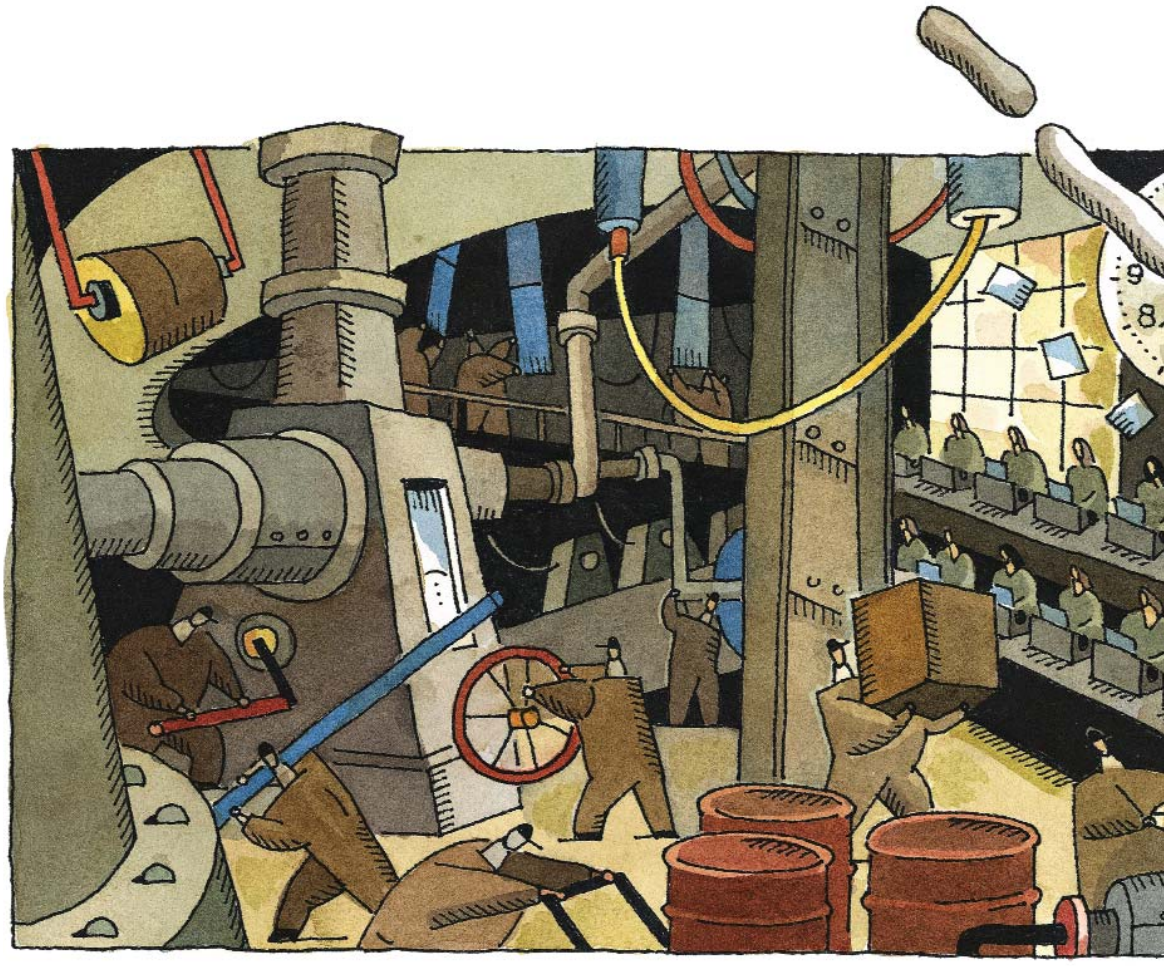
# STRUCTURAL CHANGE

# MANUFACTURING SECTOR



The manufacturing sector has continued to lose employment in the U.S. since 1999 and in Tennessee since 1995. Jobs lost in manufacturing totaled more than three million in the U.S. and 109,000 in Tennessee between 1995 and 2005. However, not all sectors within manufacturing have experienced a similar trend: for example, fabricated metals, electronic instruments, and machinery started adding jobs after 2003, while textile and apparel manufacturing continues to lose jobs. In other words, the manufacturing sectors requiring a low-tech workforce have been on the decline, but the sectors requiring a high-tech workforce have started reversing the trend.

Furthermore, preliminary findings also suggest that the extent of manufacturing job loss depends on the mix of the manufacturing sectors in a particular locality. For example, as Figure 1 clearly shows, while the U.S. and Tennessee continue to lose jobs in the manufacturing sector, the Nashville MSA has reversed that trend since 2003, adding nearly 3,000 manufacturing jobs.

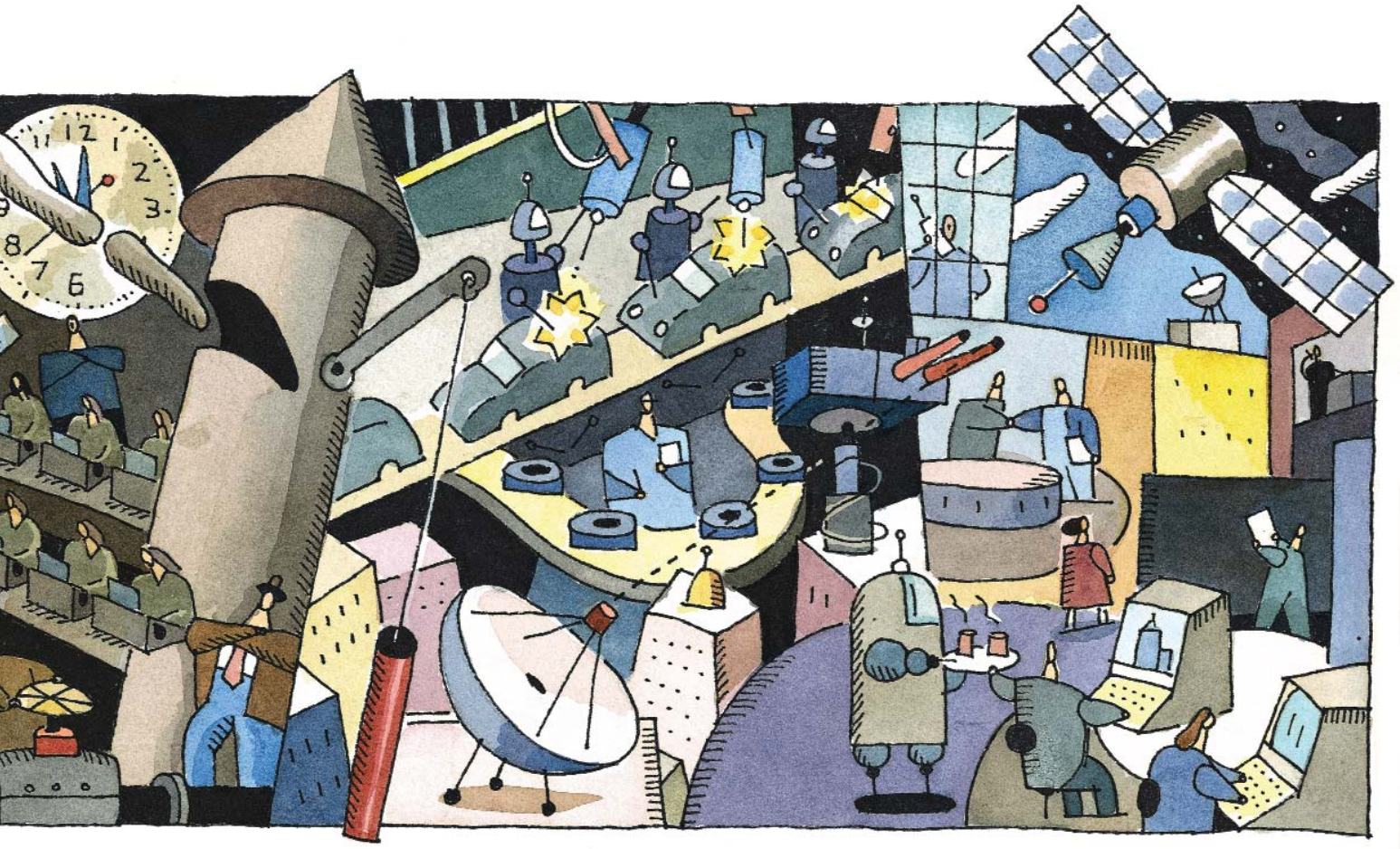
Based on these general observations, this study primarily addresses the following three questions from a comparative perspective: (1) what are the structural changes in the manufacturing sector, (2) how do structural changes in the Tennessee and U.S. manufacturing sectors compare, and (3) what implications do these structural changes have on the demand for workforce skills?

Our approach is to analyze actual structural changes in the manufacturing sector and explore their future implications for workforce skill and the overall manufacturing sector in Tennessee.

## Macroeconomic Projections

*Payroll Employment*. Total payroll employment in Tennessee is expected to expand by 520,000 jobs between 2000 and 2010, a 14.83 percent increase. The largest job expansion is expected

# AND WORKFORCE SKILL



by Murat Arik

**Structural changes in the manufacturing sector in Tennessee suggest the need for different workforce training.**

to take place in services with a 26 percent increase, and the manufacturing sector is projected to add 9,630 jobs (a 1.85 percent increase). Of all these job increases, the services sector accounts for about 51 percent and retail 15 percent.

Tennessee's total job projections are as robust as those for the U.S. (Figure 2). However, unlike the national manufacturing employment trend, Tennessee's manufacturing sector is not expected to expand jobs beyond its 1995 level between 2000 and 2010 (Figure 3).

Payroll employment projections for the nation and the state diverge for two sectors: Transportation, Communications, and Public Utilities (TCPU) and Finance, Insurance, and Real Estate (FIRE). The expected share of FIRE in payroll employment change is about 9 percent in Tennessee and 4 percent in the U.S. TCPU's trend is the opposite; its share is expected to be about 5 percent in Tennessee and 8 percent in the U.S.

*Wage and Salary Earnings*. Total real earnings in Tennessee are projected to increase $27 billion between 2000 and 2010, about 27 percent, largely fueled by the increase in real earnings in the services sector (45 percent). The second largest contributor to the projected increase in real earnings is the manufacturing sector (11 percent), suggesting a significant productivity increase in this sector (Table 1).

Total real earnings, however, are not projected to be as robust in Tennessee as in the U.S. (Figure 4). This is even truer for the manufacturing sector, where the growth of real earnings in Tennessee is projected to widen initially and then remain one step behind projected growth in the U.S. (Figure 5).

Sectoral contributions to change in real earnings reveal important structural differences between the U.S. and Tennessee economies. While the services sector accounts for about 45

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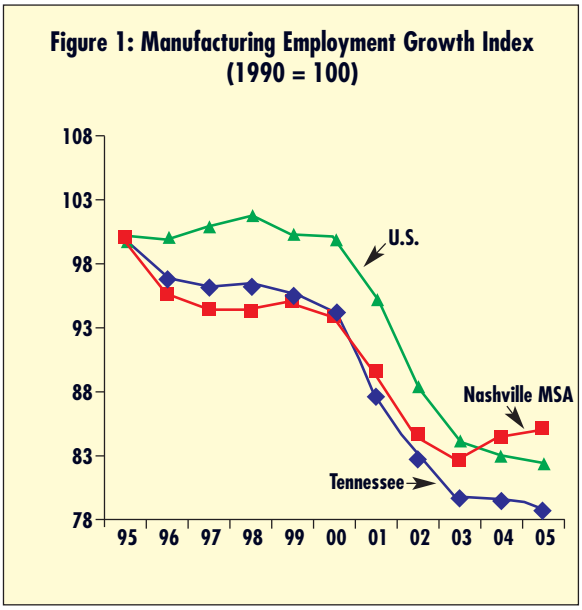


**Manufacturing's share of employment in the advanced industrialized countries has been declining for more than two decades.**

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percent of the changes in real earnings in both economies, the second and third largest contributors vary significantly: FIRE (11 percent) and state and local government (10 percent) in the U.S. and manufacturing (11 percent) and TCPU (9 percent) in Tennessee.

*Employment by Occupation*. From 2000 to 2010, Tennessee is projected to add 567,550 new jobs for an increase of 19 percent. Of these new jobs, 10.6 percent are expected to be in management, business, and financial occupations (60,250); 20.4 percent in professional and related occupations (116,000); and 21.4 percent in service occupations (121,700) (Table 2).

The projected share of professional and related services in new jobs is significantly lower in Tennessee than in the U.S, where professional and related services account for 31.4 percent of projected new jobs and service occupations contribute 23 percent in the same period.

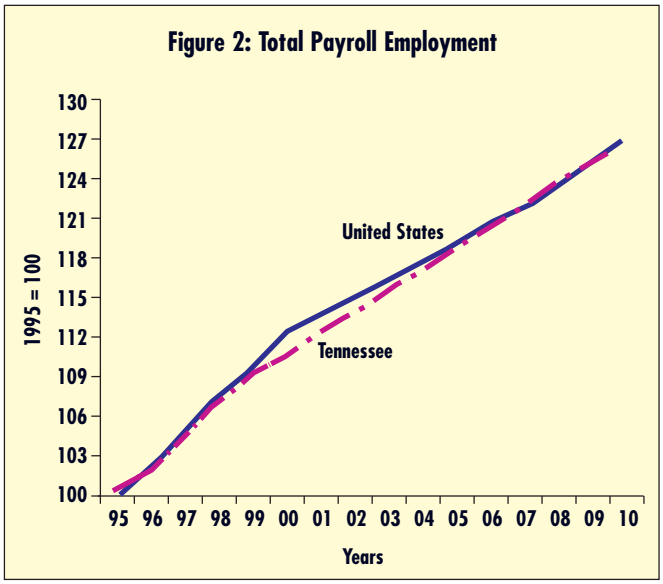
Partly because of the high-level aggregation of occupational categories, the structural shift across occupational categories between 2000 and 2010 is not very large. This occupational reallocation is expected to be around 2.3 percent in Tennessee and 2.5 percent in the U.S.

## Projected Structural Change

The manufacturing sector has undergone significant change worldwide. Manufacturing's share of employment in the advanced industrialized countries has been declining for more than two decades. Despite the decrease in relative employment share, however, manufacturing is still the backbone of many economies in the industrialized world because of its relatively high research and development spending, upstream and downstream linkages to businesses in other sectors, and export orientation.

Figures 6 and 7 highlight the employment shifts among the major industrial sectors in the U.S. and Tennessee between 1986 and 2001. The services sector was the major beneficiary in terms of increased share of employment, but the share of employment in the manufacturing and government sectors contracted during the same period. In Tennessee specific sectors with increased employment shares include services; retail trade; construction; and transportation, communication, and public utilities. In both the U.S. and Tennessee, manufacturing's employment share declined—4.1 percent in the U.S. and 5.9 percent in Tennessee.

The manufacturing sector includes diverse groups of industries that responded differently



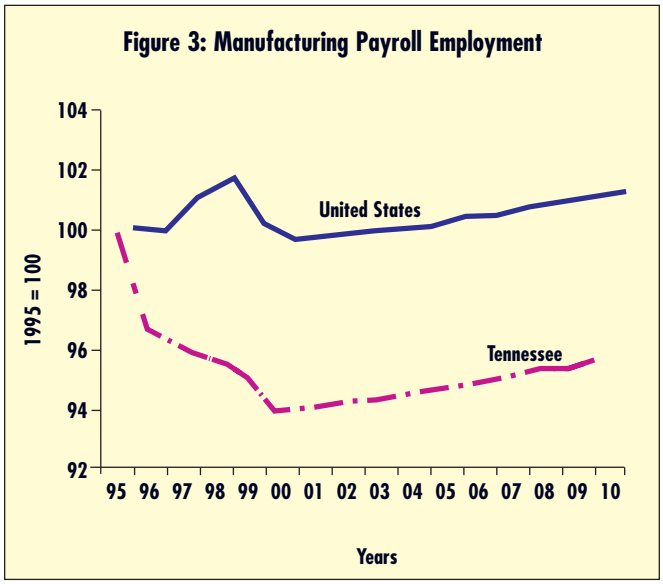



**Table 1: Projected Real Earnings (Millions 1996 $)**

| | United States | | | Tennessee | | |
|---|---|---|---|---|---|---|
| Sector | Change in Real Earnings (2000–2010) | Percent Change (2000–2010) | Percent | Change in Real Earnings (2000–2010) | Percent Change (2000–2010) | Percent |
| Total Real Earnings | $1,345,638 | 23.76 | 100.00 | $27,008 | 26.48 | 100.00 |
| Farm and Agricultural Services | $19,565 | 23.19 | 1.45 | $315 | 39.90 | 1.17 |
| Mining and Construction | $73,861 | 19.11 | 5.49 | $1,348 | 19.34 | 4.99 |
| Manufacturing | $119,036 | 13.34 | 8.85 | $2,970 | 15.20 | 11.00 |
| TCPU* | $80,849 | 20.99 | 6.01 | $2,479 | 31.06 | 9.18 |
| Wholesale | $71,596 | 20.39 | 5.32 | $1,225 | 18.61 | 4.53 |
| Retail | $82,629 | 16.76 | 6.14 | $1,980 | 18.80 | 7.33 |
| FIRE** | $147,825 | 27.52 | 10.99 | $1,841 | 25.18 | 6.82 |
| Services | $594,155 | 35.94 | 44.15 | $12,246 | 43.10 | 45.34 |
| Federal Civilian (Government) | $13,535 | 7.65 | 1.01 | $552 | 17.03 | 2.04 |
| Federal Military | $9,280 | 13.28 | 0.69 | $59 | 13.01 | 0.22 |
| State and Local Government | $133,305 | 21.05 | 9.91 | $1,994 | 19.58 | 7.38 |

Note: *Transportation, Communication, and Public Utilities. **Finance, Insurance, and Real Estate
Source: Woods & Poole, Business and Economic Research Center, MTSU

to the structural change in the economy between 1986 and 2000: some experienced declines in both employment and output, some faced employment declines but output increases, some saw employment increases but output decline, and some had both employment and output increases. Figure 8 clearly demonstrates the extent of diverse trajectories within the manufacturing sectors.

Structural change in the manufacturing sector has been evident over the years as the sector has lost employment and increased productivity. To assess the projected structural changes, however, we need to understand how the structure of the manufacturing sector differs over time. Our method of inquiry is based on three fundamental assumptions: (1) output, employment, and productivity trends in manufacturing sectors in the past 15 years are harbingers of what will emerge in the near future; (2) sectoral output, employment, and productivity in U.S. manufacturing industries represent the averages of the states' figures, toward which Tennessee's manufacturing sectors are at least likely to converge in the future; and (3) Tennessee's manufacturing sectors are likely to follow a trend similar to U.S. manufacturing sectors.

We employ four analytical methods to analyze the projected changes in the manufacturing sector: (1) we use the Krugman Specialization Index (KSI) to explore the structural difference between manufacturing sectors involving two spatial units;[1] (2) we further classify industries using the OECD manufacturing industry classification;[2] (3) we calculate annual average productivity differences between manufacturing sectors in the U.S. and Tennessee to anticipate structural changes in Tennessee; and (4) we introduce an analytical framework, the Structural Change Index (SCI).[3] We calculate this index for both U.S. and Tennessee manufacturing sectors to identify the amount of economic

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**The services sector was the major beneficiary in terms of increased share of employment, but the share of employment in the manufacturing and government sectors contracted.**

**Figure 4: Total Real Earnings (1996 $)**

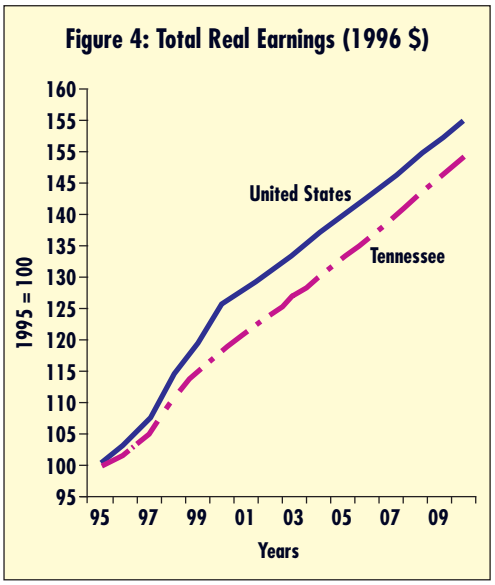


**Figure 5: Real Manufacturing Earnings (1996 $)**

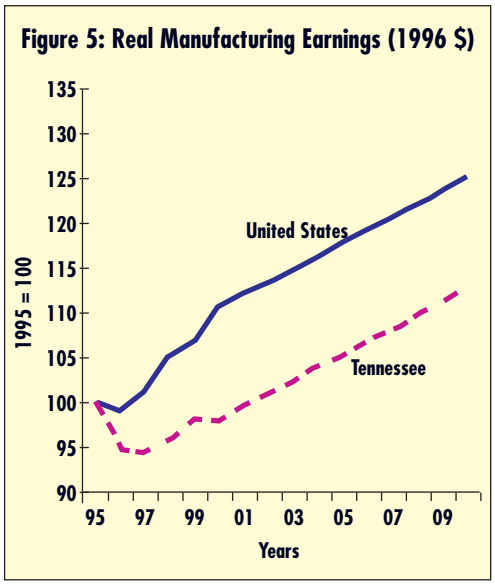

**Table 2: Employment by Occupations and 2010 Projections**

| | United States | | | | Tennessee | | | |
|---|---|---|---|---|---|---|---|---|
| | 2000 | 2010 | Change | Percent | 2000 | 2010 | Change | Percent |
| Total, All Occupations | 145,594,000 | 167,754,000 | 22,160,000 | 100.00 | 2,927,070 | 3,494,620 | 567,550 | 100.00 |
| Management Occupations | 10,564,000 | 11,834,000 | 1,270,000 | 5.73 | 225,010 | 264,430 | 39,420 | 6.95 |
| Business and Financial Operations Occupations | 4,956,000 | 5,801,000 | 845,000 | 3.81 | 77,570 | 98,400 | 20,830 | 3.67 |
| Computer and Mathematical Occupations | 2,993,000 | 4,988,000 | 1,995,000 | 9.00 | 33,630 | 54,080 | 20,450 | 3.60 |
| Architecture and Engineering Occupations | 2,605,000 | 2,930,000 | 325,000 | 1.47 | 40,570 | 50,600 | 10,030 | 1.77 |
| Life, Physical, and Social Science Occupations | 1,164,000 | 1,386,000 | 222,000 | 1.00 | 14,050 | 16,980 | 2,930 | 0.52 |
| Community and Social Services Occupations | 1,869,000 | 2,398,000 | 529,000 | 2.39 | 61,040 | 79,630 | 18,590 | 3.28 |
| Legal Occupations | 1,119,000 | 1,335,000 | 216,000 | 0.97 | 14,220 | 18,580 | 4,360 | 0.77 |
| Education, Training, and Library Occupations | 8,260,000 | 9,831,000 | 1,571,000 | 7.09 | 136,160 | 150,150 | 13,990 | 2.46 |
| Arts, Design, Entertainment, Sports, and Media Occupations | 2,371,000 | 2,864,000 | 493,000 | 2.22 | 35,030 | 43,240 | 8,210 | 1.45 |
| Healthcare Practitioners and Technical Occupations | 6,379,000 | 7,978,000 | 1,599,000 | 7.22 | 146,140 | 183,580 | 37,440 | 6.60 |
| Healthcare Support Occupations | 3,196,000 | 4,264,000 | 1,068,000 | 4.82 | 61,260 | 83,580 | 22,320 | 3.93 |
| Protective Service Occupations | 3,087,000 | 3,896,000 | 809,000 | 3.65 | 66,050 | 90,600 | 24,550 | 4.33 |
| Food Preparation and Serving Related Occupations | 10,140,000 | 11,717,000 | 1,577,000 | 7.12 | 199,840 | 244,010 | 44,170 | 7.78 |
| Building and Grounds Cleaning and Maintenance Occupations | 5,549,000 | 6,328,000 | 779,000 | 3.52 | 93,160 | 110,550 | 17,390 | 3.06 |
| Personal Care and Service Occupations | 4,103,000 | 4,959,000 | 856,000 | 3.86 | 54,810 | 68,080 | 13,270 | 2.34 |
| Sales and Related Occupations | 15,513,000 | 17,365,000 | 1,852,000 | 8.36 | 296,630 | 350,710 | 54,080 | 9.53 |
| Office and Administrative Support Occupations | 23,882,000 | 26,053,000 | 2,171,000 | 9.80 | 449,380 | 511,190 | 61,810 | 10.89 |
| Farming, Fishing, and Forestry Occupations | 1,429,000 | 1,480,000 | 51,000 | 0.23 | 18,590 | 15,300 | -3,290 | -0.58 |
| Construction and Extraction Occupations | 7,451,000 | 8,439,000 | 988,000 | 4.46 | 140,350 | 173,030 | 32,680 | 5.76 |
| Installation, Maintenance, and Repair Occupations | 5,820,000 | 6,482,000 | 662,000 | 2.99 | 116,310 | 136,660 | 20,350 | 3.59 |
| Production Occupations | 13,060,000 | 13,811,000 | 751,000 | 3.39 | 370,170 | 418,210 | 48,040 | 8.46 |
| Transportation and Material Moving Occupations | 10,088,000 | 11,618,000 | 1,530,000 | 6.90 | 277,270 | 333,240 | 55,970 | 9.86 |

Source: Bureau of Labor Statistics and Tennessee Department of Labor and Workforce Development
Note: Tennessee Department of Labor and Workforce Development is currently revising occupational employment projections. For the U.S., projections for 2012 are available at www.bls.gov.

**We anticipate changes in employment, output, and wage share of high-technology industries in the near future.**

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resources reallocated in this sector in each spatial unit and the likely projected resource reallocation trend for Tennessee's manufacturing sector compared to that of the U.S.

## The U.S. versus Tennessee

Measured by employment, there was a significant convergence between the structure of Tennessee and U.S. manufacturing from 1986 to 2000. The extent of this structural change is not, however, the same for all manufacturing sectors: low-technology, unskilled, and low-wage industries in Tennessee became structurally more similar to those in the U.S. We anticipate that Tennessee's manufacturing sector is more likely to converge toward the U.S. manufacturing sector, especially in high-technology industries, in the foreseeable future.

Measured by gross state product (GSP), however, structural differences between the manufacturing sectors in Tennessee and the U.S. widened further between 1986 and 2000 (Table 3). Increasing dissimilarities in this area are partly due to productivity differences, and we anticipate structural changes in Tennessee's manufacturing sector through cost-cutting measures to close the productivity gap between Tennessee and U.S. manufacturing industries.

Comparing structural similarities of the manufacturing sector in Tennessee and the U.S. highlights important likely changes in the structure of the manufacturing sector in Tennessee. We anticipate changes in employment, output, and wage share of high-technology industries in the near future.

## Productivity

The manufacturing sector in both Tennessee and the U.S. recorded significant increases in productivity between 1986 and 2000. The productivity gap between U.S. and Tennessee manufacturing industries, however, is likely to create pressure for structural change in Tennessee's manufacturing industries.

The trend in productivity differences between Tennessee and the U.S. demonstrates the likely direction Tennessee's manufacturing industries will follow. Only four manufacturing industries had significantly higher productivity in Tennessee than in the U.S. between 1986 and 1990. Between 1996 and 2000, however, the trend in the productivity gap changed: industries in which Tennessee had enjoyed a productivity advantage—such as stone, clay, and glass products; paper and allied products; and rubber and miscellaneous products—became less productive in the state compared to the U.S. Conversely, previously less productive industries became highly productive in Tennessee compared to the U.S., including primary metals, motor vehicles and equipment, miscellaneous manufacturing, and textile mill products.

Based on the trend in U.S. manufacturing industries and the productivity gap between Ten-

**Figure 6: Employment Share of Major Industries (Nonfarm): U.S.**

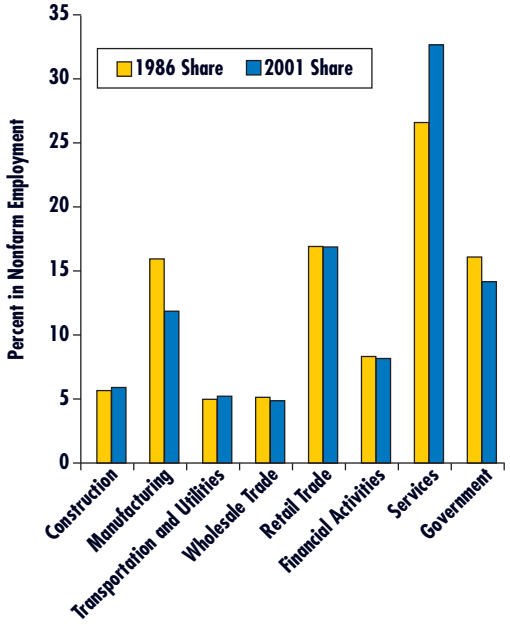
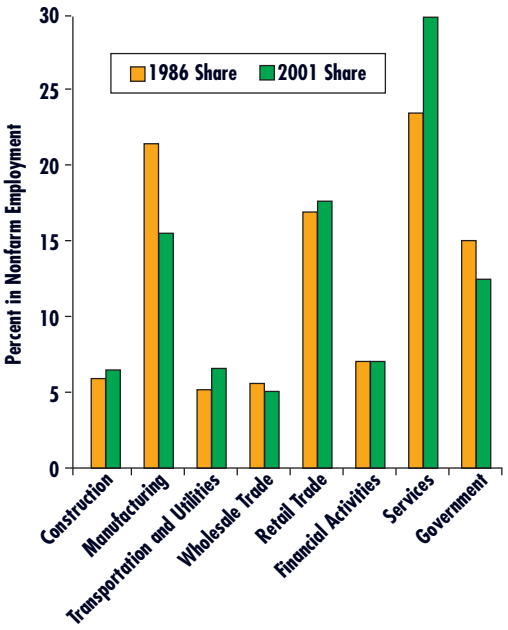



**Figure 7: Employment Share of Major Industries (Nonfarm): Tennessee**




**We expect a significant structural change in manufacturing industries through increasing productivity in furniture and fixtures, industrial machinery, electronics, instruments, chemicals, and printing and publishing.**

nessee and the U.S., we expect a significant structural change in manufacturing industries through increasing productivity in furniture and fixtures, industrial machinery, electronics, instruments, chemicals, and printing and publishing. Efforts to increase productivity in these sectors are likely to generate significant shifts in employment across manufacturing as well as nonmanufacturing sectors. Table 4 demonstrates the productivity gap and trend between the U.S. and Tennessee in the manufacturing sector.

## Structural Change within the Manufacturing Sector

The purpose of this section is to analyze the amount of resources within the manufacturing sector reallocated over the years 1986–2000 and the implication of this trend for projected structural changes in manufacturing industries. We employ the SCI to explore the future trend in manufacturing industries.

*Employment*. In Tennessee, about 15 percent of manufacturing employment was reallocated across the manufacturing sectors between 1986 and 2000 as opposed to 7.4 percent in the U.S. This sectoral employment shift primarily took place in low-wage, unskilled, or low-tech industries. We anticipate that this employment shift is likely to take place in high-technology industries as firms start introducing cost-cutting measures (Table 5).

*GSP*. In terms of GSP, an even greater share of resources was reallocated across manufacturing industries. In Tennessee, more than one-fourth of industrial output (27 percent) shifted across industries versus 25 percent in the U.S. The shift was geared toward primarily high-technology, high-wage, or low-skill industries, suggesting the impact of increasing productivity due to technological developments. As Tennessee's manufacturing industries attempt to close the productivity gap with U.S. manufacturing industries, sectoral output shifts are likely to continue in the foreseeable future.

*Earnings (Wages)*. The SCI by earnings followed a pattern somewhat similar to structural change by employment. As the future employ-

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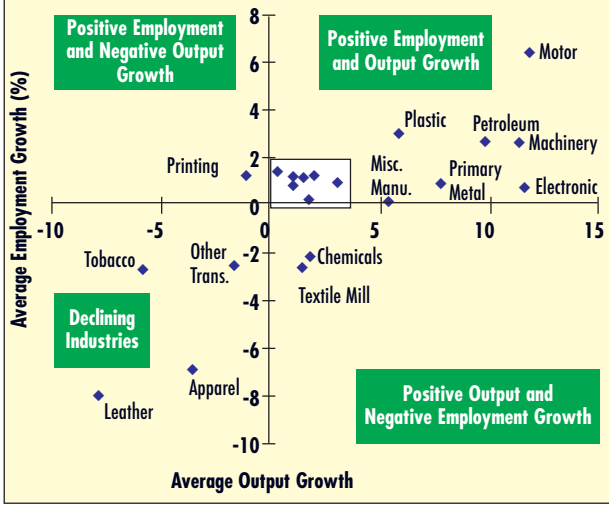
**Figure 8: Average Annual Employment and Output Growth in Manufacturing Sectors (1986–2000)**




**Box Area**

- Stone, Clay
- Wood
- Food
- Paper
- Fabricated Metals
- Furniture
- Instruments

**Table 3: Manufacturing Sector (Dis)similarity in 1986 and 2000 (Krugman Specialization Index)**

| U.S.-Tennessee | Similarity | Similarity | |
|---|---|---|---|
| **By Employment** | **1986** | **2000** | **Direction of Structural Change** |
| Overall Industry | 32.77 | 21.61 | High Convergence |
| High-Technology | 16.58 | 12.38 | Low Convergence |
| Low-Technology | 16.19 | 9.23 | High Convergence |
| Skilled | 11.82 | 8.78 | Low Convergence |
| Unskilled | 20.95 | 12.83 | High Convergence |
| High-Wage | 13.40 | 12.48 | Low Convergence |
| Low-Wage | 19.37 | 9.12 | High Convergence |
| **By Gross State Product** | **1986** | **2000** | **Direction of Structural Change** |
| Overall Industry | 36.41 | 39.33 | Divergence |
| High-Technology | 18.37 | 29.25 | High Divergence |
| Low-Technology | 18.04 | 10.09 | High Convergence |
| Skilled | 18.70 | 19.42 | Low Divergence |
| Unskilled | 17.71 | 19.92 | Low Divergence |
| High-Wage | 22.02 | 28.93 | High Divergence |
| Low-Wage | 14.39 | 10.40 | High Convergence |
| **By Wage** | **1986** | **2000** | **Direction of Structural Change** |
| Overall Industry | 36.60 | 31.15 | |
| High-Technology | 23.00 | 20.78 | Low Convergence |
| Low-Technology | 13.60 | 10.37 | Low Convergence |
| Skilled | 16.83 | 13.13 | Low Convergence |
| Unskilled | 19.77 | 18.02 | Low Convergence |
| High-Wage | 20.45 | 20.40 | No Change |
| Low-Wage | 16.15 | 10.75 | High Convergence |

**Source: Business and Economic Research Center, MTSU**
**Note: The KSI measures the structural (dis)similarities between two spatial units at a given time. Direction of structural change indicates whether the structures of manufacturing sectors in two spatial units converge or diverge between two points in time.**

**Projected changes are primarily the result of computerization and cost-cutting measures. We expect further increases in the employment share of high-technology industries in Tennessee.**

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ment shift takes place, wages will be reallocated in line with employment.

## Projected Workforce Skill Changes

Based on the three different measures of manufacturing industry trends, Tennessee's manufacturing industries are projected to experience considerable structural change. Projected changes are primarily the result of computerization and cost-cutting measures. We expect further increases in the employment share of high-technology industries in Tennessee.[4]

*Sectoral Implications*. (1) Based on past trends in Tennessee and the U.S., Tennessee is likely to lose a significant number of jobs in apparel, furniture, textile mill products, fabricated metal, and paper and allied products. Employment projections of the Bureau of Labor Statistics and structural similarities between the Tennessee and U.S. manufacturing industries suggest large employment losses for these sectors.[5] (2) A slight employment decline in Tennessee is expected in other transportation and food. (3) Manufacturing sectors expected to gain employment in Tennessee are industrial machinery, electronics, and instruments. In addition to these projected employment changes by industry, employment in motor vehicles, printing, and plastics is expected to show a slow but positive trend toward 2010. In other sectors, projected employment changes are expected to be small.

*Workforce Implications*. The nature of each industry by skill and technology intensity suggests anticipated workforce skill changes. Industries with projected employment declines are primarily low-technology and either labor-intensive or natural resource–oriented industries.

- Major declines are expected for unskilled production workers and professional and related occupations. Especially, technology-driven employment changes are projected to dislocate certain managerial-level occupations and low-skilled production jobs but increase demand for semiskilled machine operators, certified technicians, and computer specialists.
- A projected employment increase in industrial machinery, electronics, and instruments is expected to increase demand for occupations requiring at least a bachelor's degree as well as certified electricians and other technicians. In motor vehicles, because of the high median age of current workers (the highest among manufacturing sectors), cross-trainability, continuing edu-

**Table 4: Annual Average Difference in Productivity (1996 $) (1986–2000)**

| 2-Digit Standard Industrial Classification | U.S.-TN (86–00) | US-TN (86–90) | US-TN (96–00) |
|---|---|---|---|
| **Manufacturing** | **$7,942** | **$6,839** | **$11,534** |
| Lumber and wood products | $10,514 | $15,130 | $5,196 |
| Furniture and fixtures | $4,136 | $2,544 | $6,378 |
| Stone, clay, and glass products | -$571 | -$2,305 | $204 |
| Primary metal industries | -$5,697 | $4,028 | -$9,783 |
| Fabricated metal products | $466 | $472 | $2,266 |
| Industrial machinery and equipment | $6,796 | $1,736 | $15,741 |
| Electronic and other electric equipment | $29,505 | $6,798 | $61,421 |
| Motor vehicles and equipment | $2,927 | $19,288 | -$8,832 |
| Other transportation equipment | $16,777 | $11,453 | $24,256 |
| Instruments and related products | $13,124 | $10,314 | $25,739 |
| Miscellaneous manufacturing industries | -$5,662 | $2,015 | -$13,963 |
| Food and kindred products | -$12,561 | -$8,347 | -$10,467 |
| Tobacco products | $181,424 | $228,727 | $142,531 |
| Textile mill products | $3,266 | $3,215 | -$220 |
| Apparel and other textile products | $3,569 | $2,930 | $4,960 |
| Paper and allied products | $6,227 | -$4,342 | $15,528 |
| Printing and publishing | $11,765 | $10,616 | $13,999 |
| Chemicals and allied products | $28,063 | $27,334 | $32,476 |
| Petroleum and coal products | $57,995 | $57,965 | $88,290 |
| Rubber and miscellaneous plastics products | -$3,773 | -$7,145 | $1,188 |
| Leather and leather products | $11,752 | $2,307 | $20,532 |

**Source: Business and Economic Research Center, MTSU**
**Notes: US-TN (86–00) is average annual difference between the U.S. and Tennessee by industry, US-TN (86–90) is annual average difference between the U.S. and Tennessee between 1986 and 1990, and US-TN (96–00) is annual average difference between the U.S. and Tennessee between 1996 and 2000. Productivity is defined as output per worker.**

**Major declines are expected for unskilled production workers and professional and related occupations.**

cation, and competitive examinations are expected to be the major selection criteria for new employees.

- Overall, the skill requirement composition for projected employment increases in Tennessee is expected to be around 36 percent vocational education, 40 percent training, and 24 percent bachelor's degree or higher.[6]

*Institutional or Educational Implications*. The large projected increase in required skill is likely to be in areas that require an associate's degree or certificate programs. Projected workforce-related developments are increases in (1) demand for workers with associate's level training (i.e., technicians, specialists); (2) demand for workers who went through certificate programs (i.e., licensing); (3) emphasis on continuing workforce education; and (4) emphasis on cross-trainability as the cost-cutting efforts of companies are likely to continue. This calls for an increasing synergy between employers and educational institutions. ■

*Dr. Murat Arik is associate director of the Business and Economic Research Center at MTSU.*

## Data Sources

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Census Bureau at www.census.gov
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*continued on page 32*

**The skill requirement composition for projected employment increases in Tennessee is expected to be around 36 percent vocational education, 40 percent training, and 24 percent bachelor's degree or higher.**

### Table 5: Manufacturing Structural Change Index (1986–2000)

| | Employment | | Gross State Product | | Wages | |
|---|---|---|---|---|---|---|
| **Sectors** | **Tennessee** | **U.S.** | **Tennessee** | **U.S.** | **Tennessee** | **U.S.** |
| Overall SCI (86–00) | 14.94 | 7.37 | 27.02 | 25.18 | 13.18 | 7.20 |
| High-Technology | 6.52 | 3.57 | 16.60 | 15.84 | 8.63 | 4.90 |
| Low-Technology | 8.42 | 3.80 | 10.43 | 9.34 | 4.56 | 2.30 |
| Skilled | 6.09 | 2.70 | 11.77 | 14.41 | 3.64 | 2.73 |
| Unskilled | 8.85 | 4.67 | 15.25 | 10.77 | 9.55 | 4.47 |
| High-Wage | 6.74 | 3.47 | 15.70 | 13.72 | 5.21 | 3.69 |
| Low-Wage | 8.20 | 3.90 | 11.32 | 11.46 | 7.98 | 3.51 |

**Source: Business and Economic Research Center, MTSU**
**Note: SCI measures percent of resource allocations across industries within the manufacturing sector between 1986 and 2000.**

*continued from page 31*

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## Notes

1. KSI is computed thus: $KSI = \sum | x_{iTN} - x_{iUS} |$ where $x(i)$ is the share of industry employment, output, or wages in the manufacturing sector employment, output, or wages; TN is Tennessee; and U.S. is the United States. The index takes a value between zero and 200, zero indicating an entirely similar structure and 200 indicating a completely different industrial structure. Our comparison is based on two points in time, and the KSI indicates whether or not Tennessee's manufacturing sector is structurally converging toward (becoming similar to) the U.S. manufacturing sector over the years.

2. Manufacturing sectors are segmented into three major groups: technology intensity, labor intensity, and wage level. This segmentation of manufacturing sectors is useful for understanding the source of structural change and forming appropriate workforce development policies to minimize the cost of worker dislocation.

3. The structural change index (SCI) for manufacturing industries is computed using the following formula: $SCI = {}^1/_2 \sum | x_{it} - x_{it-1} |$ where $x$(it,t-1) represents $i$(th) industry's share in total manufacturing sector in time ($t$) and ($t$-$1$). Index takes a value between zero, indicating no change in structure, and 100, indicating complete reversal of the structure. We measure manufacturing structural change using employment, output, and industry salary and wage earnings.

4. For practical purposes, we collapsed middle-tech and high-tech industries into high-tech industries in this study. Similarly, we collapsed medium- and high-wage industries into high-wage industries.

5. See BLS, *Career Guides to Industries,* at www.bls.gov.

6. The figures are approximated from Tennessee Department of Labor and Workforce Development occupational projections for 2010. Only occupations with an excellent outlook are included in this calculation.

### Appendix A: Manufacturing Sector and Industry Classification

| 2-Digit SIC (Manufacturing Sector) | Technology Intensity | Wage Intensity | Skill Intensity | Competitiveness |
|---|---|---|---|---|
| Lumber and wood products | LT | LW | USK | NRI |
| Furniture and fixtures | LT | LW | USK | NRI |
| Stone, clay, and glass products | LT | MW | USK | NRI |
| Primary metal industries | MT | MW | USK | SI |
| Fabricated metal products | LT | MW | SK | LI |
| Industrial machinery and equipment | HT | LW | USK | PD |
| Electronic and other electric equipment | HT | HW | SK | SB |
| Motor vehicles and equipment | MT | HW | USK | SI |
| Other transportation equipment | MT | LW | USK | SI |
| Instruments and related products | HT | MW | SK | SB |
| Miscellaneous manufacturing industries | MT | LW | USK | LI |
| Food and kindred products | LT | LW | SK | NRI |
| Tobacco products | LT | LW | SK | NRI |
| Textile mill products | LT | LW | USK | LI |
| Apparel and other textile products | LT | LW | USK | LI |
| Paper and allied products | LT | MW | SK | SI |
| Printing and publishing | LT | MW | SK | SI |
| Chemicals and allied products | HT | HW | SK | SB |
| Petroleum and coal products | LT | HW | SK | NRI |
| Rubber and miscellaneous plastics products | MT | MW | USK | SI |
| Leather and leather products | LT | LW | USK | LI |

**Source: OECD and BERC**
**Notes: LT = low technology; MT = medium technology; HT = high technology; LW = low wage; MW = medium wage; HW = high wage; USK = unskilled; SK = skilled; NRI = natural resource–intensive; LI = labor intensive; PD = product-differentiated; SI = scale-intensive; SB = science-based.**