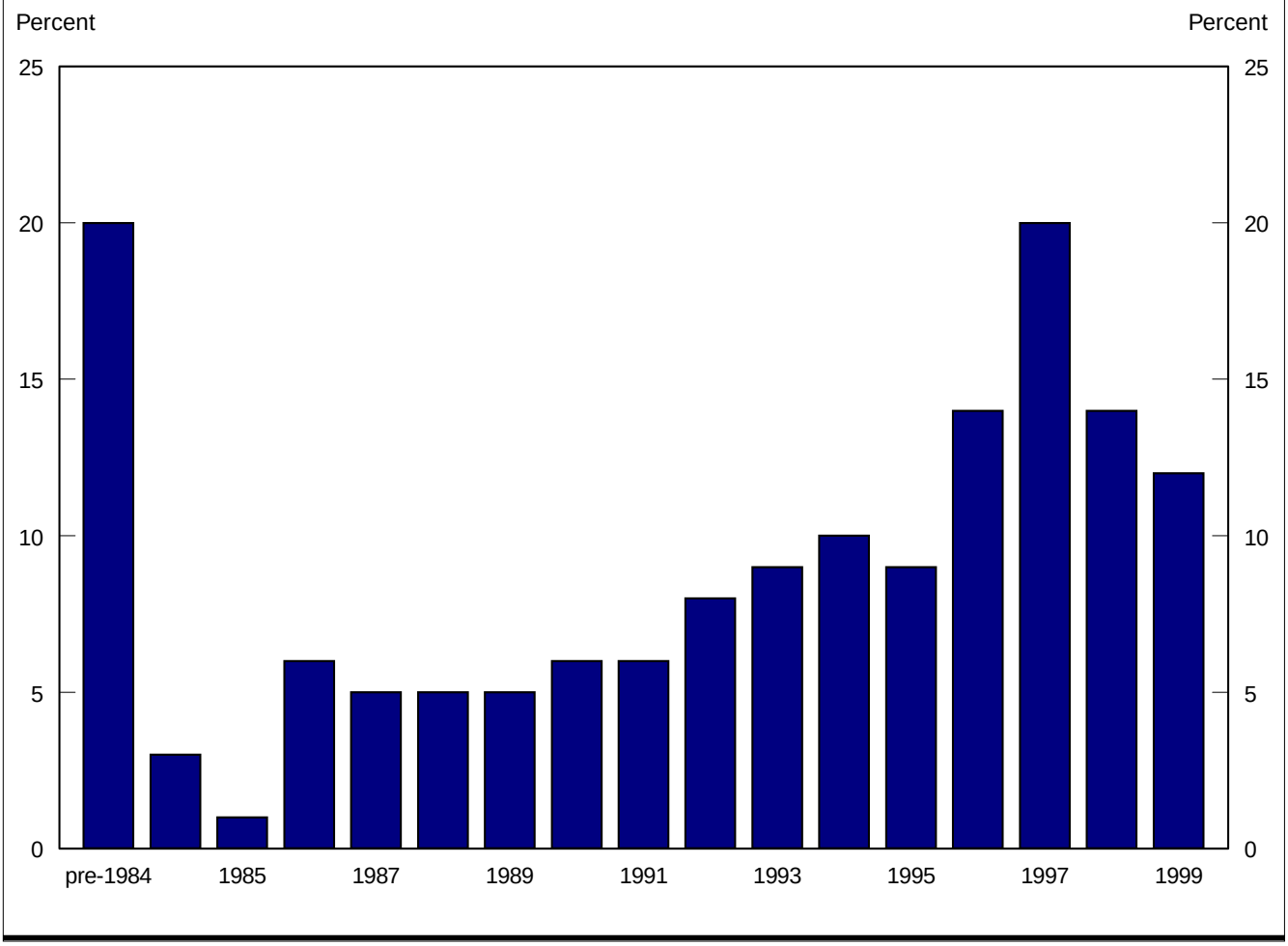
directly possible in the wage records database, because individual reporting unit numbers are not linked to employee identification numbers.

There were a total of 416 reporting units with positive employment in the second quarter of 1999. Only 231 of these had SIC codes consistent with the 11 high-tech manufacturing industries. Due to vertical integration, many of these companies have subsidiaries within various industries. For example, there were 64 worksites designated as belonging to the "Wholesale Trade—Durable Goods" industry, as shown in the table. There were also 15 other two-digit SIC industries represented. This creates some problems because individuals identified as working for a particular high-tech manufacturing company may actually be hired at one of the nonmanufacturing subsidiaries of the company. These workers cannot be distinguished and, in any case, they should be included because the subsidiaries exist, in most cases, because of the parent company's nearby location. Also, relatively few workers overall were employed at one of the non-high-tech industries. Only 12 percent of employment was in these industries.

Age distribution. The age of a particular company may be important in determining hire rates and initial pay rates. Older, more established companies may have the ability to know more about the local employee base (the kinds of skills that workers in the area possess), while job seekers may have more contacts within the company to gain preferential access. Younger companies may face a learning curve and may not offer high wages or may bring in more experienced workers from outside the area. On the other hand, more established firms may be more likely to use back-loaded wages, thereby offering lower wages to new hires, especially younger workers.[5]

Chart 1 shows the distribution of companies in the hire sample by the year in which the first unit of that company was set up in North Carolina. A few of the companies have existed

Chart 1. Distribution of companies in hire sample by initial year of employment in North Carolina



in the State for several decades, but a significant share (45 percent) was established since 1995.

Location. The geographic location of high-technology firms is an important issue for economic development. There is reason to believe that high-tech firms will cluster in areas that allow cross-learning and "sharing" of a trained labor force. David Audretsch and Maryann Feldman found that industries that place a premium on research and development, university research, and skilled labor tend to cluster to take advantage of knowledge spillovers.[6] This "propensity to agglomerate" may overcome incentives by State governments to encourage these industries to locate in depressed regions. However, this effect may not always dominate. The lower cost of labor in rural areas creates a "dispersal effect." Established companies may move their lower-skilled processing to these low-cost areas over time.

Are the companies in the high-tech industries clustered in a few counties within North Carolina? The counties with the highest employment levels in the seven three-digit manufacturing industries during the second quarter of 1999, along with their statewide shares of employment were:

	Percent
Durham County	21.1
Wake County	7.5
Gaston County	5.9
Mecklenburg	5.6
Guilford County	5.5
Catawba County	4.9

Combined, these six counties had half the State's share of employment in high-tech manufacturing industries. This seems to be a high proportion. However, 29 of the State's 100 counties had at least 1,000 high-tech employees. These counties were fairly well spread out across the State, representing both urban and rural counties from every region of the State.

Within the growing, high-tech companies chosen for this report, the counties with the highest employment levels in the second quarter of 1999, along with their statewide shares of employment were:

	Percent
Durham County	18.3
Catawba County	7.3
Guilford County	6.7

Combined, these three counties had nearly a third of total employment in growing high-tech firms in the State (32.3 percent). However, 20 of the State's 100 counties had at least 1,000 employees in growing, high-tech establishments.

Measuring wage growth

In order to compare wages of different individuals over time, two adjustments to nominal wages were made. First, wages were adjusted for inflation, using the Consumer Price Index averages for the quarters. The base period was taken as the first quarter of 2003. Second, the real wages were "discounted" to the second quarter of 1999 using a 3-percent-per-year discount factor.

Discounting wages is useful in comparing wages of workers over time, in addition to adjusting for inflation. An example is useful. Consider three individuals with wages over 3 years, as shown below:

Hypothetical intertemporal wage comparisons

	Worker A	*Worker B*	*Worker C*
Year 1	$20,000	$30,000	$40,000
Year 2	30,000	30,000	30,000
Year 3	40,000	30,000	20,000
Total wages	90,000	90,000	90,000
Present value of wages in Year 1, discount rate = 5 percent	84,852	85,782	86,712

Although the sum of each worker's wages adds up to $90,000 over the 3 years, Worker C has higher wages than the others when time-discounting is considered.

The basic idea behind discounting is that wages earned in earlier periods of time should have more weight than later earnings. This issue may be especially important to workers in new jobs because wages may start off low and increase over time as the worker gains training and progresses up the chain of command. The discounting can also be considered as a typical wage increase over the cost-of-living adjustment.

Three percent was chosen as the discount rate because it corresponds to the real rate of interest. People who earn more in earlier periods can save, earning additional interest; alternatively, people who earn less in earlier periods may have to borrow to smooth out their consumption, and thus are forced to pay interest.

Defining wages

In order to compare the wages of workers before their hire and afterwards, the definition of these concepts must be carefully specified. In effect, given the nature of the concept and the data available, there are many ways to do this. There does not appear to be a single "best" approach.

Post-hire wages were defined as taking the average of discounted real wages earned in the eight quarters (2 years) following the hire quarter. Because, in this study, the hire quarter

was the second quarter of 1999, post-hire wages were calculated by taking the average of each individual's wages from the third quarter of 1999 through the second quarter of 2001. In some instances, zero wages were recorded for individuals. These zeroes were converted to "missing" and ignored when taking the average wage.

Pre-hire wages were defined in a symmetrical fashion. Each individual's pre-hire wage is the average discounted real wage during the eight quarters prior to the quarter before the hire quarter. In this case, that means the quarters from first quarter 1997 to the fourth quarter 1998. (The quarter before the hire quarter was not included because a worker may have quit his old job during this quarter.)

Limiting the comparison to 2 years on either side of the hire is a drawback. In this case, it was done in order to obtain timely data. As discussed in the section on discounting wages, some workers may be accepting low wages in the early period of employment if training is involved. Only considering the first 2 years of employment may greatly underestimate these workers' lifetime potential earnings at the new job. This effect may be more important in high-tech jobs that involve much initial on-the-job learning.

Should the post-hire wages include only the wages earned at the company of hire? It is possible that in the 2 years after the hire, some workers left the company or took a second job. In this study, all wages were considered, regardless of the employer. It can be argued that if the worker moved on to another job, it was in part a consequence of being hired at the high-tech company.[7]

Returns to obtaining employment

According to available wage records, there were 6,541 new hires identified at the 169 high-tech companies in the second quarter of 1999. The following sections present an analysis of the changes in wages for many of these workers. First, the workers were divided into two groups: those with some history of wages in North Carolina; and those with no wage records in the database for 4 years prior to the hire period.

Second, an attempt was made to remove from this study workers who had been "marginally attached" to the work force before they obtained their high-tech job. To this end, workers from the first group above were deleted if they had no wages recorded in 1998 or the first quarter of 1999.

Returns to workers with wage histories

The differences between pre-hire wages and post-hire wages for those workers who had some wages in the North Carolina wage records database before the hire quarter are summarized below:

Quarterly Pre-Hire and Post-Hire Wage Comparisons for High-Tech New Hires

	Number of workers in group	*Mean*	*Median*
Pre-hire wage	5,305	$6,562	$5,549
Post-hire wage	5,373	7,923	6,647
Replacement ratios, by individuals	5,266	1.84	1.19

There were 5,305 workers who had some wages in the 2-year period before the hire quarter. Their mean average quarterly wages were $6,562 and the median wage was $5,549. The differences between these two numbers are typical with wage series. Wage series are generally skewed to the right, causing the mean to be greater than the median. The median is a better measure of the wages of the "average" worker.

Replacement ratios are defined as the value of real discounted post-hire average wages divided by the real discounted pre-hire average wages. The replacement ratio is calculated by comparing the post-hire wage of each individual to their pre-hire wage. The median value of the replacement ratio is 1.19, suggesting that the average worker had a 19-percent increase in wages.

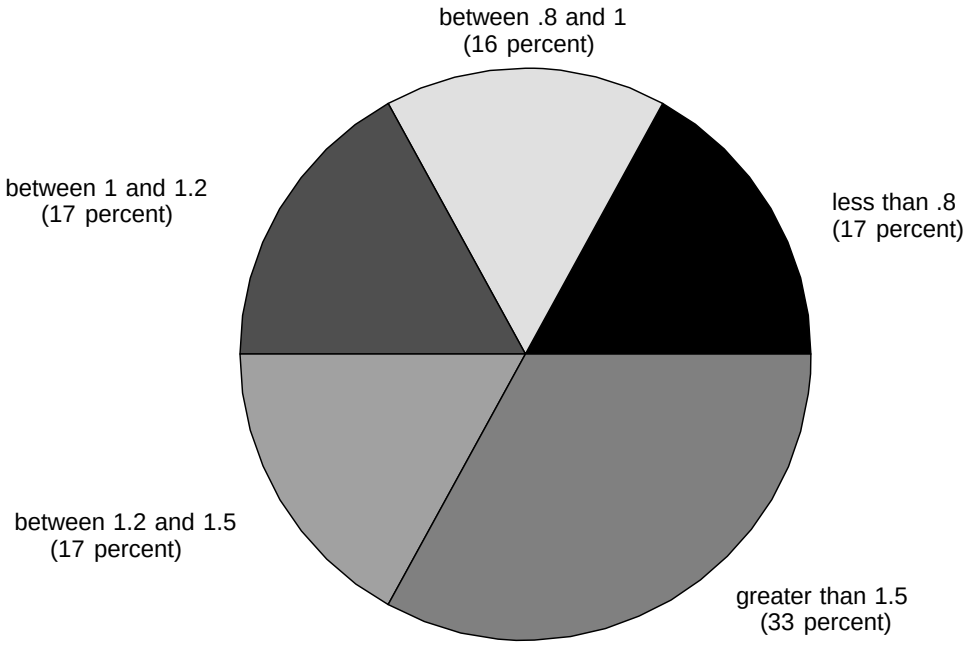
Measures of central tendency, such as the median or the mean, do not capture much of the information revealed by the distribution of data. Chart 2 shows the distribution of replacement ratios for the 5,266 workers with matched pre-hire and post-hire wages. Approximately one-third of the workers had wage gains of more than 50 percent, even after deflating and discounting later wages. However, a third of the sample had lower post-hire wages, and 17 percent had substantially lower wages.

Outcomes for laid-off workers

It seems reasonable that the outcomes of workers will differ between those who move from one job to another and those who have been laid off from a prior job. North Carolina UI administrative records were checked to match the hires of those individuals who received UI payments in March, April, May, or June of 1999. Of the 5,266 individuals in this sample, 418 had UI payments in at least one of these months. Of course, not every worker who was laid off from a previous job would be picked up in this list. There are those who did not file for benefits, and there may have been others who had exhausted their benefits before this period. Therefore, the figure, 418, represents the lower bound for the number of laid-off workers who were in the hire sample group.

Did the reemployment outcomes of these UI recipients match those of the whole sample? The median replacement

Chart 2. Distribution of replacement ratios



ratio for this group was .95 (compared with 1.19). Only about a quarter of these workers (27 percent) had replacement ratios greater than 120 percent, compared to half of the whole sample (see chart 2). One-third (33 percent) of UI recipients had post-hire earnings less than 80 percent of their pre-hire earnings, compared with 17 percent of the whole sample. Thus, the UI recipients fared somewhat worse than the average worker in the hire sample.

Wage outcomes by prior industry. In what industries did the new hires in high-tech companies work previously? In North Carolina, the question is often asked as: Are workers from traditional manufacturing industries getting the jobs at the high-tech companies? The following tabulation shows the number of hired workers who had worked in a given industry prior to the hire quarter:

Industry of prior employment	*Number of workers in group*	*Percentage of overall new hires*
High-Tech Manufacturing	596	13
Non-High-Tech Manufacturing	978	22
Services	1,155	25
Retail Trade	922	20
Other Industries	887	20
Missing Industry Code	938	–

The industry of prior employment is determined by first calculating the total wages earned by each worker at each employer in the 2 years prior to the hire period. Following this, the industry that paid the largest amount of wages was chosen as the prior employer.[8]

For those workers whom an industry code could be assigned, the largest percentage (25 percent) had been previously employed in Services. Relatively large proportions had been employed in non-high-tech manufacturing (22 percent) and retail trade (20 percent) as well.

Unfortunately, the occupations in which these workers were employed cannot be determined. It is impossible to determine from the data if the high-tech companies prefer to hire textile workers, say, for production occupations or if these workers are getting jobs in some other semi-related occupations, such as material handling. There is evidence from the BLS Occupational Employment Statistics program that high-tech companies tend to employ a smaller percentage of production workers than traditional manufacturing companies. For example, in 2001, approximately 35 percent of employees in drug manufacturing companies (SIC 283) were production workers, compared with 64 percent of workers in textile mills (SIC 22).

Do replacement ratios differ by industry of prior employment? Chart 3 compares median post-hire wages to median pre-hire wages by industry groups. There is a large difference in the median pre-hire wage across industries. The median

pre-hire wages were highest in high-tech manufacturing and other industries (which includes wholesale trade; finance, insurance and real estate; construction; government; and trade, communications and utilities) and lowest in retail trade and services.

Chart 3 shows a comparison of pre-hire wages and post-hire wages for workers, based on the industry of prior employment. Post-hire wages tend to equalize wages for workers who were previously employed in different industries. That implies higher wage gains for workers who were previously employed in low-wage industries such as services and retail trade. The percentages shown in chart 3 are the ratio of median post-hire wages to median pre-hire wages. Note that these percentages are just the ratio of median wages and do not give a person-by-person evaluation of wage gains.

Chart 4 shows the different replacement ratios for new hires by industry of previous employment. Consistent with chart 3, workers from services had the highest replacement ratios (earning on average 46 percent more than previously), while workers from other high-tech manufacturing companies had the lowest replacement ratios (3 percent more, on average). As noted previously, the median replacement ratio for all workers was 1.19.

Post-hire wages of workers with no wage histories

There were 754 individuals in the hire sample who had no wage record history for 4 years prior to the hire period. This represents approximately 12 percent of the total number of new hires in the sample. The following table shows a more complete comparison between the two groups studied:

	Wage history group	*Non-wage history group*
Number in group	5,373	754
Median post-hire wage	$6,647	$12,163
25th percentile post-hire wage	4,421	5,390
75th percentile post-hire wage	9,109	20,326

The median post-layoff wage of the no-wage-history group was $12,163. This was approximately twice as much as the average for the group with recent wage record histories.

Given that these workers had no wage records in the 4 years prior to the hire period, it is likely that they come from one of three pools of workers: those who had previously worked outside North Carolina; those who had been students; or those whose wages had not been covered by North Carolina UI Law, such as self-employed persons.

Chart 3. Median wages of workers hired by high-tech companies, by industry of previous employment

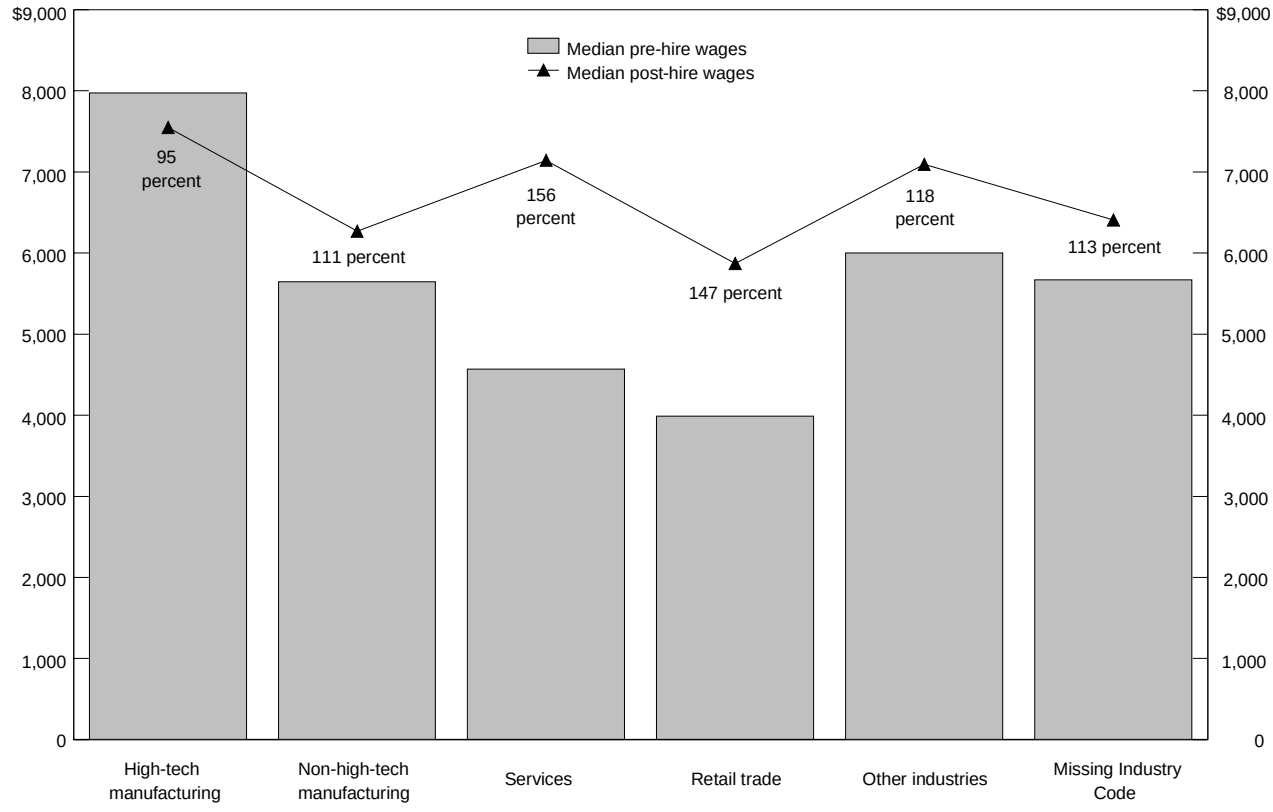
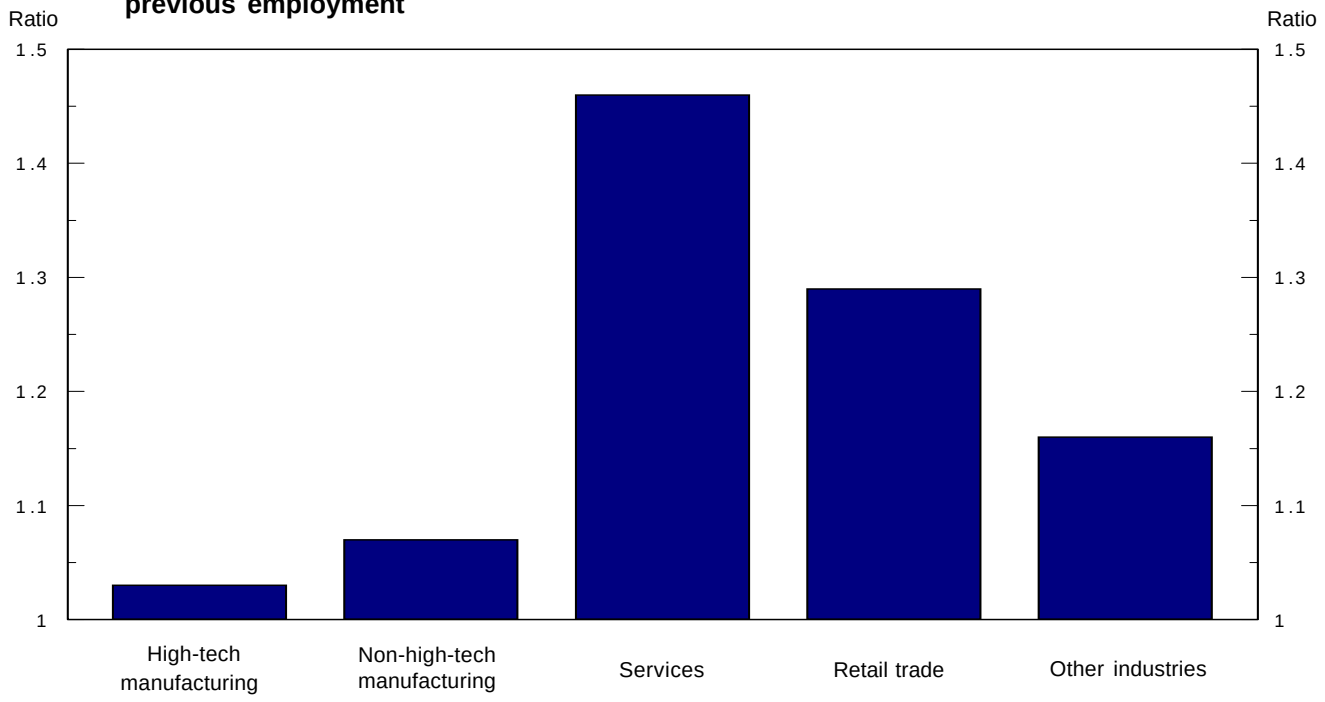


Chart 4. Median replacement ratio of wages for workers hired by high-tech companies, by industry of previous employment



Bias and choice of employment

A question such as, "What is the expected wage gain to an individual due to employment by a high-tech company?" is not directly answered by the data in this article. The data are inherently biased because only those who *chose* to accept the high-tech manufacturing jobs are in the sample. These particular individuals are more likely to have special skills needed for the job, have contacts within the hire company, and so forth, than the average worker.

For example, consider two textile workers, X and Y. Both earn $28,000 per year. These workers are exactly the same except that X has a particular skill that high-tech company Z is willing to pay more for. Both X and Y interview at Z; X is offered $30,000 per year, and Y is offered $25,000. The expected wage would be the average of these two offers: $27,500. However, Y refuses the offer and X accepts, making the *observed* wage increase $30,000.

It seems likely, as the example suggests, that this type of self-selection bias will overstate the wage gains for an average worker moving from one job to another.

Unfortunately, it is impossible to identify workers who migrated to North Carolina from other States at this time. It is likely based on the post-hire wages that these people are highly educated or experienced workers, who will contribute positively to the tax base in the State.

THIS ARTICLE SUGGESTS the possibility of using UI administrative wage records to look at the outcomes of new hires at particular types of companies. For many workers in North Carolina, obtaining a job at a high-tech manufacturing company entails a substantial wage increase. This is especially true for workers from the services and retail trade industries. In addition, high-tech companies seem to have brought in "new" workers to the State who earned relatively high wages.

The outcomes of workers who had been receiving unemployment benefits during the hire quarter give some additional indication of gains to employment in high-tech companies. Although these unemployed workers do not do as well on average as the rest of the workers in the study, there is evidence that they do well compared to laid-off workers in general.[9] It would be beneficial to measure the impact of different worker characteristics, such as education, age, industry of prior employment, tenure at previous job, and so forth, on employment probability and wage returns. These data were unavailable for this study. Even "tenure at previous job" could not be accurately measured due to the short period of the

wage records history and company predecessor/successor issues. Incorporation of these types of data could improve the analysis of the factors that affect wage increases when workers change jobs. □

Notes

[1] The term replacement wage is defined, generally, as the ratio of wages on the new job to wages on the previous job. The specific definition of the wages used in this report is described further in the article.

[2] For an example of an incentive impact study, see Michael I. Luger, "2001 Assessment of the William S. Lee Tax Act," (Office of Economic Development, Kenan Institute of Private Enterprise, University of North Carolina at Chapel Hill, 2001).

[3] Paul Hadlock, Daniel Hecker, and Joseph Gannon, "High technology employment: another view," *Monthly Labor Review*, July 1991, pp. 26–30.

[4] There were also four high-tech service industries with considerable employment in North Carolina. In order to maintain focus in this report, only the manufacturing industries were selected.

[5] Charles Brown and James Medoff, "Firm Age and Wages," *Journal of Labor Economics*, Vol. 21, No. 3, pp. 677–98.

[6] David B. Audretsch and Maryann P. Feldman, "R&D Spillovers and the Geography of Innovation and Production," *American Economic Review*, 1996, Vol. 86, No. 3, pp. 630–40.

[7] There may be a few hires who do not fit in either of the following two categories: 1) New hires at high-tech companies who had worked somewhere else in at least 1 of the preceding 5 quarters; or 2) New hires at high-tech companies who had no wages in North Carolina for the previous 4 years. The term "no wage history" is used for the latter group, even though there may be a few people in this group who worked in North Carolina more than 4 years prior to 1999Q2.

[8] As discussed previously, it is impossible to assign workers to a particular worksite for employers with multiple worksites. In order to assign an SIC to these employers, the SIC of the worksite with the largest number of employees was chosen.

[9] Robert Bowles, "The reemployment outcomes of dislocated manufacturing workers," *Insight: North Carolina's Labor and Economic Outlook*, October 2001 (Employment Security Commission of North Carolina, Raleigh, NC), pp. 11–17. The wage outcomes from these two studies are not directly comparable. The definitions of pre- and post-layoff wages are slightly different, and wages were not time-discounted or adjusted for inflation in the study cited here.