# CHAPTER 12.
# Employment and Income Trends and Projections for Forest-Based Sectors in the U.S. South

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## KEY FINDINGS

- The southern logging sector is expected to experience small increases in both industry output (3 percent) and jobs (2 percent) from 2008 to 2018. Increased demand from bioenergy is expected to counteract increasing trends toward mechanization and reduced demand from some traditional wood-using industries.
- Southern wood products manufacturing is expected to increase in industry output (2.2 percent) in conjunction with the housing recovery after the 2007–09 recession. Technical change is expected to continue—with capital substituting for labor—leading to continued declines in jobs through 2018 (8 percent).
- The southern paper manufacturing sector is expected to continue contracting, with industry output declining by 17 percent through 2018. Output declines and continued technical change are expected to reduce jobs by 26 percent from 2008 to 2018.
- Forest-based recreation is expected to increase following the 2007–09 recession, but at lower rates than overall travel and tourism. Increases in output may be limited because forest-based recreation per capita is not expected to increase at the same rate as other travel and tourism. In addition, technical change is expected to continue to reduce labor demand for the same level of output.
- Bioenergy demands resulting from State and Federal policies are expected to lead to increases in logging sector jobs and output. If competition occurs between bioenergy demands and traditional wood products demands, additional losses in jobs and output in the wood products and paper manufacturing sectors would be expected. Output and employment gains from bioenergy development and production would be offset by losses in conventional energy, including mining, drilling, transport, and fuel and electricity generation and distribution. The overall effects on output and employment in the South are expected to be small.

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## INTRODUCTION

Southern forests are used for recreation, provide wood inputs to manufacturing, create scenery, and enhance the quality of life. In addition to providing jobs and income to the local and regional economy, forests are now considered a potential source of woody biomass for bioenergy. This chapter addresses the short-term future output and jobs in forest-using sectors of the southern economy. Specific sectors addressed include forestry and logging, wood products manufacturing, paper manufacturing, forest-based recreation, and the new bioenergy sectors.

Economists represent the regional economy through production functions. A production function is a stylized model that expresses industry or business outputs (typically measured in dollars) as a function of the inputs needed to generate the outputs. For example, a generic production function would represent output as a function of capital, labor, energy, materials (such as wood), and other inputs. Over time, we expect this production function to change as technology reduces the amount of inputs needed to produce the same level of output by substituting capital for labor, energy, and other inputs.

Assuming that companies are profit maximizing and risk-neutral, the optimal output level and the optimal combination of inputs needed to achieve it will be driven by the prices of the inputs and outputs. We typically expect the inputs to be complements (an increase in one input requires an increase in the other) or substitutes (an increase in one input leads to a decrease in the other). Changes in input use levels can be the result of changes in the output level or changes in input price or quality. Thus, an industry or business can decrease its demand for labor (jobs) because of decreased demand for its outputs, or because capital or another input is substituting for labor in the production function.

A conundrum of economic analysis is that a positive outcome in one area is likely offset by a negative outcome elsewhere. For example, increasing wages is usually perceived as a positive because it leads to a higher standard of living for workers, but it also leads to increased labor costs, which

will result in substituting capital for labor in the production function. The result is a loss of jobs, which is typically seen as a negative outcome. Similarly, gains in one sector (such as logging) are likely offset by losses in a different sector (such as coal mining); and gains in one geographic area (such as the South) may be offset by losses in other regions (such as the Northern Appalachians). These outcomes illustrate that the definition of sectors, inputs, and areas of interest are likely to influence the outcome of any economic analysis of a region's economy, which should be kept in mind while reading the following assessment.

Throughout this chapter, we use some specific economic and modeling terms. They are defined below:

**Recession:** an economic term implying, generally, a decline in economic activity that is between a peak and trough of economic activity. The National Bureau of Economic Research is the accepted arbiter of when recessions begin and end (see http://www.nber.org/cycles/recessions.html). The recession referred to in this chapter began in December 2007 and continued until June of 2009.

**Technical change:** Technical change is an economic term representing any change in the relationship between inputs to a production process and outputs from a production process. This is often an improvement in capital use, leading to a reduction in labor use, but can also result from administrative or policy changes.

**Jobs (also employment):** These are not full-time equivalents, and so represent any continuous employer-employee relationship for wages and salary, whether full- or part-time.

**Output (also total industry output):** Output is an economic term representing the total dollar value of a firm or sector or economy. This value "double counts" the contribution of a sector when adding up the totals for an economy—the value of a log would be counted in the output of the logging sector, and, for example, in the output of the sawmill sector. When adding up the sector values across an economy, the total value added should be used in place of output; however in this chapter we use output because the models and forecasts were developed for output and not for total value added.

**Gross regional product (also gross domestic product):** an economic term representing the total value of the production of goods and services for a region (or State or country).

**Total value added:** an economic term that nets out the cost of inputs (such as logs) that are counted as another firm's outputs and is nearly equivalent to gross domestic (or regional) product (indirect taxes are excluded). Other components of total value added include proprietor's income and property-type income.

**Income:** represents, in this chapter, wage and salary income from a job. Wage and salary income is a large component of total value added, and thus is a large component of gross regional product.

**Forestry and logging:** a sector that includes both the growing and management of forests [forestry is part of North American Industry Classification System (NAICS) sector 115] and the harvesting and transportation of timber (NAICS 113).

**Forest-based recreation:** a sector that represents all expenditures made to participate in forest-based recreation, including hiking, hunting, winter sports, water sports, fishing, nature study and other recreation activities taking place in forests. This sector is not defined separately in NAICS, but could include portions of other sectors including transportation (NAICS 48), accommodations (NAICS 721), eating and drinking places (NAICS 722), recreation and entertainment (NAICS 713) as well as parts of other sectors.

**Bioenergy:** a sector that represents current (or potential) uses of wood to produce energy (pellets, liquid fuels, and electricity). This sector is not defined separately in NAICS, but could include portions of miscellaneous wood products (NAICS 321999), electricity generation (NAICS 237130) and ethanol sectors (NAICS 325193).

**Wood products manufacturing:** a sector that includes primary sawmills as well as manufacturers of veneer and/or plywood, engineered wood members, and reconstituted wood products (NAICS 321). These companies manufacture and/or use solid wood products such as lumber, millwork, pallets, mobile homes, and trusses.

**Paper manufacturing:** a sector (NAICS 322) that includes firms that make pulp, paper and/or converted paper products.

**Input-output models:** models used to represent static, detailed production relationships between inputs and outputs, and jobs and income.

**Computable general equilibrium models:** models used to represent changes in an economy using estimated or assumed equations and parameters.

## METHODS

To address the future of jobs, income, and contributions of forest-using sectors to the regional or local economy, we first evaluated historical trends and current conditions in the forestry and logging, wood products, and paper manufacturing sectors, as well as forest-based recreation and future bioenergy sectors. We then developed projections, to the extent possible given the data limitations, for forest-using sectors.

The forest-based recreation and bioenergy sectors have inadequate data and/or analyses at the national level and for the South that limits our ability to project these sectors. Forest-based recreation is not specifically tracked in the national economic accounts, and even the data available nationally have not been subset for the South, limiting our ability to provide Southwide trends. The bioenergy sector (distinct from by-products of wood products and paper manufacturing) is fairly new and does not have separate data for historical analysis.

Forecasts for the logging, wood products manufacturing, and paper manufacturing sectors were developed for a single decade, using trends in the southern component of each sector to downscale national forecasts. These national and southern trends were developed from the IMPLAN (MicroImplan Group, Inc. 2010) database (percent of each sectors' outputs that were from the South) and from the 2007 Resources Planning Act database (percent of each sectors' inputs that were from the South). Forecasts of economic activity at the sector level were not available beyond 2018.

The national forecasts were developed by the Bureau of Labor Statistics, Department of Labor using methods outlined in chapter 13 of the BLS Handbook of Methods (U.S. Department of Labor BLS, 2011). These forecasts are developed every two years, for a 10-year forecast period. There are six separate modeling components, each of which builds on the previous outputs. These six components are:

1. Forecast of Labor Supply: developed from forecasts of labor participation rates and population.
2. Forecast of Aggregate Economic Growth: BLS contracts with Macroeconomic Advisers, LLC to develop these forecasts, using the forecast of labor supply as an input.
3. Forecast of Commodity Final Demand: this modeling component disaggregates the economic growth into growth in the components of final demand (personal consumption expenditures, gross private domestic investment, foreign trade, and government demand) for each commodity.
4. Forecast of Sectoral Industry Outputs: using an input-output model with inputs from above and production relationships from the Bureau of Economic Analysis, the commodity final demands are converted into industry total outputs.
5. Forecasts of Industry Employment: jobs are estimated as a function of total industry output, wages, prices and time, as a system of equations. Wages derived from the Current Employment Statistics and the Current Population Survey, prices are adjusted using forecast inflation, and time accounts for changes in labor productivity.
6. Forecasts of Occupational Employment and Job Openings: a matrix of 300 industries by 750 occupations is used to calculate how forecasts of industry employment result in particular jobs.

The national forecasts for the tourism-related sectors are also presented, as are the expected changes in jobs and income that could result from these sectors. Forecasting the bioenergy sector is complicated because the technologies are under development and the markets are not well established. In addition, there is considerable uncertainty regarding the policies and technologies that will drive the industries and resulting outputs and jobs.

## DATA SOURCES

Data used in this analysis are primarily from the U.S. Department of Commerce, Bureau of Economic Analysis (BEA) (2010), Woods (2009), and the Travel and Tourism Satellite Account (Griffith and Zemanek 2009). In addition, data from IMPLAN (MicroImplan Group, Inc. 2010) and from the 2007 Resources Planning Act database were used to downscale the national labor forecasts to the South.

## RESULTS

### Past and Current Role of Forest-Based Sectors in the Southern Economy

Wood-related manufacturing, including logging and forestry comprised less than 1 percent of southern jobs and employment income in 2008 (figs. 12.1 and 12.2) (U.S. Department of Commerce 2010). This was down from 1.2 percent in 1990 (figs. 12.3 and 12.4), and resulted from both the growth of the entire southern economy as well as a decline in wood-related employment (figs. 12.5 and 12.6). Wood-related income (in constant 2008 dollars) increased from 1990 to 2000, but fell back to 1990 levels after 2000, with most of the variation coming from the wood products and paper manufacturing sectors (fig. 12.6). Wood-related manufacturing comprised 10 percent of all southern manufacturing employment (fig. 12.7) and 8 percent of all southern manufacturing income (fig. 12.8). This compares to food manufacturing with 13 percent of employment and 10 percent of income, and textiles manufacturing with 6 percent of employment and 4 percent of income (fig. 12.7 and fig. 12.8).

Of the three wood-related manufacturing sectors' employment, wood products manufacturing is the largest component (47 percent of wood-related employment) and forestry and logging is the smallest (14 percent) (fig. 12.9). The paper manufacturing sector, however, provides a much larger proportion of wood-related income (51 percent)

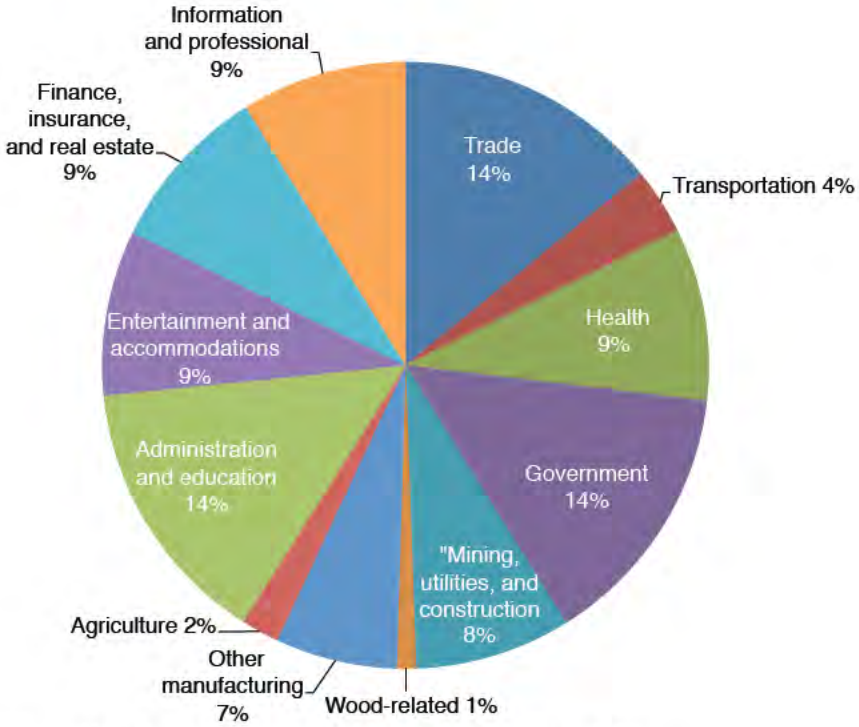


Figure 12.1—Employment by major economic sector in the South, 2008.

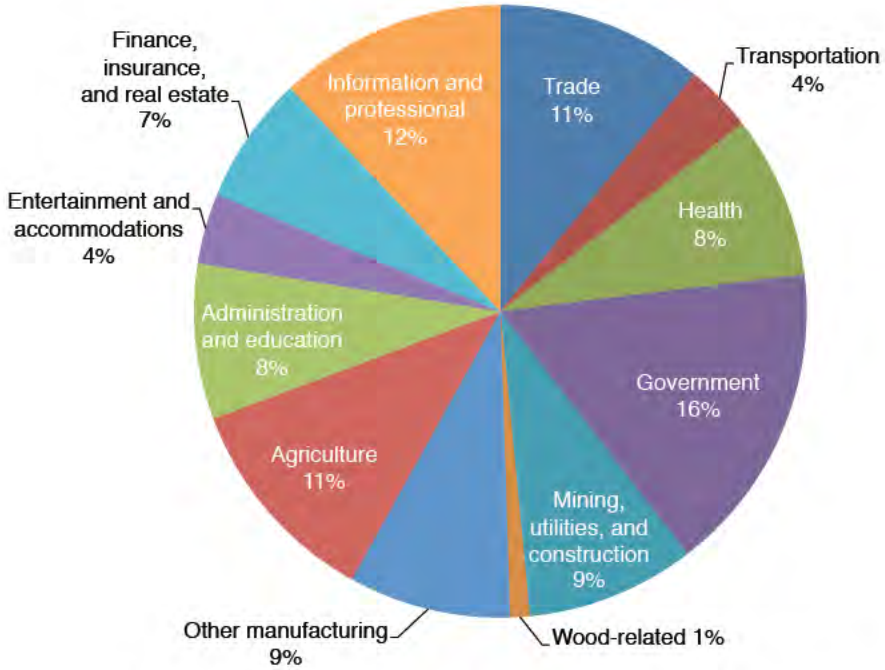


Figure 12.2—Income from employment by major economic sector in the South, 2008.

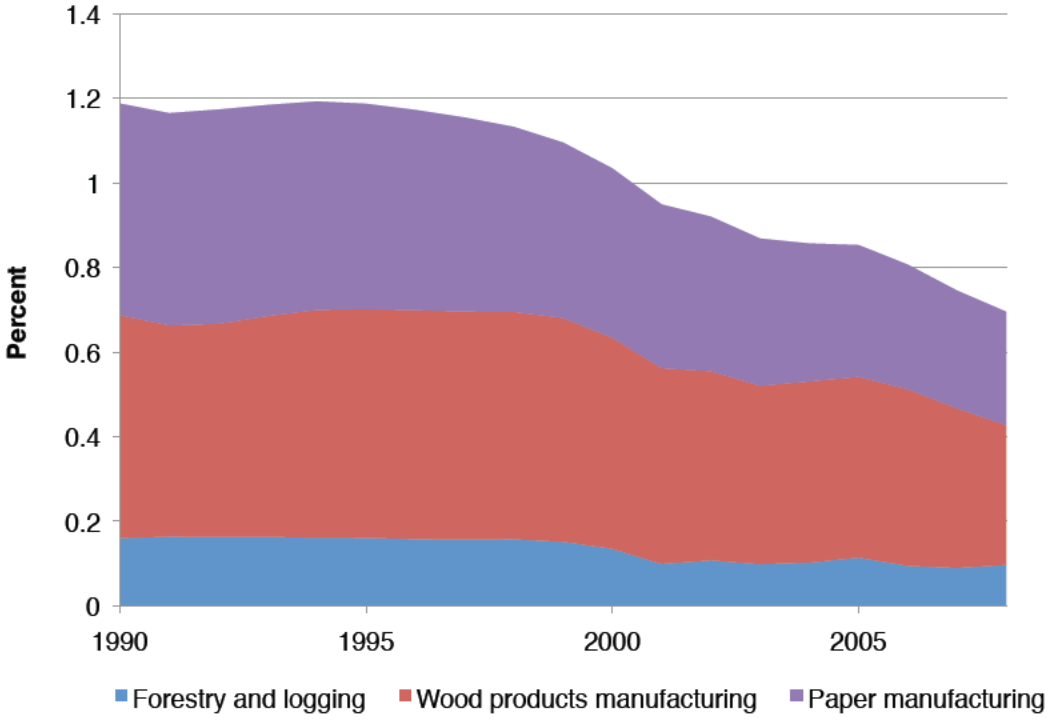


Figure 12.3—Employment in wood-related sectors as a percent of the southern economy, 1990 to 2008.

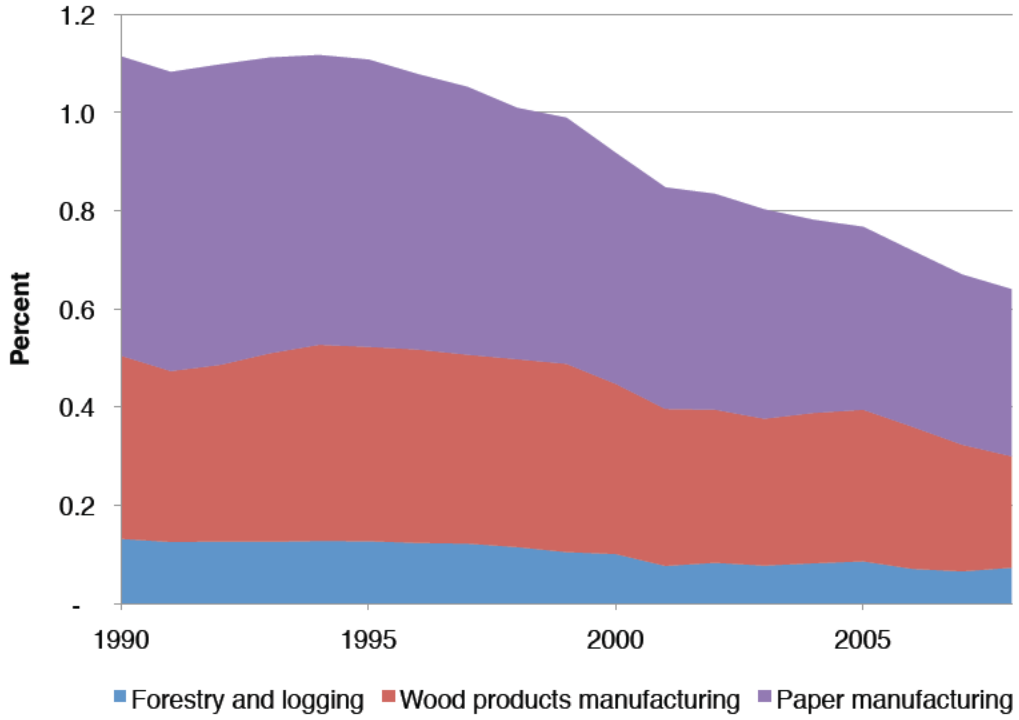


Figure 12.4—Income from employment in wood-related sectors as a percent of the southern economy, 1990 to 2008.

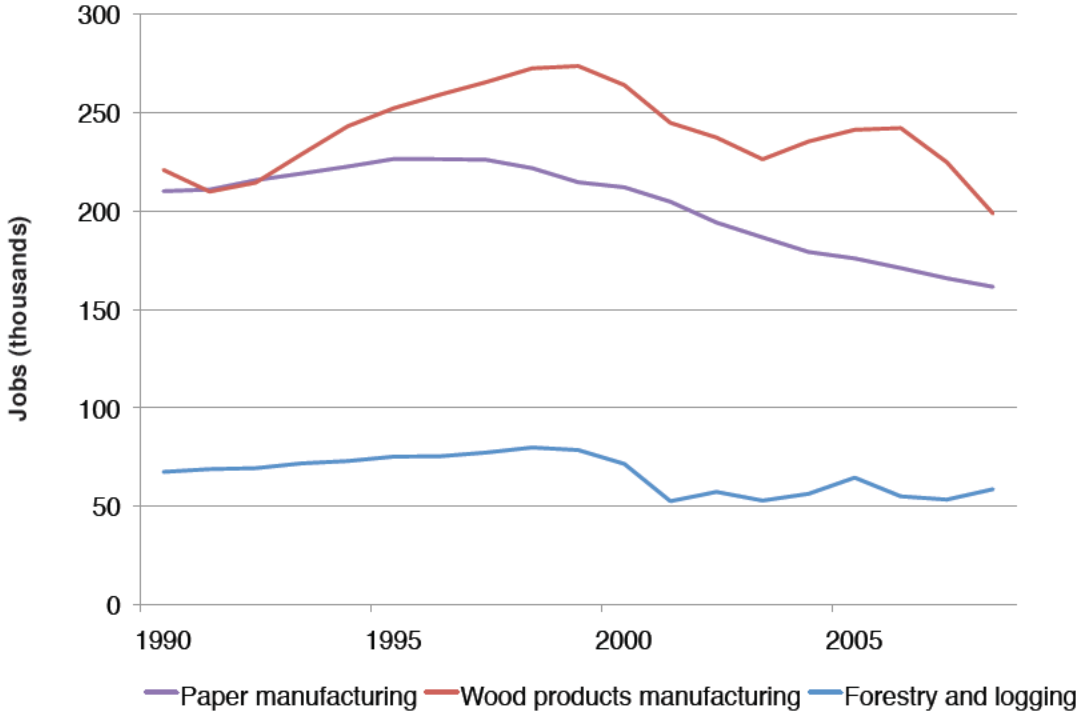


Figure 12.5—Employment in southern wood-related sectors, 1990 to 2008.

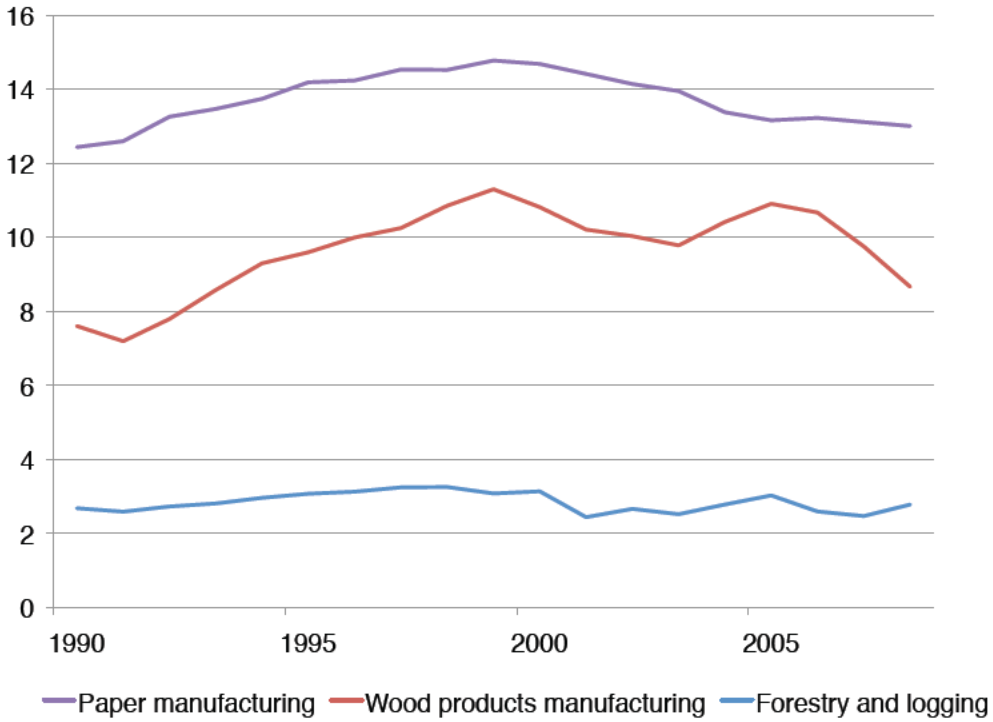


Figure 12.6—Income from employment in southern wood-related sectors, 1990 to 2008, in billions of 2008$.

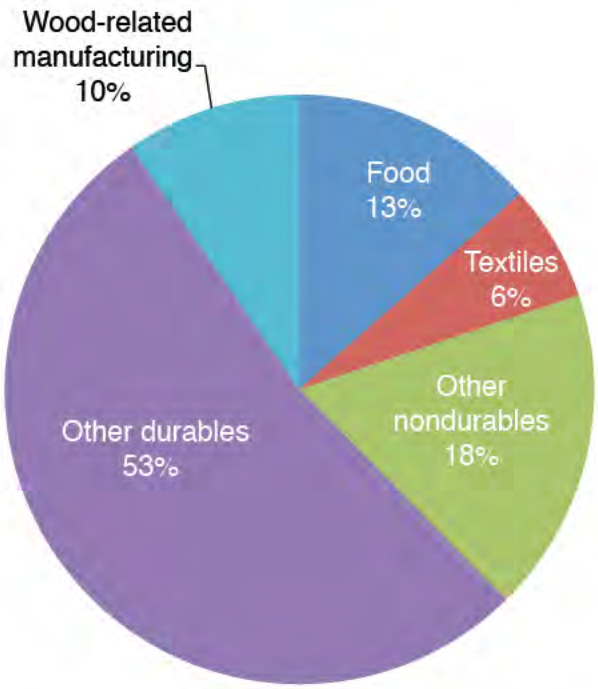


Figure 12.7—Employment by manufacturing sector in the South, 2008.

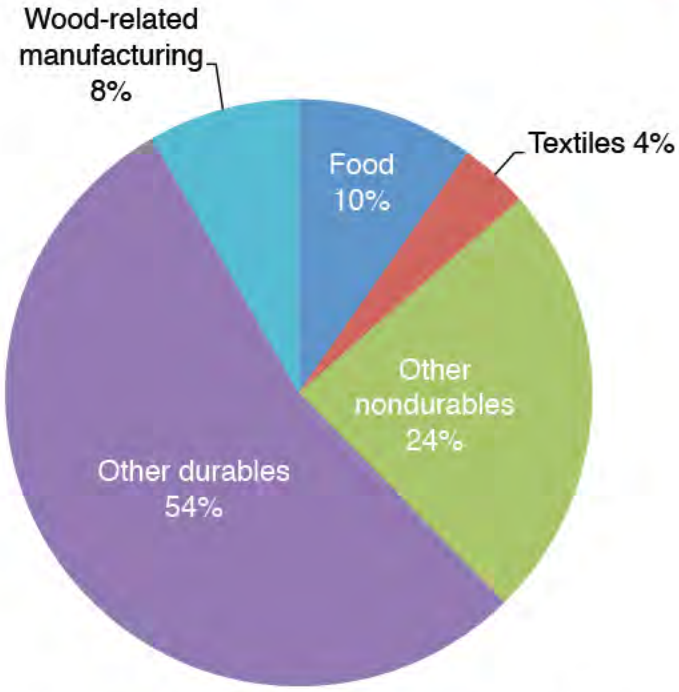


Figure 12.8—Income from employment by manufacturing sector in the South, 2008.

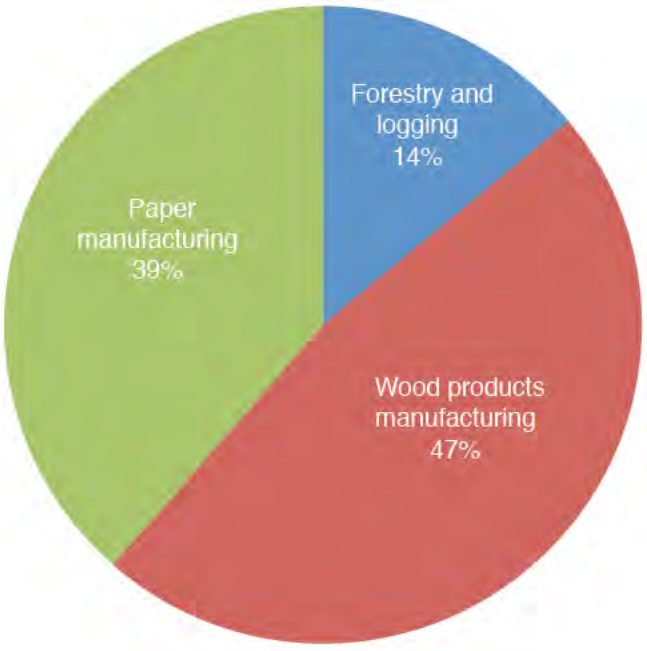


Figure 12.9—Employment by wood-related sector in the South, 2008.

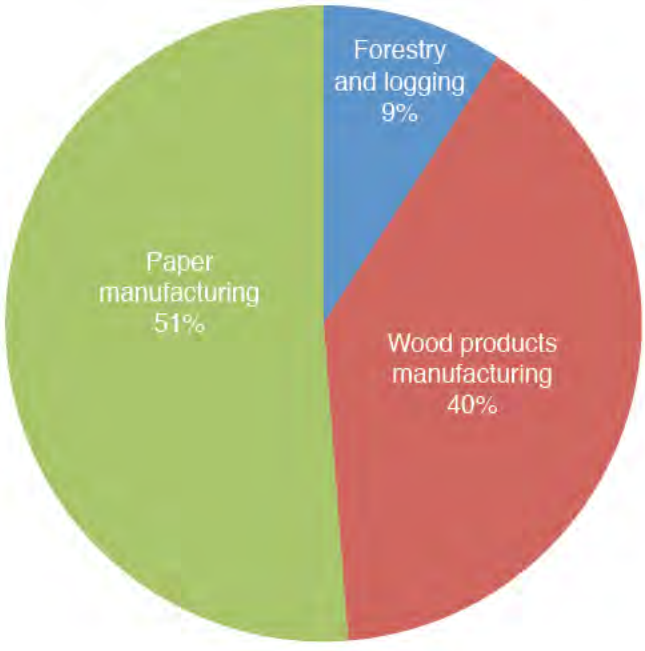


Figure 12.10—Income from employment income by wood-related sector in the South, 2008.

reflecting the higher wages and more full-time employment in this sector (fig. 12.10).

The direct and total contribution of the wood-related manufacturing sectors was also assessed using the IMPLAN (MicroImplan Group, Inc. 2010) input-output model. The thirteen Southern States were aggregated, and then the forestry and logging, wood products manufacturing, and paper manufacturing sectors were aggregated. Table 12.1 shows the direct contributions of these sectors to southern employment, employee compensation, wage and salary income, total value added, and total industry output in 2009. Table 12.2 shows the total contribution of wood-related manufacturing, which is the sum of the direct contribution plus the multiplier effects, for each sector. For details about the calculation of these results, see Abt and others (2002). Using the IMPLAN data, which is derived from different sources than the BEA data, we found that the direct contribution of the wood-related manufacturing sectors was between 0.6 (employment) to 1.4 percent (total industry output) of the southern economy. The total contribution of these sectors ranged from 1.9 percent (employment) to 2.8 percent (total industry output), with the total contribution to employee compensation and total value added in between.

The U.S. travel and tourism sector has increased since 1990 (fig. 12.11) (Griffith and Zermanek 2009, Kern and Kocis 2007). However, because a comparable analysis has not been done for the South alone, and because forest-based recreation comprises only a portion of the total travel and tourism sector, we cannot determine precisely what portion of jobs and income in the tourism-related sectors can be attributed to southern forest-based recreation.

### Logging

Concerns over a shortage of loggers have been voiced in the South for more than 50 years (Pikl 1960, Wollf and Nolley 1977). More recently, surveys of loggers indicate increases in average age, a reluctance to encourage children to enter the field, and increasing financial concerns, all of which could signal a future shortage of loggers (Baker and Greene 2008; Egan and Taggart 2004a, 2004b; Egan and Taggert 2007; Luppold and others 1998). At the same time, increasing mechanization could lead to reduced need for loggers as more of the work is accomplished by machinery.

Past surveys have indicated that insurance was a primary concern for sustainability of logging companies, but respondents to more recent surveys reported that fuel prices and timber prices are more critical today (Baker and Greene 2008, Moldenhauer and Bolding 2009). Issues that were not reported as significant barriers to sustainability include taxes and regulations (Baker and Greene 2008) and tract size and development (Egan and others 2007, Moldenhauer and Bolding 2009).

The future is likely to bring increasing mechanization and the substitution of equipment for jobs in the logging sector. This mechanization, as well as regulations and laws, has also led to increased safety and less strenuous work, which may serve to make logging a more attractive career choice. However, many current loggers indicate that their preference for logging work is derived in part from the hard, physical nature of the work (Egan and Taggart 2004a, 2004b); making the work safer and easier might lead to fewer (or different) new entrants into the field.

Although current loggers report that wages are low, they do not view wage increases as a priority. However, economic theory would imply that an increase in wages would result in an increase in numbers of loggers. Even so, the risky nature of both the work and the business may prevent a sufficient number of workers from choosing logging as a profession. If shortages do occur, other market solutions are expected; for example, arrangements could be made between wood-using companies and loggers that could include long-term contracts, immigrant labor contracts, loans for equipment, or other solutions.

The national projection shows a slight increase in the number of logging jobs and in output for the logging industry in 2018 (Woods 2009). Scaling this to the South shows increases of 2 percent in jobs and 3 percent in output for 2008 to 2018, reversing the trend from 1998 to 2008 (fig. 12.12). This increase is attributed, in part, to a slight increase in the expected use of wood for energy. Income per logging job in the South has increased and now surpasses the national average (fig. 12.13). This increase results from a combination of both increasing hourly wages and increasing hours per job (more full time employment). Beyond the projection (2018), we expect the number of logging jobs to correlate strongly with changes in harvest levels, while also continuing to respond to technical change by declining as mechanization continues to increase.

### Wood Products Manufacturing

The sector is strongly linked to the housing market, and the decline in output and jobs from 1998 to 2008 (fig. 12.14) reflects the decline in housing starts during the 2007 recession (Woods 2009). As the housing market recovers, output is expected to rise by 2.2 percent through 2018, but technical change and a change in the product mix is expected to cause employment to continue declining by 8 percent (fig. 12.14). These values were downscaled from the national labor forecasts (Woods 2009) by proportioning the national trends to the South's share of total output and employment for this sector.

**Table 12.1—Direct contributions of three wood-related sectors to employment, compensation, value added, and total industry output of the South in 2009, in millions of 2009 U.S. dollars and by percent of totals for the South**

| NAICS sector | Sector name | Employment | | Employee compensation | | Total value added | | Total industry output | |
|---|---|---|---|---|---|---|---|---|---|
| | | | *percent* | *millions of 2009$* | *percent* | *millions of 2009$* | *percent* | *millions of 2009$* | *percent* |
| 131 | Forestry and logging | 57,676 | 0.10 | 1,454 | 0.06 | 3,776 | 0.09 | 9,613 | 0.12 |
| 321 | Wood products manufacturing | 145,936 | 0.26 | 6,468 | 0.27 | 10,168 | 0.25 | 28,065 | 0.34 |
| 322 | Paper manufacturing | 143,984 | 0.25 | 11,440 | 0.48 | 23,390 | 0.57 | 79,991 | 0.98 |
| | All wood-related manufacturing | 347,596 | 0.61 | 19,363 | 0.81 | 37,333 | 0.92 | 117,668 | 1.44 |

**Table 12.2—Total contribution of three wood-related sectors to employment, compensation, value added, and total industry output of the South in 2009, in millions of 2009 U.S. dollars and by percent of totals for the South**

| NAICS sector | Sector name | Employment | | Employee compensation | | Total value added | | Total industry output | |
|---|---|---|---|---|---|---|---|---|---|
| | | | *percent* | *millions of 2009$* | *percent* | *millions of 2009$* | *percent* | *millions of 2009$* | *percent* |
| 131 | Forestry and logging | 137,461 | 0.24 | 4,104 | 0.17 | 9,000 | 0.22 | 19,350 | 0.24 |
| 321 | Wood products manufacturing | 348,001 | 0.61 | 15,180 | 0.63 | 26,803 | 0.66 | 58,474 | 0.72 |
| 322 | Paper manufacturing | 591,934 | 1.04 | 31,995 | 1.34 | 63,240 | 1.55 | 152,075 | 1.86 |
| | All wood-related manufacturing | 1,077,396 | 1.89 | 51,279 | 2.14 | 99,044 | 2.43 | 229,900 | 2.82 |

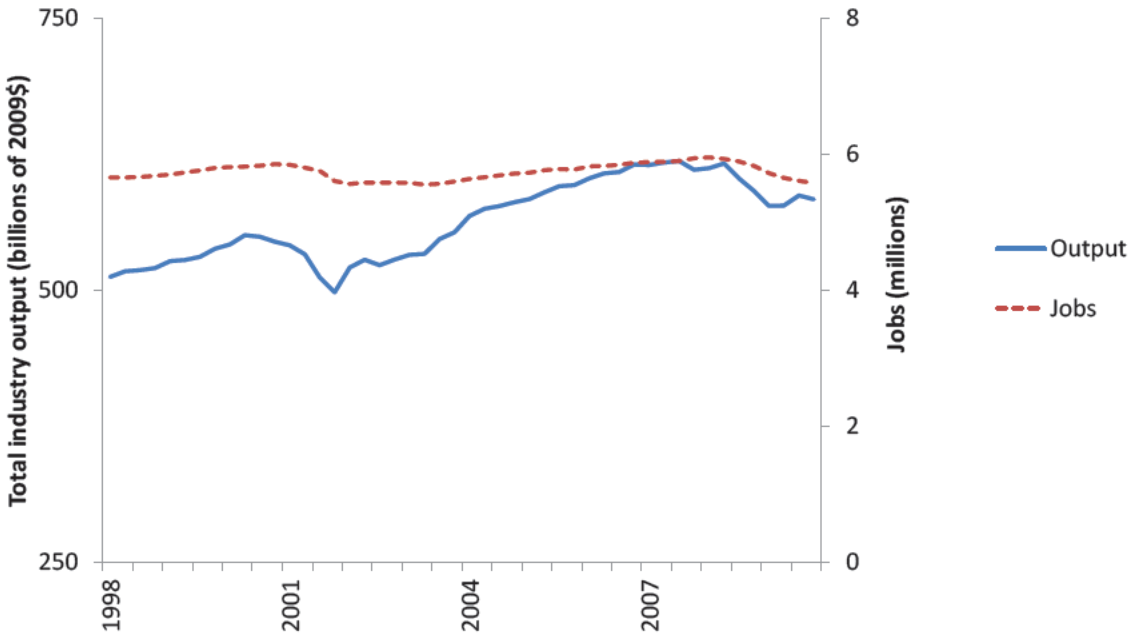


Figure 12.11—Travel and tourism total industry output and job trends, 1998 to 2009.

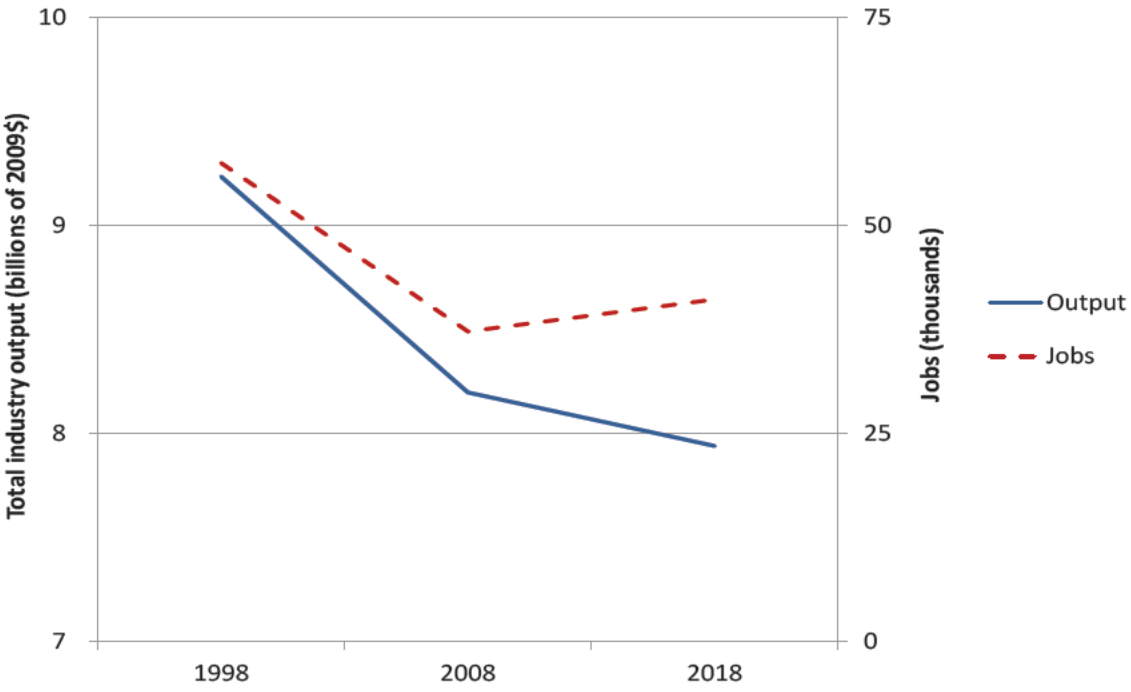


Figure 12.12—Historical (1998 and 2008) and projected (2018) jobs and total industry output for the southern logging sector.

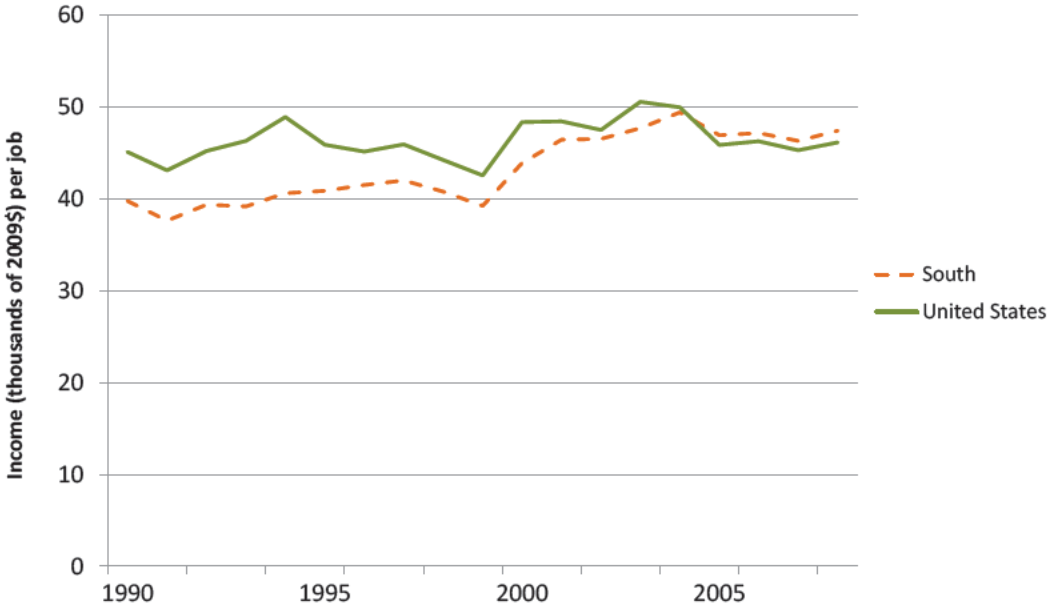


Figure 12.13—Income per logging job in 2009 dollars for the United States and the South, 1990 to 2008.

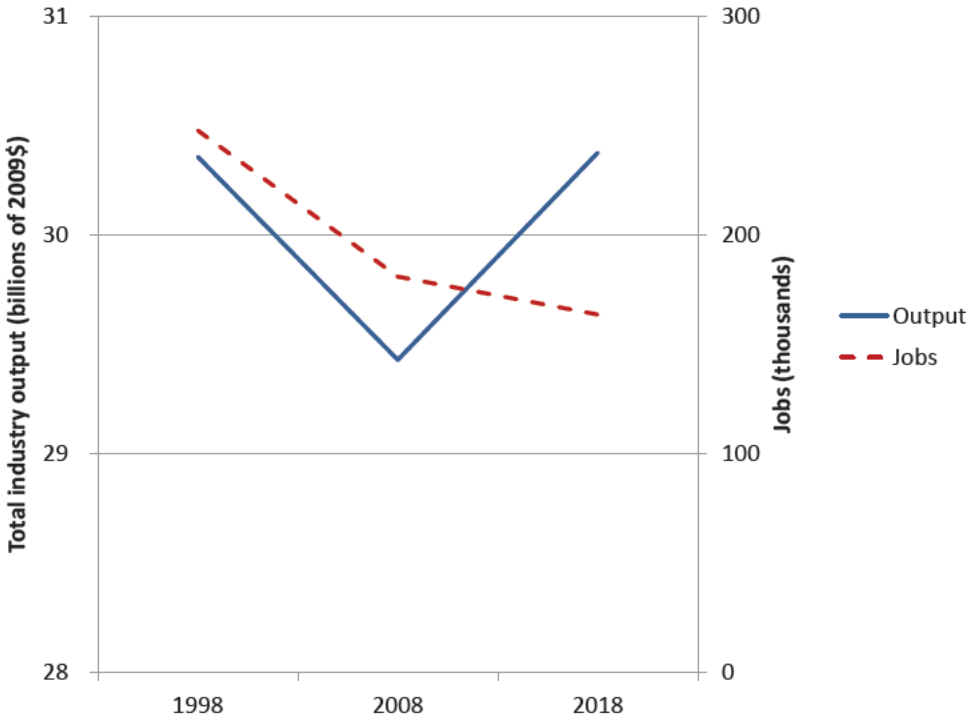


Figure 12.14—Historical (1998 and 2008) and projected (2018) jobs and total industry output for the southern wood products manufacturing sector.

The future of housing starts is critical to the level of production expected in this sector. A second influence is the level of lumber production in other U.S. regions: if the South experiences more (or fewer) mill closures than other regions as a result of the 2007–09 recession, the recovery could shift less (or more) lumber production to the South. A third influence will be the level of lumber and other wood-product imports, particularly from Canada. Large swathes of beetle-killed timber could be harvested and exported to the United States at prices below southern pine prices, thus representing competition for southern lumber. Complexities of the U.S./ Canadian timber trade will influence the levels of imports and the ultimate price effects on national and southern lumber markets. These effects are beyond the scope of this study.

Thus, overall, wood products manufacturing is expected to recover to pre-recession levels in output, but employment is expected to continue to decline through 2018.

## Paper Manufacturing

The paper manufacturing sector (NAICS 322) is potentially the most volatile of the traditional forest-based sectors. Changes in land ownership over the last decade, followed by the sale and/or merging of many of paper manufacturing mills and companies have changed the structure of the industry in ways not contemplated a few years ago. A further change occurred as the paper companies reduced production of fine papers, closing mills and substantially reducing hardwood pulpwood demand across the South. Overall pulping capacity declined from 1997 to 2008 (Johnson and others 2010), and additional declines are thought to have occurred since 2008 as a result of the 2007-2009 recession, although data are not yet available to confirm these declines.

Major changes could continue if the demand for wood use in bioenergy grows and if public policies support the diversion of pulpwood into renewable energy feedstocks. Increasing competition for pulpwood could result in the displacement of some current pulpwood use (Abt and others 2010). Positive impacts could result if companies are rewarded for current co-generation of power (such as tax rebates for using a pulping byproduct called black liquor to run pulpwood mills) or if opportunities arise for co-locating bioenergy producers at existing pulping facilities.

Labor forecasts for the United States show a decline of 24 percent in paper manufacturing jobs from 2008 to 2018

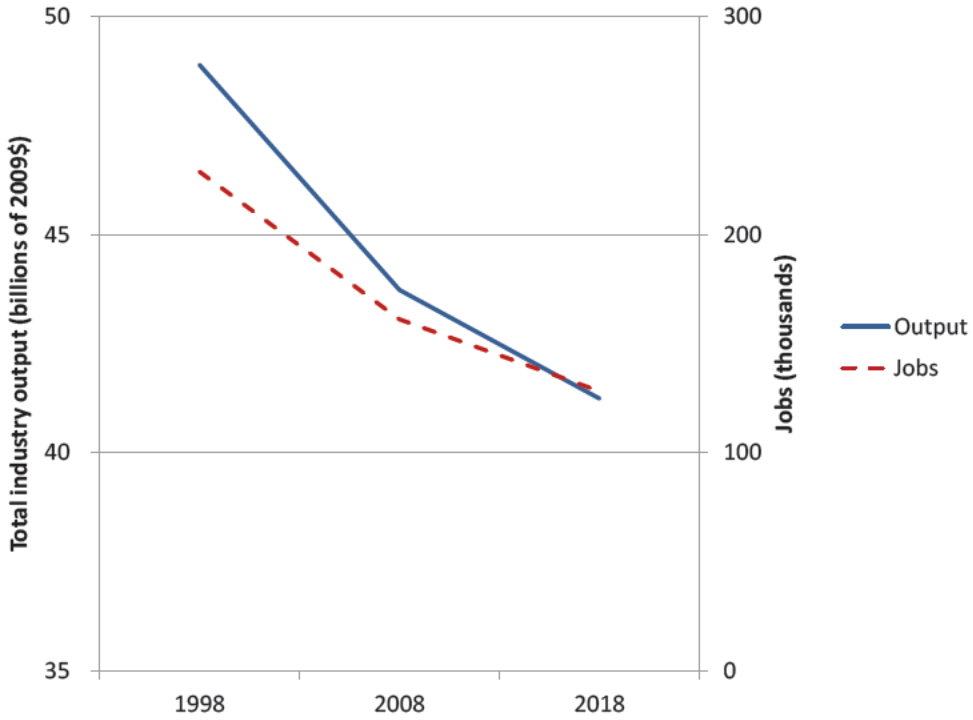


Figure 12.15—Historical (1998 and 2008) and projected (2018) jobs and total industry output for the southern paper manufacturing sector.

(Woods 2009). Any recovery from the recession is masked by overall declines in this sector. Downscaling these forecasts to the South resulted in projected declines of 26 percent in jobs and 14 percent in output (fig. 12.15). This larger decline in jobs in both the United States and the South in the paper sector represents expectations of continued technical change involving the substitution of capital for labor.

### Forest-Based Recreation

Forests in the South are used for a variety of recreational opportunities, ranging from whitewater kayaking to nature study. Forest-based recreation is not recorded as a single economic sector, but is instead part of several sectors, including transportation, entertainment, accommodations, sporting goods manufacturing, and eating and drinking places. This is also true for overall travel and tourism, where expenditures are recorded in other sectors, but then consolidated and tracked nationally as a separate account (Griffith and Zemanek 2009, Kern and Kocis 2007). Forest-based recreation is expected to be only a part of this much larger travel and tourism sector.

In a separate chapter in this study, Bowker and others (2013) developed projections for forest-based recreation participation by southern residents. They concluded that per capita forest-based recreation would stay fairly constant for most activities, while declining slightly for hunting, fishing, and motorized off-road activities. This contrasts with the projections for national forests, where the per capita rate of recreation visits declines for all activities. Their chapter also shows that national forest per capita recreation visits are expected to decline more for overnight and general visits than for day use developed visits. Further, they conclude that recreation pressures are likely to increase proportionately more near urban areas. A separate study shows that expenditures per visit per party are three to four times higher for overnight visits than for day visits, and are 40 to 80 percent higher for non-local visits (Stynes and White 2006). These results, taken together, provide some, although weak, support for somewhat lower per capita expenditures on forest-based recreation in the South, resulting in forest-based recreation becoming a smaller part of total travel and tourism expenditures in the future. Expenditures, and thus output, are expected to grow, however, although below the rate of population growth, which will reduce the percentage of the economy deriving from forest-based recreation.

Alternatively, we could assume that the projected demand for forest-based recreation aligns with the demand for all travel and tourism and that the South follows the national trends. In this case, forest-based recreation total industry output in the South would increase slightly through 2018. Even this small increase in output, however, will likely not keep jobs in tourism, and thus in forest-based recreation, from rising at a rate slower than the rate of rise in output. Even the service-based sectors in travel and tourism have experienced, and are expected to continue to experience, technical change that reduces the jobs even if output were to stay the same. Franchising, low-service accommodations, self- and low-service restaurants, and central offices for management and marketing are all expected to reduce labor demand in the travel and tourism sectors (Griffith and Zemanek 2009, Woods 2009).

### Bioenergy

Small amounts of wood are currently used to produce liquid transportation fuels or electricity in the South, although there is a potential for significant increases in one or both of these uses of southern wood in the near future, depending on policies and markets. In this chapter, we discuss the potential for changes in jobs and output that might result from an increase in the use of wood for energy and previous literature in this area.

Introduction of policies to reduce the amount of carbon in the atmosphere (including Federal and State renewable fuel standards and renewable electricity standards) or the imposition of a carbon tax or carbon cap-and-trade could shift production of energy to renewable sources, including wood. Thus, economic theory would imply that output and jobs in the conventional liquid fuels and conventional electricity sectors would decrease, with an offsetting increase in output and jobs in the bioenergy sectors, all other things held constant. This means that increases in the demand for non-renewable energy could lead to increases in output and jobs in the conventional liquid fuels and electricity sectors, provided that technology is held constant. If markets fail to account for the costs of carbon disposal to the atmosphere and if all other aspects of the economy are held constant, we expect that any imposition of new standards and regulations would cause an overall decrease in output and jobs in the economy (Huang 2010).

All of the studies conducted to date indicate that economic activity (including output and jobs) will increase in the logging sector. These increases are likely at the expense of jobs and output in the coal-mining sector, which is often excluded from the smaller regional analyses (English and others 2009, Faaij and others 1998, Gan and Smith 2007, Hodges and others 2010, Perez-Verdin and others 2008). Depending on the variations in wage rates and in full-time/part-time employment rates, net jobs may be increased or decreased slightly as a result of bioenergy-feedstock

procurement policies. In the bioenergy sector, jobs and output are expected to increase, with a corresponding decrease in jobs and output in the conventional energy sector (Huang 2010, Hodges and others 2010, Winston 2009).

Previous studies of the conversion to bioenergy typically use either a computable general equilibrium model or an input-output model to evaluate the impacts on jobs and output. Input-output models are simple and rich in data, providing a snapshot of the economy and clearly illuminating the linkages among sectors in the system. Computable general equilibrium models, often using the data developed for the input-output models, are more complex and can provide either a snapshot or a dynamic view of the economy. Although they have the advantage of allowing input substitution to adjust over time, their complexity often makes explaining results and outcomes difficult.

In the development of input-output and computable general equilibrium models, the designation of the regions of importance has a significant effect on outcomes: the smaller the region the greater the likelihood of excluding areas where losses would occur, while including areas where gains would occur. Input-output models may also overstate impacts because dynamic adjustment is not part of the modeling framework. English and others (2009), Faaij and others (1998), Gan and Smith (2007), and Perez-Verdin and others (2008) all conducted studies in States, regions, or countries without coal, and thus do not address the negative effects on coal mining. Many of these studies also fail to account for the negative effects of bioenergy production on the conventional electricity sector. Only English and others (2009) address the negative effects that a utility rate increase would have on households. Forecasts of increased economic activity from the conversion to bioenergy result from some or all of the following: (1) large multiplier effects from increases in bioenergy feedstock production, as well as increases in power and fuel production; (2) smaller multiplier effects from costs to households; (3) analysis of small regions that may not fully capture effects on sectors such as coal mining; and (4) excluding the coal feedstock, conventional power and fuel sectors. The incomplete nature of these analyses limits their usefulness in evaluating economy-wide effects of a conversion to bioenergy or indeed, any renewable energy, from conventional energy.

Computable general equilibrium models typically include the effects on households (increasing utility and fuel costs), conventional energy providers, wood-products companies (increasing wood costs), and bioenergy providers (Hodges and others 2010, Huang 2010, Winston 2009). These studies predict losses to conventional energy providers and households, gains to bioenergy providers, and varying effects on the wood-products sector. One reason for the discrepancy in the wood-products predictions may be Huang's (2010) assumption of a large increase in biofuels, which may exceed the model's ability to correctly represent the sectors. Huang provides no explanation for the counterintuitive results that sawmill output and jobs increase when cellulosic ethanol production increases, or that jobs decrease and output increases for woody electricity with implementation of the bioelectricity policies. Hodges and others (2010) show small increases in economic activity while Huang shows small decreases. As these studies use the same model and data, one possible explanation for discrepancies is the geographic scale of their analyses as Huang analyzes the southeast while Hodges and others analyze only Florida.

The most complete studies, Hodges and others (2010) and Huang (2010), indicate small future changes overall (reductions in conventional sectors and increases in the bioenergy sector) with the changes occurring in the power sectors. For the South, economic theory would imply an increase in logging jobs and output, which may be offset at larger regional and national levels by declines in coal production and transport but would nonetheless provide increases in local jobs and income. Depending on the specific policies implemented, competition for wood between traditional wood-using companies and bioenergy companies may increase wood costs and thus decrease jobs and output in the traditional sectors, although these changes will likely be masked by larger structural changes in the wood products and paper manufacturing sectors. Finally, a shift to bioenergy on a large scale would require the construction of facilities with accompanying growth, albeit temporary, in jobs and income. It is unclear how much of this construction will substitute for decreases in construction and/or maintenance of conventional energy facilities.

## DISCUSSION AND CONCLUSIONS

The future of forest-related jobs and income in the South is uncertain. Forecasting is complicated by large recent changes in these sectors, combined with the effects of the 2007–09 recession and the potential for bioenergy. The logging sector is expected to respond to changes in the demand for timber products at paper mills, sawmills, and bioenergy plants. Unknowns include how the evolution to a more highly mechanized and less family-firm oriented sector will affect timber production. Shortages of workers have been noted in Maine, although contract loggers from Canada have readily filled the void. Concern is frequently voiced, but shortages have not been documented.

The wood products manufacturing sector, which includes sawmills, is expected to recover to pre-recession levels of output, although jobs per unit of output is likely to continue to decline due to technical change, which will influence overall sector employment. Beyond the next decade, we do not know precisely how wood will continue to be used in housing, or how technical change will affect the production process.

The paper manufacturing sector is expected to continue to contract slightly, even after recovering from the recession. A reduction in fine paper production in the South and declining overall demand for virgin paper are likely to reduce output. And continued technical change is likely to further reduce employment in this sector over the next decade.

Future changes in jobs, income, and output deriving from forest-based recreation in the South will depend on changes in the demand for recreation and the level of technical change in the service sector. Recreation demand is a positive function of population and income, so increases in these factors would be expected to lead to increases in jobs and income in the sectors that provide recreation services. However, it is likely that forest-based recreation will increase at rate slower than the rate of increase in population.

Considerable uncertainty surrounds the potential for wood use in bioenergy, including the success of commercial conversion technologies for cellulosic ethanol, policy requirements for renewable energy, carbon emissions control schemes, and even the future employment and output profiles of specific activities such as co-firing and ethanol production. Under standard economic theory, implementation of policies to correct a nonmarket externality, such as unpriced carbon emissions, would be expected to lead to short-run monetary losses in an economy. By sector, an increase in wood use for bioenergy could lead to (1) increases in logging accompanied by decreases in coal mining, (2) increases in bioenergy production accompanied by decreases in conventional energy production, (3) decreases in household income because of increases in electricity and fuel costs, (4) increases in construction activity, and (5) a potential loss in traditional wood products sectors if increased demand for timber results in higher timber costs.

## KNOWLEDGE AND INFORMATION GAPS

Considerable information is lacking in the literature and in the data that complicate the development of industry and employment forecasts for the forest-based sectors. The bioenergy sector is new and currently untracked in national data as a distinct sector and thus is lacking historical data. As in any developing industry, technologies and industry structures are likely to change significantly over the next decade. And this assumes the bioenergy sector does develop—there is a chance this sector will not become a major wood user. Interactions between existing sectors and this new sector are also unknown.

Assessing the future of employment and output in the forest-based recreation sector is likewise hampered by the lack of data, although this is neither a new nor developing sector. The only data available on forest-based recreation are collected by individual land management agencies. For example, the National Visitor Use Monitoring Survey conducted by the U.S. Forest Service (Stynes and White 2006), collects information on recreational activities on national forests only and a comparable study is not available for private- and State-owned forest-based recreation.

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