ECONOMIC CONTRIBUTION OF THE FOREST-BASED INDUSTRIES IN GEORGIA

by

UNMESH KOIRALA

(Under the Direction of Jacek P. Siry)

ABSTRACT

This study estimated the economic contribution of the forest-based industries in Georgia using IMPLAN model and its 2012 database. This research looked at IMPLAN database as possible alternative to the ES202 data and also did a regional economic contribution analysis of forest-based industries for five FIA survey regions. Results showed that the forest product industries contributed 2.2% of the total employment, 2.4% of the total labor income, 2.4% of the total value added and 3.2% of the total output of the state. IMPLAN database was simpler, easier and more popular alternative to using ES202 data for estimating the economic contribution of forest sector. North Central Georgia had the highest economic contribution from the forest-based industries and North Georgia had the lowest contribution. Similarly, Southwest and Southeast region had the highest dependency on the forest-based industries and North Central region had the lowest dependency.

INDEX WORDS: ES202, IMPLAN, economic contribution, forest sector, FIA regions.

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CHAPTER 1

INTRODUCTION

Georgia is one of the largest timber producing state in the US. It lies in the US South, which is the largest wood supply region in the world (Clutter et al., 2009). Georgia timberland covers 24.4 million acres or 66% of the total land area in the state (Harper, 2012). *Pinus taeda* (loblolly pine) - *Pinus echinata* (shortleaf pine) is the predominant forest type which accounts for 31% of the total timberland area followed by *Quercus spp.* (oak) – *Carya spp.* (hickory) (26%), *Pinus palustris* (longleaf pine) – *Pinus elliottii* (slash pine) (15%) and *Quercus spp.* (oak) – *Liquidambar styraciflua* (sweetgum) – *Taxodium distichum* (cypress) (13%) forest types. In 2009, this timberland produced 50 million tons of roundwood to the different forest-based industries in the state. This included 46 million tons of merchantable roundwood and 3.9 million tons of merchantable residue delivered to the mills (Harper, 2012).

In 2009, there were 152 primary wood-using facilities in Georgia (Johnson et al., 2011). These industries produce primary wood products such as lumber, pulp, veneer, logs, Oriented Strand Board (OSB), poles, chips and other products (posts, mulch, residential firewood, industrial fuel, logs for log homes, and others). Among them, there were 88 sawmills, 12 pulp and paper mills, 6 veneer mills, 3 composite panel or OSB mills and 43 others. Since 1971, the number of primary wood-using facilities in the state have declined dramatically from more than 350 to 152 in 2009 (Knight and McClure, 1974). However, the total mill production or output have increased drastically from 801 million cubic feet to 1.05 billion cubic feet or 31% from 1971 to 2009 (Johnson et al., 2008). The output further increased to 1.22 billion cubic feet by

2011 (Bentley et al., 2014). Also, 85% of the total output in 2011 was supplied by softwood mills.

Similarly, there are more than 1,000 secondary wood-using facilities in Georgia (GFC, 2014). These facilities use the products from primary wood-using industries and produce converted paper bags, architectural woods, engineered woods and kitchen cabinets and other secondary wood products.

Forest-based industries in Georgia play an important part in the forest-based economy of the US South. Dahal (2014) reported that in 2009, the forest-based industries in Georgia ranked third in the total number of jobs provided, total labor income and total value added in the US South. They accounted for 10.6% of the total forest-based employment in the region. Similarly, they contributed 11.4% of total labor income, 12.1% of the total output and 11.8% of the total value added by the forest-based industries in the US South. In Georgia, they accounted for 0.9% of the state's total employment, 1.2% of the total labor income, 2.2% of the total output and 1.2% of the total value added in the state (Dahal, 2014).

Given the importance of the forest-based industries for the state as well as the whole region, it is essential that the economic contribution of those industries is evaluated on continuous basis. Since 2002, Enterprise Innovation Institute (EII) at the Georgia Institute of Technology has been producing reports with the analysis of economic benefits of forestry in Georgia. These studies have relied on ES202 or Covered Employment and Wages (CEW) data, which is collected and maintained by Georgia Department of Labor, as the main data source (EII, 2013). As there are no other reports analyzing the economic contribution of the forest sector, EII reports have been the only source of information regarding the economic contribution of the forest sector in Georgia and have been used by Georgia Forestry Commission (GFC) to produce their annual economic contribution reports.

Though, ES202 data, which is used in EII reports, have been used as a source of secondary data for studies involving local job flows and informing local economic development policies, there are some noteworthy limitations associated with them. White et al. (1990) used Wisconsin's ES202 data and identified problems with them like missing data for records of sole proprietor, raw data errors and geographic location errors. Although that research only used data from one state, those problems can be related to other state level ES202 data because of their uniform structure across states. Further, Feser and Sweeney (2006) identified problems with the spatial location of business establishments in the ES202 file and found the possibility of 50 to 55% sample bias of export-oriented business establishments in the federal data.

The purpose of this study is to develop a consistent methodology for assessing the economic contribution from the forest-based industries located in the state of Georgia. In this study, IMpact Analysis for PLANning (IMPLAN) database and software were used as the source of data and also for developing the model for estimating the economic impacts. IMPLAN is a non-survey based input-output model that is comprised of economic modelling software and regional data sets (Day et al., 2012). This is one of the most popular methods of analyzing the economic contribution for a specific region because it is very easy to understand and provides flexibility to its users to vary various parameters during the analysis. Even though IMPLAN uses ES202 data as one of its data sources, it revises and corrects these data using several other data sources. Thus, IMPLAN database is not subjected to the data errors associated with ES202 data. IMPLAN method has been used for examining the economic impacts of forest-based industries in Mississippi, Alabama, Texas, Kentucky, Florida and Tennessee (Fields et al., 2013;

Henderson et al., 2008; Hodges et al., 2005; Joshi et al., 2014; Stringer et al., 2013; Young et al., 2007).

This research will estimate the economic impact of the forest sector in Georgia for the year 2012 and compare and contrast these results with the results from EII (2013). This report will also produce regional economic contribution for five forest survey units used by Forest Inventory and Analysis (FIA) regions in Georgia. Those five regions are North, Northcentral, Central, Southwest and Southeast. Each of these regions represents group of counties located in different geographical regions of the state. These regions have different forest types, forest condition and different types of forest product industries. By producing these results, the importance of the forest sector in different geographic regions as well as policy implications can be developed. Also, we will relate that economic contribution outputs with the available forest condition and forest industry information for those regions.

1.1 Objectives

- Estimate the economic contribution of the forest-based industries in Georgia for 2012
- Compare and contrast the results to those found by EII (2013) and discuss similarities and differences
- Estimate the economic contribution of the forest-based industries in 5 FIA regions and relate the results with the available forest condition and presence of the forest product industries in the region

CHAPTER 2

METHODS AND DATA

2.1 Review of previous studies estimating economic contribution of the forest sector

Forest-based industries in the US South play an important role in the region's economy (Dahal, 2014). Understanding the economic contribution of the forest-based industries is essential for developing the regional policies and decisions. Thus, many studies have been conducted in the regions to estimate the economic contributions of the forest-based industries. Along with estimating the overall contribution of the forest-based industries, some studies have also focused on understanding the economic impacts of events like establishment of a new forest-based industry and economic changes brought by different natural and economic disturbances. Input-Output (I-O) model has been the most popular method used to examine the economic contribution or impacts these events or activities create in terms of creation of new jobs, increase in value added and total income (Day et al., 2012).

Teeter et al. (1989) examined interregional impacts of economic activities related to forests across South, West, Northeast and Midwest regions of the US. The authors concluded that there are significant interregional spillover effects among the forest product industries in those four regions. Guan and Munn (2000) performed an assessment of the impact of the logging restrictions enforced in the Pacific Northwest in 1990 and found that the forest-related investments increased markedly in the US South after 1988 and this region had brighter prospects for forest-based industries than the Pacific Northwest. Aruna et al. (1997) found an increase in the forest-based contribution in the South with the forest-based employment increasing by 1.4% from 1982 to 1992. The forest-based employment saw further increase of 13% from 1992 to 2001. However, substantial improvement in the technology led to decrease in the forest-based employment by 33.35% from 2001 to 2009 (Dahal, 2014). Brandeis and Hodges (2015) used input-output modelling to assess the economic contribution of the forest sector in the South in 2011. In their assessment, they found a sustained decline of the southern forest sector due to the recession, falling housing market and diminishing demand for paper for print. Nevertheless, they predicted improvement in the forest-based economy in the South with the recovering housing market, growing wood pellet demand and slowly improving global economy.

Similarly, several state level studies have been conducted to assess economic impacts of the forest products industry. Hodges et al. (2005) studied the economic contribution of the forest product industries in Florida in 2003 and found that the forest-based industries produced $16.6 billion in total output, $7.5 billion in total value added and provided 30,000 total jobs. Young et al. (2007) performed a similar study in Tennessee and reported that the forest-based industries contributed 6.6% of the state's economy and generated $21.7 billion of total output in 2000. Henderson et al. (2008) analyzed the impact of Hurricane Katrina on the economic contribution of the forest sector in Mississippi and reported 6.5% decrease in the direct employment from 2001 to 2006 (before and after the hurricane). However, the total industry output, total value added and total wages generated increased after the event suggesting that the forest-based industries managed to survive the catastrophe without long-term damage. A study evaluating economic impacts of woody biomass utilization in Mississippi showed that recovery of logging and thinning residues can create more employment opportunities and would be able to boost the rural economy (Perez-Verdin et al., 2010). Gan and Smith (2007) analyzed economic impacts of utilizing residues from logging for bio-energy production in East Texas using the input-output model. Their results showed that East Texas could benefit from establishment of such bio-energy in terms of creation of jobs and higher income generation. Bailey et al. (2011) investigated potential economic impacts that lingo-cellulosic biofuel production can create in rural areas of Alabama and concluded that such production could help in poverty reduction in the rural areas of the US South through economic growth by increased jobs, income and tax revenues. Kebede et al. (2013) analyzed the economic impacts of using locally produced wood pellet co-firing along with imported coal in West Alabama and found that wood pellet co-firing plant will generate additional employment and income in miscellaneous forest product and commercial logging directly that will help forest land owners to generate additional income.

Furthermore, Aruna et al. (1997) assessed the economic contribution of the forest-based industries in Georgia. They reported that the forest-based industries in Georgia provided 66 thousand jobs in 1992. The number of forest-based jobs increased by 8% to 72 thousand jobs in 2001 (Tilley and Munn, 2007). The forest-based earning increased by 9.5% from 1990 to 1998 and gross state product, which consist of value of shipments and value added, increased by 62.5% from 1991 to 2001. Further, $2.6 billion dollars was generated by forest-based industries as federal non-defense and state and local government non-education taxes. Dahal (2014) published a follow-up study where he compared the economic contribution of the forest-based industries from 2001 to 2009. In his study, he showed the total forest-based employment in Georgia decreased by 29%, the forest-based earning decreased by 15% and the total federal non-defense and state and local government non-education taxes decreased by 10% from 2001 to 2009. The only improvement was seen in the gross state products that saw an increase of 7%. Dahal (2014) suggested the recession and decline in housing and other constructional activities over that period as the reason for such decline.

Further, EII (2013) reported 43 thousand people directly employed by the forest industries in Georgia in 2012. Among the various forest-based sectors, the pulp and paper products industry accounted for the highest contribution to the total forest based industry output and employment with 72% of total industry output and 48% of total industry employment. Forest industry was ranked third in total employment after food processing and textile industry and second in employee compensation only after food processing industry. Likewise, a yearly comparison of economic impacts of the forest industry from 2003 to 2012 showed a rapid decline in total output, employment and employee compensation from 2007 to 2010, followed by steady increase in 2011 and 2012. The regional comparison of economic impacts of the forest industry in various parts of Georgia showed that the Atlanta Regional Commission has significantly higher total output as well as number of people employed, followed by Central Savanna River Area.

2.2 Theoretical background

I-O analysis is a systematic quantification of mutual inter-relationship between different sectors in a complex regional economic system (Leontief, 1986). Wassily W. Leontief developed this analysis method in 1936 (Blue, 2014), for which he won the Nobel Prize for Economics in 1973 (Beleiciks, 2005). I-O analysis uses an appropriately defined vector of structural coefficients that represents the quantitative relationships between inputs used and the resulting outputs (Leontief, 1986). Also, this analysis describes interdependence between different sectors of a given economy by tracing how the output from one sector is used as input by another sector (Teeter et al., 1989). I-O model used in the analysis consists of a set of linear equations that relates supply and demand of commodities produced by different sectors of a defined region at a certain point of time (Beleiciks, 2005).

To better understand the concept of the I-O model, we need to look at the total final demand for industries in a specific economy. The following equations represent the simplified version of the theoretical concept behind I-O model. Equation 2.1 and 2.2 were taken from Shaffer (2004) and equation 2.4 to 2.11 were taken from Chiang (1984).

The following equation represents the total output of sector *i* in an economy:

$x_i = z_{i1} + z_{i2} + z_{i3} + \ldots.. + z_{in} + Y_i$ (Equation 2.1)

where, x_i represents the total output of sector *i* in monetary terms, Y_i represents the total final demand for the product from sector *i*, z_{ij} represents the inter-industry demand for input from sector *i* to the output from sector *j* and *n* is the total number of sectors from which sector *i* fulfill its demand (Shaffer, 2004).

In order to produce each unit of the *j*th commodity, the input needed for the *i*th commodity must be a fixed amount which is called a technical coefficient and denoted by a_{ij}. The technical coefficient indicates how much of the *i*th commodity is used in the production of the *j*th commodity. The coefficient also assumes fixed prices for inputs and constant input to output ratios during production (Chiang, 1984). The mathematical representation for the technical coefficient is:

$a_{ij} = \frac{z_{ij}}{x_j}$ (Equation 2.2)

The following transaction table represents a specific economy with inter-industry relationship shown through buying and selling of products between different sectors.

Table 2.1. Transaction table

Intermediate Demand (j)						Other Demand				
Intermediate Inputs (i)		Buying Sector 1	Buying Sector 2	Buying Sector 3	Buying Sector 4	Household	Investment	Government	Export	Total Output
	Selling Sector 1	Z_{11}	Z_{12}	Z_{13}	Z_{14}	H_1	I_1	G_1	E_1	x_1
	Selling Sector 2	Z_{21}	Z_{22}	Z_{23}	Z_{24}	H_2	I_2	G_2	E_2	x_2
	Selling Sector 3	Z_{31}	Z_{32}	Z_{33}	Z_{34}	H_3	I_3	G_3	E_3	x_3
	Selling Sector 4	Z_{41}	Z_{42}	Z_{43}	Z_{44}	H_4	I_4	G_4	E_4	x_4
Factors Inputs		F_1	F_2	F_3	F_4					
Taxes		T_1	T_2	T_3	T_4					
Imported Inputs		M_1	M_2	M_3	M_4					
Total Outputs		x_1	x_2	x_3	x_4					

[Source: Taken from Shaffer (2004)]

In the above transaction table, Z_{23} represents the inter-sector transaction as goods or services supplied from sector 2 to sector 3. The inter-sector transactions occur as the goods or services are used among the same sectors in the economy. Variables H, I, G and E represent demand from households, investments, government and exports, respectively, for each sector's output. Also, variables F, T and M represent primary suppliers who produce inputs that do not require the purchase of intermediate goods and services from the local producing sector to generate those inputs (Shaffer, 2004). Finally, x represents the total output for each sectors. The technical coefficient can be rearranged as:

$$z_{ij} = a_{ij}x_j \qquad \text{(Equation 2.3)}$$

Using Equation 2.1 and 2.3,

$x_1 = a_{11}x_1 + a_{12}x_2 + \ldots\ldots + a_{1n}x_n + d_1$ (Equation 2.4)

or,

$(1 - a_{11})\ x_1 - a_{12}x_2 - \ldots\ldots - a_{1n}x_n = d_1$ (Equation 2.5)

where, x_1 is the output level of industry 1 and n represents the number of industries whose input requirements are fulfilled by industry 1.

Now, for the n industries, Equation 2.5 can be presented as set of linear equations:

$$\left.\begin{array}{l} (1 - a_{11})\ x_1 - a_{12}x_2 - \ldots\ldots - a_{1n}x_n = d_1 \\ -a_{21}x_1 + (1 - a_{22})\ x_2 - \ldots\ldots - a_{2n}x_n = d_2 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ -a_{n1}x_1 - a_{n2}x_2 - \ldots\ldots + (1 - a_{nn})x_n = d_n \end{array}\right\} \quad \text{(Equation 2.6)}$$

The above shown Equation 2.6 can be written into matrix notation as:

$$\begin{bmatrix} (1 - a_{11}) & -a_{12} & \ldots & -a_{1n} \\ -a_{21} & (1 - a_{22}) & \ldots & -a_{2n} \\ . & . & . & . \\ -a_{n1} & -a_{n2} & . & (1 - a_{nn}) \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ . \\ x_n \end{bmatrix} = \begin{bmatrix} d_1 \\ d_2 \\ . \\ d_n \end{bmatrix} \quad \text{(Equation 2.7)}$$

If we denote the matrix of technical coefficients as $-A = [-a_{ij}]$, the left side of Equation 2.7 is the sum of identity matrix I_n and the matrix $-A$.

Hence,

$(I-A)\ x = d$ (Equation 2.8)

or,

$x = (I-A)^{-1}\ d$ (Equation 2.9)

The matrix $(I-A)^{-1}$ is also known as Leontief Inverse, which represents the direct and indirect requirements per dollar of output and helps in estimating multiplier effects (Shaffer, 2004). It can also be represented as:

$$(I-A)^{-1} = I + A + A^2 + A^3 + \ldots + A^n \qquad \text{(Equation 2.10)}$$

Thus the predictive model for the total output with the change in final demand is represented as:

$$\Delta X = (I-A)^{-1} * \Delta D \qquad \text{(Equation 2.11)}$$

This I-O models assumes a state of economic equilibrium where the output of any sectors equals to the total sum of inputs and final demand, which means supply must initially equal demand (Sobolewski, 2010).

For better understanding of the I-O model, we create a simple example of a hypothetical economy that consist of three sectors: Agriculture (Ag), Manufacturing (Mf) and Services (Sc). The input-output table below shows the total input and total output from these sectors in commodity terms.

Table. 2.2. Input-Output transaction table

Seller/Buyer	Agriculture	Manufacturing	Services	Other Demand	Total Output
Agriculture	50	5	0	55	110
Manufacturing	30	55	20	70	175
Services	15	25	40	110	190
Other Payments	15	90	130		
Total Input	110	175	190		

[Source: Adapted from Leontief (1986)]

In the above table, we can see that the Agriculture sector in the region sells 50 units of its production to itself, 5 units to the Manufacturing sector and 55 units to its finished good consumers making the total output of 110 units. Further, Agriculture sectors buys 50 units as input from itself, 30 units from the manufacturing sector, 15 units from service sectors and 15 units from other inputs and wages, making its total input of 110 units. Similarly, other sectors also sell and buy different number of units from itself and other sectors that sums up as their total output and input.

Table 2.3. Structural coefficients table

Seller/Buyer	Agriculture	Manufacturing	Services
Agriculture	0.45	0.03	0.00
Manufacturing	0.27	0.31	0.11
Services	0.14	0.14	0.21

Table 2.3 shows the structural coefficient reflecting the interrelationship between input and output between the sectors. Each structural coefficient represents quantity of the output of sector (i) utilized by sector (j) per unit of its total output (Leontief, 1986). Mathematically,

$$a_{ij} = x_{ij} / x_j \qquad \text{(Equation 2.12)}$$

where, a_{ij} represents each value in the table, x_{ij} represents the amount of product of sector (i) utilized by sector (j) as its input and x_j represents the total output of sector (i).

Example,

$a_{11} = 50/110 = 0.45$

$a_{12} = 5/175 = 0.03$

Now, using the predictive model,

$$I\text{-}A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} - \begin{bmatrix} 0.45 & 0.03 & 0.00 \\ 0.27 & 0.31 & 0.11 \\ 0.14 & 0.14 & 0.21 \end{bmatrix} = \begin{bmatrix} 0.55 & -0.03 & 0.00 \\ -0.27 & 0.69 & -0.11 \\ -0.14 & -0.14 & 0.79 \end{bmatrix}$$

$$(I-A)^{-1} = \begin{bmatrix} 1.88 & 0.08 & 0.01 \\ 0.82 & 1.54 & 0.20 \\ 0.47 & 0.29 & 1.31 \end{bmatrix}$$

Further,

$$\Delta X = \begin{bmatrix} 1.88 & 0.08 & 0.01 \\ 0.82 & 1.54 & 0.20 \\ 0.47 & 0.29 & 1.31 \end{bmatrix} \times \begin{bmatrix} 50 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 93.81 \\ 40.94 \\ 23.61 \end{bmatrix}$$

The above result shows that if we change the final demand of the Agriculture sector by adding 50 units, then the total impact on the economy of the region (ΔX) is close to 158 units. This includes the direct impact of 50 units and 108 units of indirect impacts created from it. Thus, 50 units increase in Agriculture sector will require additional increase of 44 units in Agriculture sector, 41 units increase in Manufacturing sectors and 23 units increase in Service sector. Hence, even in a complex economy with many sectors and industries the final demand change in one of the sector affects the output and demand from other sectors. The increase in demand from one sector means it requires more input for its production. This leads to increased purchases of inputs that creates higher demand for sector producing those inputs. This increases the production from other sectors as well. This process continues until the effect is exhausted (Watts, 2008). This effect will also impact the employment and labor income associated with those sectors. This is how the economic impacts due to change in demand from one sector flows through the economy.

2.3 IMPLAN

IMpact Analysis for PLANning (IMPLAN) is a non-survey based input-output model that was developed in 1979 by the US Department of Agriculture (USDA) Forest Service in co-operation with Federal Emergency Management Agency and the US Department of the Interior (USDI) Bureau of Land Management for land and resource management planning (Day et al., 2012). I-O models can be constructed at national, state, county and zip-code levels as well as a combination of them using the commercially available IMPLAN software and database. Using those models, economic outputs such as employment, earnings, total output, value added, tax impacts and multipliers could be generated (Tilley, 2006).

Data for the IMPLAN database are gathered from various federal data sources that include:

- the US Bureau of Labor Statistics (BLS) Covered Employment and Wages (CEW) program,
- the US Bureau of Economic Analysis (BEA) Regional Economic Information System (REA) program,
- the US Bureau of Economic Analysis Benchmark I/O Accounts of the US,
- the BEA Output Estimates,
- the BLS Consumer Expenditure Survey,
- the US Census Bureau County Business Patterns (CBP) program,
- the US Census Bureau Decennial Census and Population Survey,
- the US Census Bureau Economic Censuses and Surveys,
- and the US Department of Agriculture Census (Day et al., 2012)

Based on North American Industrial Classification System (NAICS), the IMPLAN model uses a 440-sector I-O transactions table to track the impact of expenditures in one sector spreading through other sectors of the economy (Henderson and Munn, 2013). Each of those sectors represents a group of firms that are involved in the same type of business (Riggs et al., 2011). IMPLAN Sectors 1 to 426 consist of all the private sector producers of goods and services, Sector 427 consists of private and quasi-public postal service, Sectors 428 to 432 consist of all the public sectors producing goods and services, and government administrative sectors make up the final Sectors 433 to 440 (Santos et al., 2011).

The IMPLAN Group, which is a private company responsible for managing IMPLAN models and database, annually adds new data sets into their database that includes regional employment, income, value added, and household and government consumption (Henderson and Munn, 2013). This database follows a top-down pattern with a national account constructed first, followed by regional, state, county and zip-code level accounts, which is overall internally consistent (Crihfield and Campbell, 1991).

IMPLAN software has an important feature that allows its users to manipulate data from its database so that the economic conditions of the working area could be properly represented (Henderson and Munn, 2013). It also allows users to incorporate primary or secondary data collected to create more precise outputs (Dahal, 2014). With the proper understanding of the working area and appropriate IMPLAN parameters, users can also select and define appropriate inputs in the software (Lynch, 2000). It enables the users to change the production function and trade flow model (Day et al., 2012).

IMPLAN reports its results of economic impact analysis in terms of employment, labor income, total industry output and total value added. Employment value represents the total average annual jobs that include self-employed as well as wage and salary employees who work full-time, part-time and seasonal jobs. This is estimated based on a count of full-time/part-time averages over a year (Day et al., 2012). Labor income consist of two elements: Employee Compensation and Proprietor Income. Employee compensation consist of the total cost of labor such as wages and salaries along with benefits such as health insurance, retirement benefits and social insurance. Likewise, Proprietor Income consist of total income of a sole proprietor or self-employed “employee”. Total industry output refers to the total value of increased production or total value of sale. If the total production is higher than total sales, then the surplus production is considered as inventory and it is not included in direct output. Total value added refers to an industry’s value of production over the cost of goods and services as its inputs to make its final product. This includes sum of earnings and indirect business taxes (excise, property, sales taxes and fees) (Dahal, 2014).

2.4 Multipliers

In the I-O model, multipliers represents the change in the total output as a result of a dollar added to the specific sector in the regional economy. The magnitude of the multiplier depends on two main factors, i.e., how much the added expenditure of the industry in focus is used for purchasing goods and services from other industries and whether or not the structure of a local economy consists of industries that could supply inputs to the industry under study (Lazarus et al., 2011).

Generally, the magnitude of multipliers is higher for larger and diverse economies because the quantities of inputs required to fulfill the increased demand will be provided by the local economy (Tilley, 2006). Thus, the benefits of extra spending is contained locally and will generate more employment and household spending in that area (Lazarus et al., 2011). However, the multiplier effects in a smaller and less diverse region are limited by leakages where the effects of extra expenditures move outside the region due to higher import of inputs (Sobolewski, 2010).

IMPLAN generates its output based on direct, indirect and induced impacts that occur due to the change in final demand of the industry. Direct impact comprises added contribution to the economy through its final products, employment, value added and total income by the industry to fulfill its increased final demand (Tilley and Munn, 2007). Indirect impact represents the effect on the economy due to the purchase of products or services from others to meet the demands of industry with increased final demand (Dahal, 2014). Lastly, induced impact is the effect that results from purchase of goods or services by people employed directly or indirectly by supporting sectors (Tilley and Munn, 2007). This represents the increase in household spending due to added income of the employees (Tilley, 2006).

For capturing these impacts, I-O model uses four types of multipliers (Bonn and Harrington, 2008; Shields et al., 1996). Type I multiplier represents the sum of direct and indirect impacts due to change in final demand divided by direct impacts (Tilley and Munn, 2007). This multiplier is the smallest as it does not take into account the induced effects created by household spending (Tilley, 2006). Type II, Type III and Type Social Accounting Matrix (SAM) multipliers are estimated by summing the direct, indirect and induced effects and divided by direct effects (Aruna et al., 1997; Dahal, 2014). However, the difference between these multipliers is the induced impacts used. Type II multiplier estimates its induced effects based household expenditures created by new labor income. Thus, this multiplier assumes linear relationship between increase in final demand, employee’s income and their expenditure (Dahal, 2014). This causes overestimation of the induced impacts for the region (Shields et al., 1996) as the employee's expenditure increases slower than income (Dahal, 2014). Type III multiplier tries to rectify this problem by including induced impacts based on employment by using per capita expenditure for each employee in the study area (Tilley, 2006). Although, this makes it more accurate than Type II multiplier, it still tends to overestimate the induced impacts in low-wage sectors and underestimate in high-wage sectors (Charney and Leones, 1997). Type SAM used information from SAM to estimate the induced impacts (Henderson and Munn, 2013). SAM is a summary table that represents the inter-linkages of production process, income distribution and redistribution that occurs between different sectors inside a regional economy within specific period of time (Day et al., 2012). Type SAM multiplier allows users to include or exclude certain factors like employee compensation, proprietary income, other property income and indirect business tax. Also, it accounts for social security and income tax leakage, institutional savings, and commuting. Thus, Type SAM multiplier is considered as the most accurate and preferred multiplier.

2.5 Data

In this study, 2012 IMPLAN Georgia county database, which was the most recent database available for Georgia during the time of this research, was used as the source of data. This database was published at the end of 2013 and provided the total employment, output and labor income values for all the 440 industrial sectors present in the Georgia counties for the year 2012. This database was created using Covered Employment and Wages (CEW), Regional Economic Accounts (REA), County Business Patterns (CBP) data, along with other available federal data sources.

While there are other options available for estimating the economic contribution of any sector, IMPLAN software is the most popular choice among researchers. As in several other studies assessing the economic contribution of the forest-based industries, this thesis used IMPLAN as the preferred choice of input-output modelling software. This software is known for its flexibility, allowing customization of the data sets and producing out results that are easy to understand (Day et al., 2012).

For this study, 23 sectors among the 440 IMPLAN sectors were considered suitable to be classified as the forest-based sectors. These sectors include both primary and secondary wood-using sectors. All the forest-based sectors were aggregated into five major forest product sectors. They are miscellaneous forest products, logging, solidwood products, wood furniture, and pulp and paper sectors. Also, all other 417 sectors were also aggregated into 26 broad categories. This aggregation procedure followed Dahal et al. (2013), who modeled the economic impact of the forest product industry on the Mississippi economy. They used 2010 IMPLAN database and model to estimate the economic contribution provided by the forest-based industries in Mississippi. The impacts of the five aggregated sectors of the forest-based industries were examined individually as well as an entire industry.

Further, 2012 IMPLAN Georgia county database was used to estimate the direct contribution of each of the forest product sectors using a multi-sector contribution analysis technique. This technique was used to eliminate the double-counting that happens if a single sector multiplier is used as double counting would cause overestimation of the total contribution from all the sectors. The multi-sector contribution analysis technique used in this study was based on the concept of Leontief I-O model and Leontief Inverse and followed the procedures used in Henderson and Munn (2013).

2.6 IMPLAN model for Georgia

First, IMPLAN model was constructed for the state of Georgia by adding the IMPLAN data files of all 159 Georgia counties. This model used 2012 IMPLAN database to create the economic relationships between different sectors across the state and provide a model of the Georgia economy in 2012. IMPLAN software built the model and produced outputs like gross regional product, total employment, number of industries and population for the specified region. Likewise, IMPLAN also provided other information as the study area data included total employment, output and labor income from all 440 IMPLAN sectors. These values represented the sum of direct contributions from each sector along with the indirect and induced impacts generated by those contributions within those sectors. This meant the total employment value given for commercial logging sector in the study area data section of IMPLAN included the direct employment from the logging sector and the indirect and induced impacts created within the logging sector. IMPLAN also provided information such as social accounts, industry accounts for all the sectors and multipliers associated with each sectors.

Now, multi-sector contribution analysis was used for estimating the direct contribution for all the forest product sectors. Total output values for those sectors along with multipliers associated with each of those sectors were extracted from the software. The extracted multipliers values formed a matrix which was inversed to form a matrix that represented Leontief Inverse Matrix. The inversed matrix was multiplied by the matrix with the total output from different forest product sectors, which provided the required direct contribution values.

The direct contribution values derived for all the forest-based sectors was used in IMPLAN model to estimate the direct, indirect and induced values for employment, labor income, total output and value added. The federal government non-defense taxes and state and local government non-education taxes were also estimated using the model. The economic contribution values in dollars were deflated to 2013 dollar values using deflators from the 2012 IMPLAN database. These deflated values were used to compare with the results from EII (2013).

2.7 IMPLAN model for FIA regions

First, IMPLAN model was constructed for each of the five regions separately by using the IMPLAN data files of the counties in those regions. Using the multi-sector contribution analysis, direct contribution values for all the forest-related sectors were estimated. Then, the direct contribution values were used in IMPLAN models of the region to estimate the economic impacts from the forest-based sectors. Different forest product sectors were aggregated into five broad sectors. The forest-based earning were deflated to 2013 dollar values to maintain consistency in the results.

Further, FIA EVALIDator Version 1.6.0.02 was used as the source of forest-related data. FIA performs periodic forest surveys collecting and reporting data on timber inventory, growth, removals, land area and other characteristics. In this study, data like timberland area, species group, net annual growth and annual removals for all the FIA regions were used. GFC (2013, 2014) were used as the source for information regarding the primary wood-using and secondary wood-using facilities respectively. These sources provided information such as the number, type and location of different forest product industries in Georgia. Also, ArcMap 10.3 was used to create map to show locations and type of primary wood-using industries in Georgia.

CHAPTER 3

RESULTS

3.1 Economic contributions of the forest-based industries in Georgia

In this study, three types of contributions from the forest-based industries were estimated. They were direct, indirect and induced contributions. Direct contribution refers to the direct economic impact created due to the production values of the forest-based industries. Indirect contribution is created by the purchase of products and services as input materials through inter-industry linkages for the production of output by the forest-based industries. Induced contribution represents the economic impacts created due to the household spending of people employed directly or indirectly by the forest-based sectors. Table 3.1 shows economic contribution from the forest-based industries in Georgia in 2012. The contributions are presented in terms of number of jobs, labor income, value added and output generated by these industries. Overall, forest product industries provided 37.5 thousand direct jobs (full-time/part-time) along with 42.7 thousand indirect and 34.8 thousand induced jobs in the state. The total employment from these industries represented 2.2% of the total employment in the state in 2012. Further, the total labor income contribution of $6.5 billion was estimated that accounted for 2.4% of the state's total. The total value added from the forest-based industries was 2.4% of the overall value added in the state. Likewise, the total production from forest based industries generated $26 billion worth of total output (sales) that included $14.8 billion, $7.3 billion and $4.2 billion of direct, indirect and induced impacts respectively. This accounted for 3.2% of the overall $822 billion total output generated in the state.

Table 3.1 Economic contribution summary for the forest-based industries in Georgia, 2012

Contribution Type	Employment	Labor Income ($MM)	Value Added ($MM)	Output ($MM)
Direct Contribution	37,525.5	2,612.1	5,537.7	14,804.0
Indirect Contribution	42,762.3	2,491.1	3,710.5	7,297.0
Induced Contribution	34,778.2	1,484.3	2,608.2	4,260.7
Total Contribution	115,066.1	6,587.5	11,856.4	26,361.7
Percentage of the state's total	2.2%	2.4%	2.4%	3.2%

Table 3.2 Aggregated sectors with highest indirect and induced benefits from the forest-based industries

Aggregated IMPLAN Sectors	Employment	Labor Income ($MM)	Value Added ($MM)	Output ($MM)
Miscellaneous Manufacturing	15,113.7	813.0	964.7	1,530.8
Miscellaneous Services	13,229.5	461.7	552.4	963.7
Wholesale and Retail Trade	12,781.7	729.8	1,192.4	1,715.9
Financial and Real Estate	5,660.3	295.3	785.2	1,201.2
Health Services	4,428.5	315.0	333.8	567.4

Table 3.2 shows top five aggregated sectors in Georgia that had the highest indirect and induced impacts from forest-based industries. Miscellaneous manufacturing, which represents different manufacturing based industries in Georgia, had the highest indirect and induced contribution for employment and labor income. Wholesale and retail trade had the highest total value added and total output impacts. Miscellaneous services, financial and real estate and health services were among other aggregated sectors that had higher indirect and induced impacts from the forest-based industries.

Table 3.3 Federal government non-defense taxes and state/local government non-education taxes generated by the forest product industries in Georgia, 2012

Description	Employee Compensation ($MM)	Proprietor Income ($MM)	Production and Imports ($MM)	Households ($MM)	Corporations ($MM)	Total ($MM)
State/Local Tax	11.1	0	574.0	172.4	19.0	776.6
Federal Tax	573.9	26.9	96.0	400.3	302.6	1,399.7
Total	585.0	26.9	670.0	572.7	321.6	2,176.3

Along with the economic contribution through employment, labor income, value added and output, the forest-based industries also contribute as a major source of government revenues through federal and state taxes. These include employee compensation taxes, proprietor income taxes, taxes on production and import and corporation taxes. The employee compensation taxes include employee contribution and employer contribute taxes, proprietor income taxes include employee contribution taxes for the proprietor, taxes on production and imports include sales, property, vehicle, severance and other taxes, household taxes comprise of personal income, vehicle license, property, fines and other taxes and corporation taxes include dividends and corporate profit tax. As shown in table 3.4, the forest-based sectors contributed $777 million as the total state and local government non-education taxes and $ 1.4 billion as the total federal government non-defense taxes in 2012. These taxes were generated through direct, indirect and induced impacts from the forestry sector.

Table 3.4 illustrates the economic contribution from different aggregated sectors in Georgia. Although, there were some other aggregated sectors like miscellaneous manufacturing and construction, these are the sectors that are more comparable to the forest product sectors. In 2012, forest products sector had the highest employment value followed by agricultural products sector, transportation equipment sector and petroleum and chemicals sector. Also, the forest products sector was ranked fourth for the labor income contribution after transportation equipment sector, petroleum and chemicals sector and food processing sector. In terms of the total output contribution, the forest products sector was ranked fifth. It lagged behind food processing sector, petroleum and chemicals sector, transportation equipment sector and agricultural processing sector.

Table 3.4 Economic contribution of aggregated sectors in Georgia, 2012

Description	Employment	Output ($MM)	Labor Income ($MM)
Forestry Products	46,383.6	16,450.0	3,097.4
Agricultural Products	44,102.1	9,253.9	2,380.8
Metal Industries	32,394.0	12,523.3	1,901.9
Food Processing	28,545.0	33,806.4	3,228.5
Transportation Equipment	41,755.2	25,022.4	3,627.1
Machinery and Equipment	29,613.5	12,487.7	2,286.0
Petroleum and Chemicals	39,372.8	28,650.5	3,315.2
Fabric Mills and Leather	18,265.3	4,834.5	832.7
Agricultural Processing	38,608.4	17,608.3	1,476.8
Technology Industries	18,764.2	7,489.6	1,779.8

3.2 Economic contribution of the forest-based industries in Georgia by sub-industry

3.2.1 Miscellaneous forest products

Miscellaneous forest products sector represents the industries that are involved in gathering and extraction of Non-Forest Timber Products (NTFPs) and forest nurseries management. Table 3.5 shows the total direct, indirect and induced contribution from miscellaneous forest product sector in Georgia. In 2012, this sector created the lowest employment among the five aggregated forest product sectors. It accounted for only 2% of the total direct jobs provided by the overall forest products industries. Also, this sector accounted for 3% of the total direct labor income, 2% of the total direct value added and 2% of the total direct output from the overall forest product industries in Georgia.

Table 3.5 Economic contribution of miscellaneous forest products sector in Georgia, 2012

Contribution Type	Employment	Labor Income ($MM)	Value Added ($MM)	Output ($MM)
Direct Contribution	624.0	80.6	91.2	258.6
Indirect Contribution	726.3	93.8	106.2	301.0
Induced Contribution	0.9	0.1	0.1	0.4
Total Contribution	1,351.3	174.5	197.5	560.0

3.2.2. Commercial logging

Commercial logging includes operations involved in harvesting and transportation of timber along with tree pilling, stump removing and tree chipping in field.

Table 3.6 Economic contribution of commercial logging sector in Georgia, 2012

Contribution Type	Employment	Labor Income ($MM)	Value Added ($MM)	Output ($MM)
Direct Contribution	1,493.5	75.6	47.7	136.4
Indirect Contribution	4,372.6	221.4	139.7	399.3
Induced Contribution	3.1	0.2	0.1	0.3
Total Contribution	5,869.2	297.1	187.5	536.0

Table 3.6 shows this sector contributed 4% of the total direct employment, 3% of the total direct labor income, 1% of the total direct value added and 1% of the total direct output contributed by the overall forest product industries. Likewise, commercial logging created 6 thousand total jobs, contributed $297 million as total labor income, $188 million as total value added and $536 million as the total output.

3.2.3 Solidwood Products

Solidwood products sector consists of sawmills, wood preservation, veneer and plywood manufacturing, engineered wood manufacturing, wood container manufacturing, wood building manufacturing and architectural woodwork.

As shown in Table 3.7, these industries were responsible for 10 thousand direct jobs accounting for 28% of the overall direct employment contribution. This sector also accounted for 20% of the overall direct labor income, 13% of direct value added and 16% of the overall direct output of the overall forest product sectors. This sector ranked second among the five aggregated forest products sector for the highest economic contribution in the state.

Table 3.7 Economic contribution of solidwood products sector in Georgia, 2012

Contribution Type	Employment	Labor Income ($MM)	Value Added ($MM)	Output ($MM)
Direct Contribution	10,399.2	531.0	697.3	2,295.8
Indirect Contribution	2,698.4	140.2	175.0	672.2
Induced Contribution	17.6	0.9	1.1	3.5
Total Contribution	13,115.2	672.1	873.4	2,971.5

3.2.4 Wood Furniture

The aggregated wood furniture sector represents industries that are engaged in manufacturing of wooden windows, doors, kitchen cabinets, countertops, upholstered/non-upholstered household furniture and office furniture. This aggregated sector was ranked third among all the forest product sector for highest economic contribution in the state.

Table 3.8 Economic contribution of wood furniture sector in Georgia, 2012

Contribution Type	Employment	Labor Income ($MM)	Value Added ($MM)	Output ($MM)
Direct Contribution	7,794.9	349.1	475.6	1,280.7
Indirect Contribution	157.1	7.3	8.7	27.5
Induced Contribution	16.1	0.7	1.0	2.6
Total Contribution	7,968.2	357.1	485.3	1,310.9

Table 3.8 shows the direct, indirect, induced and total contribution from the wood furniture sector. The direct jobs provided by wood furniture industry accounted for 21% of the total direct employment created by the forest-based industries. This aggregated sector accounted for 13% of the direct labor income, 9% of the direct value added and 9 of the overall direct output. Also, wood furniture sector generated $485 million dollars as the total value added and $1 billion as the total output.

3.2.5 Pulp and Paper

Aggregated pulp and paper sector includes pulp mills, paper mills, paperboard mills, paperboard container manufacturing, laminated paper manufacturing, sanitary paper product manufacturing and all other converted paper product manufacturing industries. This was the most prominent forest-related sector in Georgia with the highest estimate for employment, labor income, value added and output.

Table 3.9 Economic contribution of pulp and paper sector in Georgia, 2012

Contribution Type	Employment	Labor Income ($MM)	Value Added ($MM)	Output ($MM)
Direct Contribution	17,213.8	1,575.8	4,225.9	10,832.4
Indirect Contribution	840.8	83.1	231.4	590.0
Induced Contribution	25.1	2.0	4.9	12.9
Total Contribution	18,079.7	1,660.9	4,462.2	11,435.3

Table 3.9 shows the economic contribution from this sector in 2012. This sector accounted for 46% of the total direct employment, 60% of the total direct labor income, 76% of the total direct value added and 73% of the total direct output contributed by the overall forest product industries in Georgia.

3.3 Comparison with the results from EII (2013)

Enterprise Innovation Institute (EII) published a report titled “2012 Economic Benefits of the Forestry Industry in Georgia” in 2013. This was part of their reports reporting yearly economic impact values for forestry industry in Georgia since 2002. These reports were prepared for the Georgia Forestry Commission. EII (2013) presented the estimate of economic impacts created by the forest industries in Georgia for 2012 in terms of employment, wages and salaries and output. Forest industries were aggregated into 9 different categories. ES202 data was used as the source of data. IMPLAN model and software were used for estimating the indirect and induced impact values of the forest industries. This report also presented regional economic benefits of the forest industries according to the 12 regional commissions in Georgia.

Table 3.10 Comparison table with economic contribution values of the forest-based industries in Georgia, 2012

Impact Type	Employment (thousand)		Wages and Salaries (billion $)		Output (billion $)	
	EII report	Our estimate	EII report	Our estimate	EII report	Our estimate
Direct Impact	43.1	37.5	2.8	2.6	15.4	14.8
Indirect and Induced Impact	92.6	77.5	4.7	4.0	13.5	11.6
Total Impact	135.7	115.0	7.5	6.6	28.9	26.4

[Source: EII (2013)]

Table 3.10 shows the direct, indirect and induced and total benefits from the forestry industry in Georgia for 2012 as reported in the EII report. If we compare these values with our estimate, the EII report benefits results are higher for employment, wages and salaries as well as output. According to the EII report, the forest product industries in Georgia provided 43 thousand direct jobs in 2012 that is 15% higher than our estimate of 37.5 thousand. The total employment value is 18% higher than our estimate. Likewise, the direct and total labor income benefits from the forest product industries are 8% and 14% higher respectively. The direct output contribution from the forest-based sectors estimated in the EII report is 4% higher and total output is 10% higher than our estimation.

Table 3.11 shows the total benefits by sub-industry from the forest product sectors in Georgia from the EII report. The nine forest industry categories used in the EII report were converted to five aggregated sector to match the aggregation used in our study. The total benefits in the table represents the direct impact from each sector along with indirect and induced impacts within those sectors. The direct benefit estimates for combined miscellaneous forest products and commercial logging from the EII report are considerably lower than our estimates. The direct employment values for those combined sectors differ by nearly 5 thousand jobs. The direct labor income and output values also differ by $357 million and $846 million respectively. The direct contribution values for solidwood products sector are also lower in the EII report with 4 thousand less employment, $101 million less labor income and $712 million less direct output. However, the direct contribution values for both wood furniture and pulp and paper products are higher in the EII reports. The direct employment estimates are higher by 4 thousand for wood furniture sector and 3.5 thousand for pulp and paper products sector. The direct labor income estimates are higher by $161 million and $111 million for wood furniture and pulp and paper products sector respectively. The direct output estimates are $705 million higher for wood furniture and $292 million higher for pulp and paper products sector in the EII report as compared to the estimates from this report. Further, the EII report has also included direct impact estimates for bioenergy sector which is not included in our analysis.

Table 3.11 Economic impacts from different aggregated forest-based sectors in Georgia, 2012

Aggregated Sector	Employment	Wages and Salaries ($MM)	Output ($MM)
Miscellaneous forest products and commercial logging	2,024	93.4	210.9
Solidwood products	8,174	524.4	1,978.0
Wood furniture	12,083	515.0	2,006.8
Pulp and paper products	20,722	1,689.9	11,146.5
Bioenergy	158	7.8	36.8
Total	43,162	2,830.4	15,379.1

[Source: EII (2013)]

3.4 Regional economic contribution analysis of the forest-based industries in Georgia

3.4.1 North Georgia

Lying in the northernmost part of the state, this region is located in the Appalachian plateau, ridge and valley and Blue Ridge zones. This region has high proportion of hardwood as compared to other regions in the state.

As shown in table 3.12, hardwood accounts 63.5% of the net volume of live trees (at least 5 inches d.b.h.) on timberland. The softwood and mixed trees accounts for 20% and 16.5% of the 6 billion cubic feet of total net volume of live trees on timberland. The total average annual net growth on timberland is 166 million cubic feet. Further, the total average annual harvest removals in timberland for the region is 75 million cubic feet, which is considerably lower than other regions in the state.

Table 3.12 Estimates for net volume, average annual net growth and average annual harvest removals of live trees (at least 5 inches d.b.h.) on timberland in North Georgia

Estimates	Softwood (MMCF)	Mixed (MMCF)	Hardwood (MMCF)	Non-stocked (MMCF)	Total (MMCF)
Net volume	1,263.2	1,027.3	3,992.2	0.4	6,283.0
Average annual net growth	81.5	14.4	70.3	-0.04	166.2
Average annual harvest removals	50.0	6.7	18.6	0	75.1

[Source: FIA Evalidator]

There were 26 primary wood-using facilities in North Georgia in 2012. Most of these 26 facilities were small and medium sized as the region had only 1 large and 2 extra-large facilities. Among them, mixed hardwood and softwood using industries were highest in number with 69% followed by softwood with 23% and hardwood with 8%. Figure 3.1 shows the location of different type primary wood-using facilities in the region.

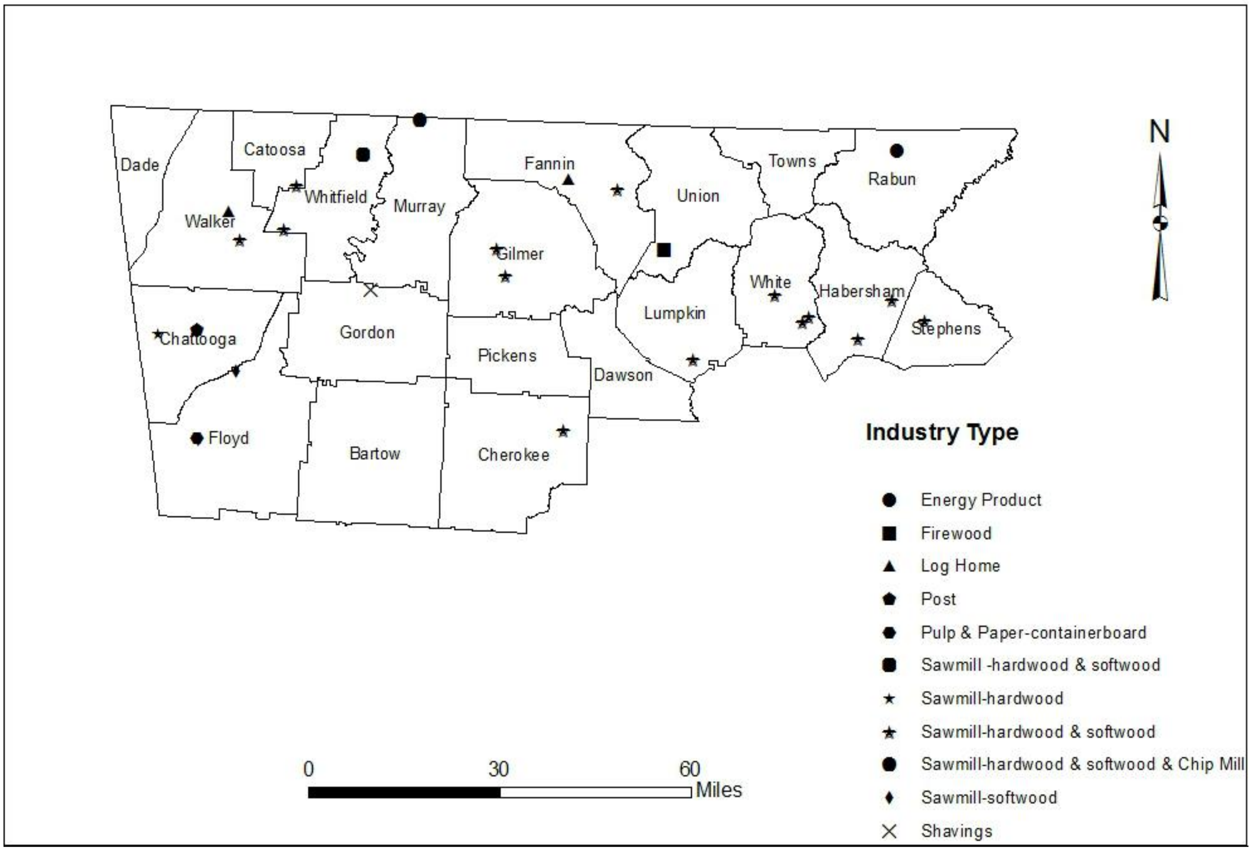

Figure 3.1 Location of primary wood-using facilities in North Georgia

Additionally, 151 secondary wood-using facilities were located in the region in 2014. These facilities generally produced wood-based finished products using the outputs from primary wood-using facilities. Their products include converted paper products, furniture products, architectural woodworks, paperboard containers and others.

The total contribution from the forest-related industries in this region is lowest in the state. Table 3.13 shows the forest-based industries provided 3 thousand direct jobs. Also, 7 thousand jobs were created as the total employment contribution that accounted for 1.6% of the total employment of the region. These industries contributed 2.1% of the total labor income, 2.1% of the total value added and 2.4% of the total output from the forest product industries of the region.

Table 3.13 Economic contribution of the forest product industries in North Georgia, 2012

Contribution Type	Employment	Labor Income ($MM)	Value Added ($MM)	Output ($MM)
Direct Contribution	3,336.3	224.0	392.8	1,114.1
Indirect Contribution	2,212.3	85.1	136.3	291.2
Induced Contribution	1,432.7	45.3	92.9	154.2
Total Contribution	6,981.3	354.3	622.1	1,559.4
Percentage of the region's total	1.6%	2.1%	2.1%	2.4%

3.4.2 North Central Georgia

The North Central region covers the Piedmont zone of Georgia. This region also has high proportion of hardwood forests as compared to softwood and mixed forests. Table 3.14 shows that in this region hardwood accounts for 55% of the 7 billion cubic feet total net volume in the region. Softwood accounts for 34% and mixed forests account for 11% of the total net volume. These has the average annual net growth of 266 million cubic feet and average annual harvest removals of 138 million cubic feet.

Table 3.14 Estimates for net volume, average annual net growth and average annual harvest removals of live trees (at least 5 inches d.b.h.) on timberland in North Central Georgia

Estimates	Softwood (MMCF)	Mixed (MMCF)	Hardwood (MMCF)	Non-stocked (MMCF)	Total (MMCF)
Net volume	2,424.9	798.2	3,886.8	0.6	7,110.5
Average annual net growth	135.5	28.4	102.6	-0.2	266.3
Average annual harvest removals	87.8	22.2	28.8	0	138.8

[Source: FIA Evalidator]

In 2012, there were only 10 primary wood-using facilities in the region. This was the lowest number of primary wood-using facilities in the state. This region also had very few large industries with 3 large industries and 1 extra-large industries. The location of those facilities are shown in figure 3.2. Among the 10 industries, 50% of the industries used softwood, 20% used hardwood and 30% used both hardwood and softwood. Furthermore, this region housed 515 secondary wood using facilities. This was the highest number of secondary wood-using facilities in the state that accounted for 48% of the total number of facilities.

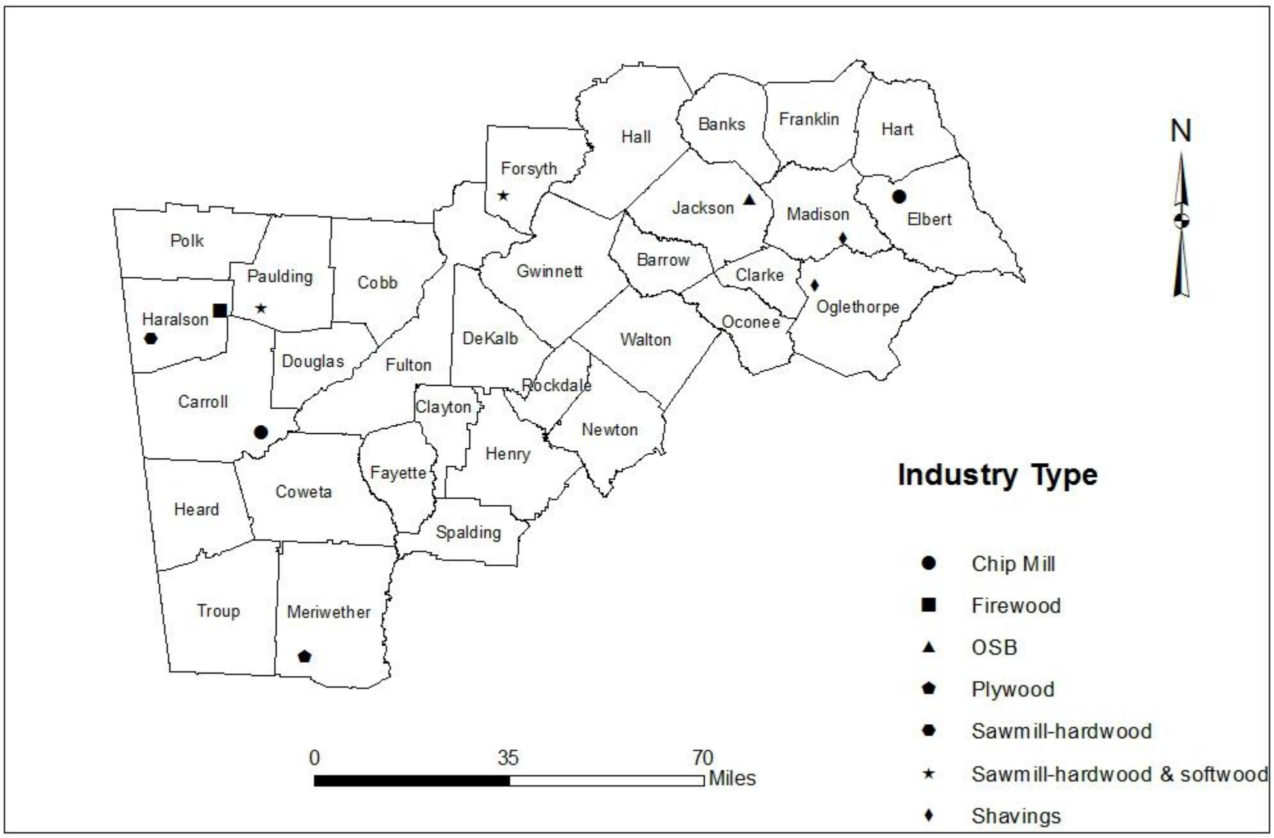

Figure 3.2 Location of primary wood-using facilities in North Central Georgia

The forest-based industries contribution in this region was highest in the state. As shown in Table 3.15, these industries contributed 12 thousand direct jobs, $851 million as direct labor income, $1.3 billion as direct value added and $3.8 billion as the direct output. However, these contributions accounted for very low percentage of the region's total. The total employment contribution from the forest-related industries was 0.9% of the region's total employment. Similarly, the total labor income contribution was 1%, total value added was 0.9% and total output was 1.2% of the region's total.

Table 3.15 Economic contribution of the forest product industries in North Central Georgia, 2012

Contribution Type	Employment	Labor Income ($MM)	Value Added ($MM)	Output ($MM)
Direct Contribution	12,502.4	851.6	1,353.1	3,860.6
Indirect Contribution	8,980.6	593.2	901.0	1,603.5
Induced Contribution	9,003.7	425.9	724.3	1,159.4
Total Contribution	30,486.7	1,870.7	2,978.4	6,623.5
Percentage of the region's total	0.9%	1%	0.9%	1.2%

3.4.3 Central Georgia

This region lies in the coastal plains of Georgia. In contrast to the northern regions, this region has high proportion of softwood forests as compared to hardwood and mixed forests.

Table 3.16 Estimates for net volume, average annual net growth and average annual harvest removals of live trees (at least 5 inches d.b.h.) on timberland in Central Georgia

Estimates	Softwood (MMCF)	Mixed (MMCF)	Hardwood (MMCF)	Non-stocked (MMCF)	Total (MMCF)
Net volume	6,444.5	1,205.6	5,032.3	4.5	12,686.9
Average annual net growth	487.4	31.8	102.8	0.3	622.3
Average annual harvest removals	339.8	29.1	67.8	0	436.6

[Source: FIA Evalidator]

As shown in table 3.16, this region had the highest net volume of live trees in timberland in the state. Softwood in the region accounts for 51% of the total net volume of live trees. Meanwhile, hardwood accounts for 40% and mixed for 10% of the total net volume. This region has high annual net growth and harvest removal of timber as compared to two northern regions. Also, very high proportion of the annual harvest removal is from softwood.

This region had 47 primary wood-using facilities in 2012. As shown in figure 3.3, these facilities were involved in production of chips, firewood, log, mulch, saw-timber, pulp, paper and others. They consisted of 12 large and 14 extra-large facilities. Among them, 49% used softwood, 28% used hardwood and 23% used both. Also, there were 165 secondary wood-using facilities in the region.

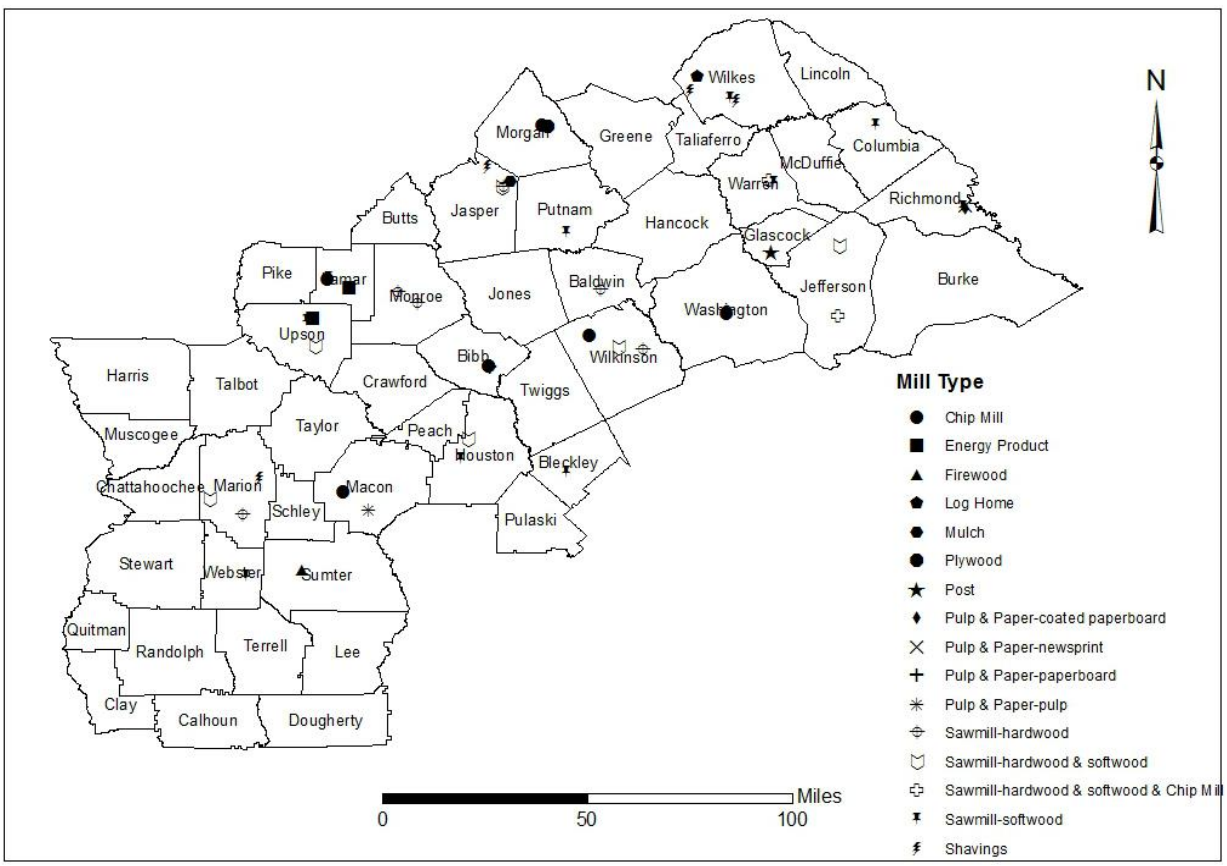

Figure 3.3 Location of primary wood-using facilities in Central Georgia

Forest-related industries provided considerable contribution to this region's economy. The total economic contribution values of the forest-based industries in the region ranked third in the state. Table 3.17 shows the economic contribution of the forest-based industries in the region. The forest-related industries provided 25 thousand total jobs in the region that accounted for 3.1% of the region's total employment. Similarly, these industries contributed $1.3 billion as the total labor income that accounted for 3.6% of the region's total, $2.8 billion as the total value added that accounted for 4.5% of the region's total and $6.2 billion as the total output that accounted for 6.0% of the region's total.

Table 3.17 Economic contribution of the forest product industries in Central Georgia, 2012

Contribution Type	Employment	Labor Income ($MM)	Value Added ($MM)	Output ($MM)
Direct Contribution	9,574.9	664.7	1,750.0	4,221.1
Indirect Contribution	8,935.6	414.4	634.4	1,349.0
Induced Contribution	6,264.9	211.8	399.8	663.9
Total Contribution	24,775.3	1,290.9	2,784.2	6,234.0
Percentage of the region's total	3.1%	3.6%	4.5%	6.0%

3.4.4 Southwest Georgia

This region is also located in the coastal plains of Georgia. Table 3.18 shows nearly 50% of the net volume of live trees in the region is accounted by softwood forests. This region has lower average annual net growth and annual harvest removals as compared to neighboring central and southeast regions. Softwoods accounts for 86% of the region's average annual harvest removals.

This region had only 29 primary wood-using facilities in 2012. Figure 3.4 shows the location of these facilities. Among the primary wood-using facilities in this region, 59% were large or extra-large in size. Also, 62% of those 29 industries used softwood, 10% hardwood and 28% used both. There were only 87 secondary wood-using facilities in this region. This was the lowest among all the regions.

Table 3.18 Estimates for net volume, average annual net growth and average annual harvest removals of live trees (at least 5 inches d.b.h.) on timberland in Southwest Georgia

Estimates	Softwood (MMCF)	Mixed (MMCF)	Hardwood (MMCF)	Non-stocked (MMCF)	Total (MMCF)
Net volume	2,240.1	509.0	1,744.7	4.8	4,498.5
Average annual net growth	152.4	30.4	27.7	0.1	210.7
Average annual harvest removals	123.3	4.1	15.1	0.9	142.6

[Source: FIA Evalidator]

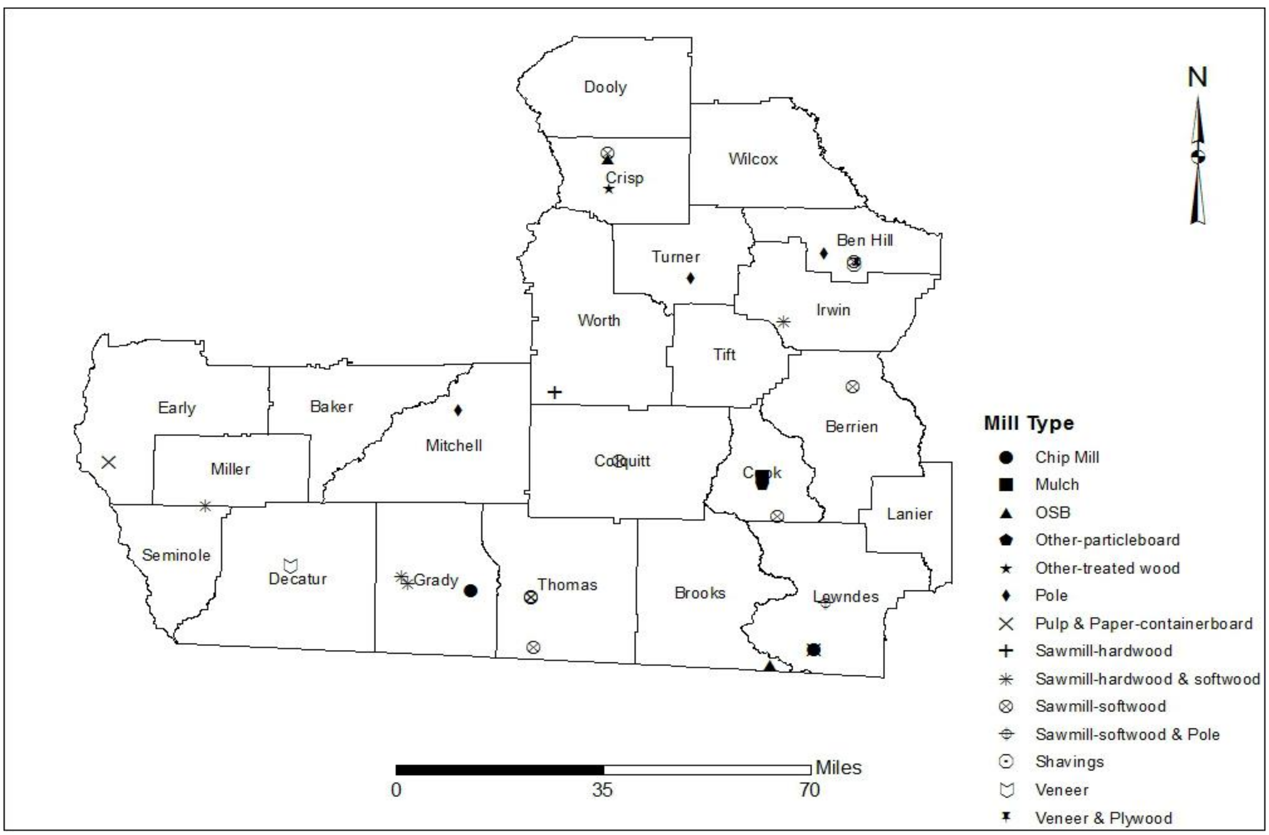

Figure 3.4 Location of primary wood-using facilities in Southwest Georgia

Forest-based industries were major contributor to this region's economy. Table 3.19 shows the economic contribution of the forest product industries in the region. Although, the total employment contribution from forest-related industries was second lowest among all the regions, it accounted for 5% of the region's total employment. The total labor income contribution accounted for 6%, total value added for 6.2% and total output 7.8% of the region's total.

Table 3.19 Economic contribution of the forest product industries in Southwest Georgia, 2012

Contribution Type	Employment	Labor Income ($MM)	Value Added ($MM)	Output ($MM)
Direct Contribution	4,906.9	292.8	558.4	1,656.5
Indirect Contribution	4,525.5	194.8	270.7	616.6
Induced Contribution	2,421.8	74.3	152.0	259.1
Total Contribution	11,854.2	561.9	981.1	2,532.1
Percentage of the region's total	5.0%	6.0%	6.2%	7.8%

4.4.5 Southeast Georgia

This region also lies in Coastal Plain of Georgia. As with other two coastal plain regions, this region also has high proportion of softwood forests. Table 3.20 shows the net volume of softwood accounts for 58% of the total net volume of live trees in the region. This region has the highest average annual net growth and annual harvest removals in the state.

This region had the highest number of primary wood-using facilities in the state. Figure 3.5 shows the location of these facilities. In 2012, there were 56 of such facilities among which 55% are large or extra-large in size. Also, 70% of those industries used softwood, only 2% used hardwood and 28% used both hardwood and softwood. There were 150 secondary wood-using facilities in this region.

Table 3.20 Estimates for net volume, average annual net growth and average annual harvest removals of live trees (at least 5 inches d.b.h.) on timberland in Southeast Georgia

Estimates	Softwood (MMCF)	Mixed (MMCF)	Hardwood (MMCF)	Non-stocked (MMCF)	Total (MMCF)
Net volume	6,662.1	870.9	4,010.0	3.4	11,546.5
Average annual net growth	567.0	22.1	110.5	0.09	699.6
Average annual harvest removals	423.6	17.4	71.3	0.1	512.0

[Source: FIA Evalidator]

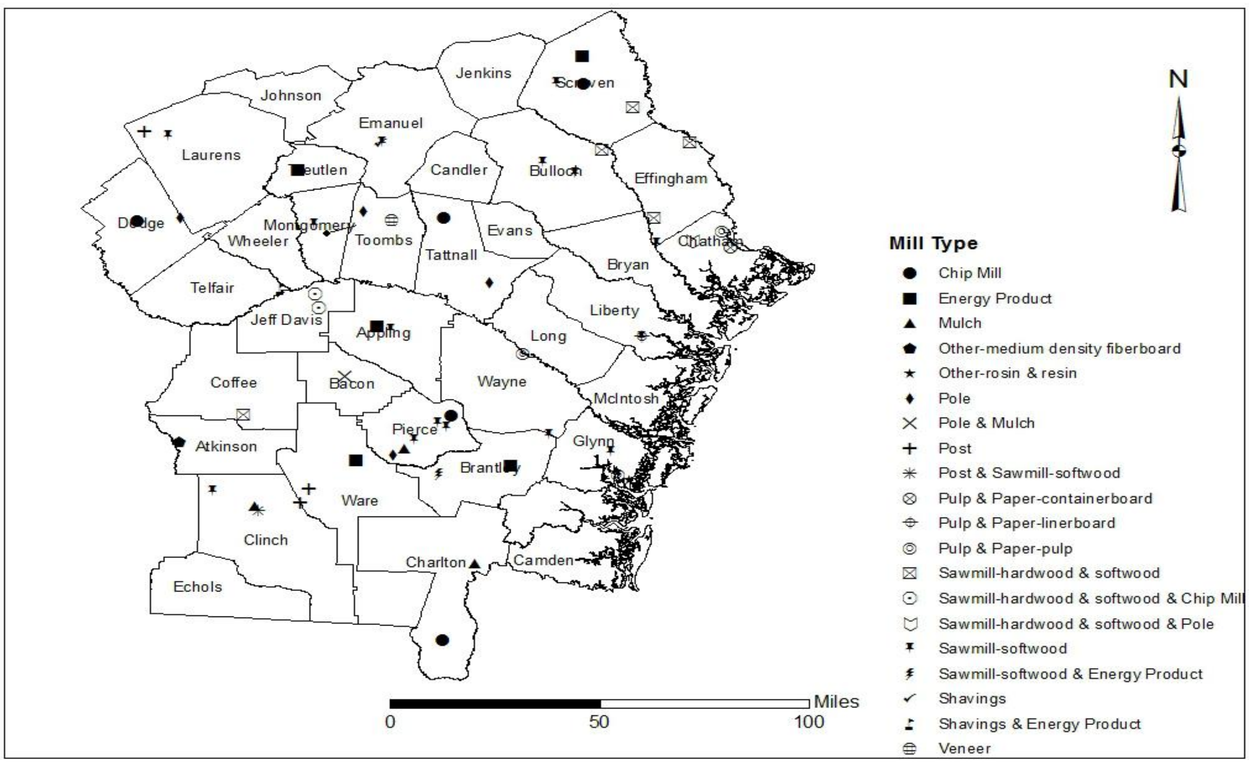

Figure 3.5 Location of primary wood-using facilities in Southeast Georgia

Forest-based industries in this region also played very important part in the region's economy. As shown in table 3.21, the forest-based industries contributed 5% of the total employment, 5.9% of the total labor income, 6.9% of the total value added and 9.1% of the total output of the region.

Table 3.21 Economic contribution of the forest product industries in Southeast Georgia, 2012

Contribution Type	Employment	Labor Income ($MM)	Value Added ($MM)	Output ($MM)
Direct Contribution	8,869.1	692.5	1,670.3	4,470.1
Indirect Contribution	10,857.5	494.4	740.7	1,598.6
Induced Contribution	6,428.9	209.1	402.1	669.4
Total Contribution	26,155.5	1,396.0	2,813.1	6,738.1
Percentage of the region's total	5.0%	5.9%	6.9%	9.1%

CHAPTER 4

DISCUSSION AND CONCLUSIONS

Forest-based industries provide a substantial contribution to the Georgia economy through the large number of jobs and large amount of money they bring in the economy. The results from our I-O analysis showed that the forest products sector is among the highest contributors in terms of employment, output and labor income among some of the comparable sectors. We found that the forest-based industries also provide considerable contribution to the state's economy through its indirect and induced contributions. Miscellaneous manufacturing, miscellaneous services and wholesale and retail trade were among the top sectors that are influenced by the indirect and induced impacts from the forest-based industries. Likewise, forest products industries directly support the state and federal governments through state/local government non-education tax and federal government non-defense tax contributions. Our analysis has shown that considerable amount of money is contributed through those taxes collected as employee compensation taxes, proprietor income taxes, production and import taxes, household taxes and corporation taxes. This sizeable amount of taxes can be an important factor for policy makers while making decisions about policies influencing the forestry sector in the state.

Dahal (2014) compared the economic contribution of forest product industries in the US South from 2001 with 2009 and found that the number of forest-based jobs, labor income and output decreased and the value added increased over that period in Georgia. A similar trend was seen for the forest-based economic contribution values in Georgia from 2009 to 2012. The decline of the forest-based employment could be contributed to the fact that more advanced technology are being introduced in the forestry sector which is making this sector less labor intensive. Further, the economic recession of late 2000s and the downfall of timber prices in the South contributed to the decrease in the labor income and total output from the forest product sector. However, the value added contribution increased because of the decreasing cost of intermediate inputs in terms of timber products in the forest-based sectors.

Results from our economic contribution analysis by sub-industry showed that pulp and paper sector was the highest contributing forest product sector in Georgia. This sector accounted for more than half of the employment, labor income, value added and output. Also, the proportion of the contribution from pulp and paper to the overall forest-based contribution had increased from 2009 to 2012 (Dahal, 2014). The economic contribution from pulp and paper is decreasing at a slower rate than the overall forest-based contribution. Although, there is decline in the use of writing paper, this industry is mostly profiting from the growing demand of different pulp-based and converted paper based products. Also, the increase in export to the international market is helping this sector in sustaining production.

Further, we found that our estimates for the economic contribution of the forest-based industries in Georgia were lower than the estimates reported by the EII report (EII, 2013). This differences could be contributed to the fact that we used different data sources and also omitted few sectors that were included in the EII report. The EII report used ES202 data as their primary source of data whereas we used IMPLAN database as our primary data source. Although ES202 data is one of the sources for creating IMPLAN database, it uses other data sources such as Regional Economic Accounts (REA) data and County Business Patterns (CBP) data as well. CBP data are used to make non-disclosure adjustments and sole proprietor information adjustments to the ES202 data and REA data are used as control totals. Thus, IMPLAN database used in our analysis will have fewer limitations compared to raw ES202 data.

Further, we did not use bioenergy and burial casket manufacturing sector in our analysis because IMPLAN database did not have distinct sector for them. Also, we omitted manufactured home (mobile home) manufacturing, institutional furniture manufacturing and stationery product manufacturing sectors because they use considerable amount of non-forest related inputs for their final production. For instance, manufactured home (mobile home) manufacturing uses wood as their major input but also use other metal-based, ceramic-based and other products for producing their final product. Thus, using these industries could overestimate the economic contribution values for the forest-based industries. Considering all these facts, we were able to produce estimates that are comparable with the results from the EII report and methodology we used in our analysis was simpler, easier and popular for estimating the economic contribution of various sectors.

The five regions used in our analysis varied considerably in terms of forest types, annual net growth and harvest, types of forest-based industries, the economic contribution that forest-based industries provide to the region and level of dependency of the region's economy in the forest-based industries. There were higher proportion of hardwoods in terms of net volume, annual net growth and annual harvest removal in timberlands across the North and North Central Georgia. Most of the timberlands in these regions were publicly owned naturally-regenerated hardwoods and were less intensively managed in terms of silvicultural treatments and rotation periods. These regions had lower annual net growth to harvest removal ratio. As we moved to southern regions the proportion of softwoods increased. The timberlands in Southwest and Southeast Georgia were mostly artificially-regenerated pine forests that are controlled by Non-

Industrial Private Forest (NIPF) owners. These timberlands were managed more intensively and had higher annual net growth to annual harvest removal ratio.

Similarly, there were higher number of primary wood-using facilities using only softwood in the southern regions as compared to the northern regions. The southern regions also had higher number of large and extra-large facilities. One third of the total number of primary wood-using facilities in the state were located in the Southeast region. Lying in the coast of the Atlantic Ocean, this region harbored highest number of large and extra-large forest product industries. In terms of the secondary-wood using facilities, nearly half of them were located in the North Central region. These facilities were mostly located around the highly developed Atlanta Metropolitan Area.

In terms of the total contribution values, North Central region had the highest contribution from the forest-based industries followed by Southeast region. On the other hand, North and Southwest region had very low number of forest-based industries in the area. The number and size of the forest-based industries in a region were the main factor influencing their economic contribution value. Along with this, factors like forest type, intensity of management and ownership also impacted on the number of jobs created. The southern regions had higher percentage of jobs contributed by miscellaneous forest product and commercial logging because of the intensively-managed, artificially-regenerated pine forests in the region. However, the northern regions had less intensively-managed, naturally-regenerated hardwood forests with lower percentage of jobs contribution from those sectors.

In terms of regional dependency to the forest-based contribution, Southeast and Southwest regions had the highest percentage contribution to the region’s economy. The higher dependency of the Southeast region’s economy to the forest-based industries is mainly due to the relatively larger number of forest-based facilities and higher economic contribution value. In the Southwest region, there are comparatively few forest-based facilities and the overall contribution of the forest-based industries is also low. In spite of this, the percentage contribution from the forest-based industries is high because the economy of the region is small and not well developed. There are only few sectors in the region that provide substantial contribution to the economy. Hence, even the small contribution from the forest based industries have considerable influence in the region's economy.

Similarly, North Central region's economy had the lowest dependency on the forest-based industries contributions. In this region, there are many large sectors that have substantial influence in the region's economy. Due to this, the overall economy of the region is very large and the percentage contribution of the forest-based industries is very low for the region. These results shows that even though the total contribution values from the forest-based industries is directly affected by the number and size of those facilities located in the region, the importance of such contribution to the regional economy depends on the presence and prominence of other sectors in the region. This information can be important for policy makers. When making the forest-based policy decisions, they need to look at the overall economic contribution from the forest-based industries seen through the contribution values as well as their level of influence in the region's economy.

4.1 Limitations of the research

This research is subjected to several limitations. I-O models follow few assumptions such as inputs not being substitutable, output depending only on the quantity of inputs purchased rather than other economic changes, household pattern not being influenced by income increase and supply of resources being infinite and perfectly elastic. In the I-O model used in our study, we were not able to examine if these assumptions were followed perfectly by the sectors involved.

Commercial logging sector in IMPLAN does not include establishments involved in trucking timber as they are represented in a separate sector with all the trucking-related establishments. Hence, our estimate for the commercial logging sector is understated compared to the actual contribution from the sector.

Further, the regional IMPLAN model considers all the money that move outside the region, either through import of inputs or commuters living outside the region, as leakage. Hence, the regions that have many forest-based industries located on the boarder counties will have high amount of leakage that will underestimate the overall economic contribution of the forest sector for that region.

4.2 Suggestions for future research

In our study, we used IMPLAN's national averaged multipliers. Although, these multipliers can be used to represent the economy of different regions of the country, future research could use more accurate regional multipliers collected from another regional source.

Further, there is a need of standardization of the number of forest-based sectors in IMPLAN as different economic contribution studies have used different number of forest-based sectors. Future research can focus on establishing more consistent criteria for determining the number of forest-based sectors to be used in the economic contribution analysis.

Similarly, forest-based bioenergy sector in Georgia has grown considerably in number and size over the last few years. Thus, future research can focus on developing the methodology that incorporates bioenergy sector when estimating the economic contribution of the forest sector.

The results from this study only show the market-based benefits from the forest-based industries. Other benefits from forestry sectors such as wildlife and recreation benefits are not included. Hence, future research could focus on developing methods to capturing these benefits in the examination of economic contribution from the forestry sector. This could be very useful in making natural resource policy decisions as including those sectors will increase the contribution value of the forest-based industries.

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APPENDIX A

AGGREGATED FOREST-BASED AND COMMERCIAL SECTORS WITH ASSOCIATED IMPLAN SECTORS

Aggregated Sectors/IMPLAN Sectors	IMPLAN Sector ID
1. Miscellaneous Forest Products	
i. Forestry, forest products, and timber tract production	15
2. Logging	
i. Commercial logging	16
3. Solid Wood Products	
i. Sawmills and wood preservation	95
ii. Veneer and plywood manufacturing	96
iii. Engineered wood member and truss manufacturing	97
iv. Reconstituted wood product manufacturing	98
v. Wood container and pallet manufacturing	100
vi. Prefabricated wood building manufacturing	102
vii. All other miscellaneous wood product manufacturing	103
viii. Custom architectural woodwork and millwork manufacturing	301
4. Wood Furniture	
i. Wood windows and doors and millwork manufacturing	99
ii. Wood kitchen cabinet and countertop manufacturing	295
iii. Upholstered household furniture manufacturing	296
iv. Non-upholstered wood household furniture manufacturing	297
v. Office furniture	300
5. Pulp and Paper	
i. Pulp mills	104
ii. Paper mills	105
iii. Paperboard Mills	106
iv. Paperboard container manufacturing	107
v. Coated and laminated paper, packaging paper and plastics film manufacturing	108
vi. All other paper bag and coated and treated paper manufacturing	109
vii. Sanitary paper product manufacturing	111
viii. All other converted paper product manufacturing	112

6. Resource Services ii. Commercial fishing iii. Commercial hunting and trapping iv. Support activities for agriculture and forestry	 16 18 19
7. Mining i. Extraction of oil and natural gas ii. Mining coal iii. Mining iron ore iv. Mining copper, nickel, lead, and zinc v. Mining gold, silver, and other metal ore vi. Mining and quarrying stone vii. Mining and quarrying sand, gravel, clay, and ceramic and refractory minerals viii. Mining and quarrying other nonmetallic minerals ix. Drilling oil and gas wells x. Support activities for oil and gas operations xi. Support activities for other mining	 20 21 22 23 24 25 26 27 28 29 30
8. Construction i. Construction of new nonresidential commercial and health care structures ii. Construction of new nonresidential manufacturing structures iii. Construction of other new nonresidential structures iv. Construction of new residential permanent site single and multi-family structures v. Construction of other new residential structures vi. Maintenance and repair construction of nonresidential structures vii. Maintenance and repair construction of residential structures	 34 35 36 37 38 39 40
9. Agricultural Products i. Oilseed farming ii. Grain farming iii. Vegetable and melon farming iv. Fruit farming v. Tree nut farming vi. Greenhouse, nursery, and floriculture production vii. Tobacco farming viii. Cotton farming ix. Sugarcane and sugar beet farming x. All other crop farming xi. Cattle ranching and farming	 1 2 3 4 5 6 7 8 9 10 11

xii. Dairy cattle and milk production xiii. Poultry and egg production xiv. Animal production, except cattle and poultry and eggs(14)	12 13 14
10. Agriculture Processing i. Dog and cat food manufacturing ii. Flour milling and malt manufacturing iii. Wet corn milling iv. Soybean and other oilseed processing v. Fats and oils refining and blending vi. Breakfast cereal manufacturing vii. Fluid milk and butter manufacturing viii. Cheese manufacturing ix. Dry, condensed, and evaporated dairy product manufacturing x. Ice cream and frozen dessert manufacturing xi. Animal (except poultry) slaughtering, rendering, and processing xii. Poultry processing	 41 43 44 45 46 47 55 56 57 58 59 60
11. Food Processing i. Sugar cane mills and refining ii. Beet sugar manufacturing iii. Chocolate and confectionery manufacturing from cacao beans Confectionery manufacturing from purchased chocolate iv. Non-chocolate confectionery manufacturing v. Frozen food manufacturing vi. Fruit and vegetable canning, pickling, and drying vii. Seafood product preparation and packaging viii. Bread and bakery product manufacturing ix. Cookie, cracker, and pasta manufacturing x. Tortilla manufacturing xi. Snack food manufacturing xii. Coffee and tea manufacturing xiii. Flavoring syrup and concentrate manufacturing xiv. Seasoning and dressing manufacturing xv. All other food manufacturing xvi. Soft drink and ice manufacturing xvii. Breweries xviii. Wineries xix. Distilleries	 48 49 50 51 52 53 54 61 62 63 64 65 66 67 68 69 70 71 72 73

xx. Tobacco product manufacturing	74
12. Farm Inputs and Machinery	
i. Other animal food manufacturing	42
ii. Fertilizer manufacturing	130
iii. Pesticide and other agricultural chemical manufacturing	131
iv. Farm machinery and equipment manufacturing	203
v. Lawn and garden equipment manufacturing	204
13. Fabric Mills and Leather	
i. Fiber, yarn, and thread mills	75
ii. Broad woven fabric mills	76
iii. Narrow fabric mills and schiffli machine embroidery	77
iv. Textile and fabric finishing mills	80
v. Leather and hide tanning and finishing	92
vi. Other leather and allied product manufacturing	94
14. Petroleum and Chemicals	
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[Source: Dahal et al. (2013)]

APPENDIX B

FIVE FIA SURVEY REGIONS AND ASSOCIATED COUNTIES

Region	Counties
North	Bartow, Catoosa, Chattooga, Cherokee, Dade, Dawson, Fannin, Floyd, Gilmer, Gordon, Habersham, Lumpkin, Murray, Pickens, Rabun, Stephens, Towns, Union, Walker, White, Whitfield
North Central	Banks, Barrow, Carroll, Clarke, Clayton, Cobb, Coweta, DeKalb, Douglas, Elbert, Fayette, Forsyth, Franklin, Fulton, Gwinnett, Hall, Haralson, Hart, Heard, Henry, Jackson, Madison, Meriwether, Newton, Oconee, Oglethorpe, Paulding, Polk, Rockdale, Spalding, Troupe, Walton
Central	Baldwin, Bibb, Bleckley, Burke, Butts, Calhoun, Chattahoochee, Clay, Columbia, Crawford, Dougherty, Glascock, Greene, Hancock, Harris, Huston, Jasper, Jefferson, Jones, Lamar, Lee, Lincoln, Macon, Marion, McDuffie, Monroe, Morgan, Muscogee, Peach, Pike, Pulaski, Putnam, Quitman, Randolph, Richmond, Schley, Stewart, Sumter, Talbot, Taliaferro, Taylor, Terrell, Twigs, Upson, Warren, Washington, Webster, Wilkes, Wilkinson
Southwest	Baker, Ben Hill, Berrien, Brooks, Colquitt, Cook, Crisp, Decatur, Dooly, Early, Grady, Irwin, Lanier, Lowndes, Miller, Mitchell, Seminole, Thomas, Tift, Turner, Wilcox, Worth
Southeast	Appling, Atkinson, Bacon, Brantley, Bryan, Bulloch, Camden, Candler, Charlton, Chatham, Clinch, Coffee, Dodge, Echols, Effingham, Emanuel, Evans, Glynn, Jeff Davis, Jenkins, Johnson, Laurens, Liberty, Long, McIntosh, Montgomery, Pierce, Screven, Tattnall, Telfair, Toombs, Treutlen, Ware, Wayne, Wheeler

APPENDIX C

SIZE SPECIFICATIONS FOR PRIMARY-WOOD USING FACILITIES

Mill Size	MMBF (Lumber)	Tons (Roundwood Received)
Extra-Small (E-S)	< 0.5	< 3,500
Small (S)	0.5 - 1.0	3,501 - 7,000
Medium (M)	1.1 - 5.0	7,001 - 35,000
Medium-Large (M-L)	5.1 - 10.0	35,001 - 70,000
Large (L)	10.1 - 50.0	70,001 - 350,000
Extra-Large (E-L)	> 50.0	> 350,000
conversion factor = 7 tons / MBF		

[Source: GFC (2013)]