The Economic Contributions of Ohio's Forest Products Industry: Changes Over Time, and the Value of Timber as a Resource

THESIS

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Abstract

Market forces have driven the downsizing and restructuring of the U.S. forest economy, which prompted our assessment of the current conditions of forestry and forest products manufacturing in Ohio. Economic modeling was used to determine the current state of Ohio's forest products industry. We constructed a series of input-output models with 2011 year data using the IMpact Analysis for PLANning system to determine the economic impacts of Ohio's forest-based industries. We then compared the 2011 findings to those from 2001, the year for which the industry impacts had last been assessed. Direct impacts of all forestry and forest products sectors in 2011 summed to 47,200 employees, $4.00 billion in value added, and $13.7 billion in outputs. Nearly all of the 2011 industry values in real terms were lower than those from 2001, which were inflation-adjusted to 2011 constant dollars. Input-output models were also constructed to describe the economic impacts of timber product outputs in Ohio and its three timber market regions - the Northeast, West, and Southeast- for 2012. Impact Analysis for PLANning was used to describe these impacts in terms of employment, output, and value added based on 1) the total value of outputs delivered to market by each region's logging sector and 2) a per-unit change in the regionalized delivered value of one million board feet (MMBF) of hardwood sawtimber. Direct impacts of timber products were greatest in the Northeast (for output and value added) and Southeast (for employment). The total economic impacts of timber products in Ohio were 2,880 employees, $287 million in output, and

$147 million in value added. The per-unit impact results were more varied due to regional differences in economies and timber price determinants. Employment and output economic impacts per MMBF were both highest in the Southeast.

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Table of contents

List of tables

List of Figures

Chapter 1: Introduction

Forest products play an essential role in our society. Timber and other fibers from the forest are used to manufacture homes, furniture, paper, and more than 5,000 other products. In addition, forest fibers can be converted to produce electricity or liquid fuels. This study's main focus will be the economic contributions provided by forest products sectors in Ohio that directly produce and manufacture of timber, wood and fiber-based products.

Lumber is an exemplar forest product that can serve as a proxy as to the performance of the overall forest products industry. However, hardwood lumber markets, which predominate in Ohio, have seen great change due to the recent recession. The mid 2000's showed the beginning of a stark decline in housing starts, lumber consumption by construction and remodeling industries, and lumber consumption by wood household furniture industries nationally (Luppold et al. 2014). Softwood lumber markets in the South and West regions of the United States have seen similar trends. The South lost jobs in all of its forest products manufacturing sectors between 2006 and 2011 (Hodges et al 2011). In the West, the value of primary (wood and paper) forest products sales dropped from $49 billion in 2005, to $34 billion in 2009. Thirty large mills in the West were also closed in this same time period (Keegan et al 2012). With a decline in domestic demand for forest-based materials, exportation can sometimes be seen as a more feasible economic opportunity. For example, the south showed higher export revenues in 2011 than in 2006 in all four of the categories presented by Hodges and others (2011). Countries around the world appreciate our products because they are highly valued, and sustainably managed, processed, and manufactured. Timber is an environmentally, economically, and socially beneficial crop. Benefits from timber as a resource include carbon sequestration, wildlife habitat, soil stabilization, economic gains, resource input, and recreation opportunities. A number of sustainability measurement tools are becoming available for researchers to gauge the environmental, economic, and social impacts of industries, raw materials, and final products. Economic impact analysis through the use of an input-output model is one such means and is becoming increasingly common in many different industries across America. One specific industry where this is occurring is the forest products industry. Forest-based industries are often more rural in nature, and the role(s) these businesses play in economies can frequently be overlooked or underappreciated.

Researchers assessed the economic impacts of the forest products industry in many states. Recent analyses were published for Kentucky (Stringer et al. 2014), Mississippi (Dahal et al. 2013a), Tennessee (Young et al. 2007), and Texas (Li et al. 2011). Often, these reports assess the impacts of forest products industry contributions in their state's economies. Impact Analysis for PLANing (IMPLAN), which was created in 1976 to assist the U.S. Forest Service in their land management programs reporting, is the commonly employed system used to assess these impacts.

The housing market, which is the primary driver for wood demand, began a precipitous decline in the mid-2000s, and this has affected wood products values and prices across America. Furthermore, the effects of the recent 2007 to 2009 recession on the forest products industry were like none other since World War II. For example, this recession was the first since the mid-1940s where hardwood lumber prices of all species declined (Luppold et al. 2014). This raised concern over the forest products industry's current status, which spurred many of the state-level assessments of forestry and forest products manufacturing.

These studies are now providing states a useful benchmark to gauge industry impacts moving forward. Few, though, can evaluate how global market forces have transformed the American forest products industry in the relatively few years of this current century. Two recent reports in Mississippi (Dahal et al 2013) and the U.S. South (Dahal et al 2013) have observed the forest products industry over time, but they investigated markets that are based on softwood trees for their forest products. No studies to date can provide a similar assessment of a predominately hardwood-based forest economy, like Ohio's.

A comprehensive assessment of Ohio's forest products industry in 2001 was compiled by Hushak (2005). Then, Ohio's forest products industry provided direct impacts of 71,000 employees, $3.99 billion in value added, and of $11.7 billion of outputs (in 2001 dollars). The total economic impacts of forest products outputs when accounting for the industry’s multiplier effects were 131,000 employees, $7.29 in billion in value added, and $18 billion in outputs. Given all of the broader changes to the U.S. forest economy, the current impacts of Ohio’s forest products industry needs to be assessed.

Eight million forested acres are found throughout Ohio, and 87% of these forests are privately owned (Widmann et al. 2009). These lands contribute to a forest products industry that is unique in several aspects. Ohio contains three distinct timber purchasing regions, the Northeast, West, and Southeast. The Northeast and Southeast are the more forested regions, located south and east of the glacial line in the Appalachian foothills. The Northeast contains the greatest number of sawmills (Wiedenbeck and Sabula 2008) and is also known for its Amish wood producing communities (Bumgardner et al. 2007). This region is largely rural but includes the greater Cleveland metropolitan area. The Southeast is the most rural timber region and contains no major cities. Much of the land use in the West timber market centers on farming. As such, it has the fewest primary wood processing facilities (Wiedenbeck and Sabula 2008). However, this region also contains several urban areas.

Objectives

One third of Ohio's total land area is forested, and timber products annually rank among the ten most valued commodities in the state. The effects of growing, harvesting, and processing this raw material into wood and fiber products ripple throughout the economy. However, given the 2007 to 2009 recessions impacts on the U.S. forest economy, the current structure and performance of these industries is not fully understood. Therefore, the specific objectives of this research were to:

1. Conduct a comprehensive economic impact analysis of Ohio's Forest Products Industry in 2011.

2. Compare the 2011 impacts to those from an earlier 2001 economic impact report (Hushak 2005).

3. Determine the 2012 economic impacts of total timber product outputs in Ohio

and its three timber market regions.

4. Determine the economic impacts of timber product outputs on a per unit of output basis, which provided a measure of impacts given the structure of the respective regional forest-based economies. The price per one million board feet of delivered hardwood sawtimber ($/MMBF, Doyle) in each area represented one unit.

Chapter 2

The 2011 Economic Impacts of Ohio's Forest Products Industry with Comparisons to 2001 Values

Introduction

The management and conversion of standing timber into primary and secondary wood and fiber products provides sizable support to the U.S. economy (McKeever and Howard 1996). Measuring forestry and forest products' economic role is often found using an input-output model. The input-output model quantifies inter-industry linkages to the output and employee spending of forest-based production and its supply chain. This provides a gauge for not only the size of the forest products industry but also how integrated it is in the economy.

Recent input-output state assessments include those published in Kentucky (Stringer et al. 2014), Mississippi (Dahal et al. 2013a), Tennessee (Young et al. 2007), and Texas (Li et al. 2011). A baseline regional study of forest products economic impacts in the U.S. South was conducted by Aruna et al. (1997). An update to that analysis was provided by Tilley and Munn (2007a), with comparisons made to Aruna et al.'s (1997) earlier report (Tilley and Munn 2007b). Dahal et al. (2013b) provided the most recent southern U.S. update and compared the region's forest contributions for the years 2001 and 2009. Cox and Munn (2001) defined and compared the forest economies of the U.S. South and Pacific Northwest. An input-output model of the Lake States' forest industries was constructed by Pederson and Chappelle (1990). A common finding from these studies was the significance of the forest products industry's multiplier effects, which rippled throughout those economies via indirect and induced activities.

An analysis of Ohio's forest products industry was conducted by Hushak (2005) using 2001 economic data. Direct impacts included 71,000 employees, $3.99 billion in value added, and outputs of $11.7 billion (in 2001 dollars). Paper Manufacturing employed the most people, 42% of all employees, followed by Wood Products Manufacturing, Wood Furniture Manufacturing, and Forestry and Logging respectively. Output ranged from $294 million in Forestry and Logging to $7.5 billion in Paper Manufacturing. The total economic contributions of forest products when accounting for the industry's multiplier effects were 131,000 employees, $7.29 in billion in value added, and $18 billion in outputs.

However, much has happened in the forest products industry in the relatively short period of time since 2001. Hardwood timber prices in Ohio, for example, continued to climb until reaching all-time highs in 2004 (Luppold et al. 2014). A rapid decline in Appalachian hardwood lumber prices due to falling demand in the home construction and remodeling sectors quickly eroded what had been a 15 year general rise in local timber prices (Duval et al. 2014). Housing starts were over 2.0 million in 2005 but had dropped to 554,000 in 2009 (Keegan et al. 2011).

Inflation-adjusted stumpage prices in Ohio were 33% lower in 2011 compared to 2001 while sawlog prices had declined -39% (McConnell 2014). Appalachian No. 1 Common hardwood lumber prices had dropped more, -42%, over the same time period (Hardwood Review 2001; 2014). Likewise, falling demand caused steep price declines in softwood markets, which led to production curtailments in forest economies dependent upon the processing of southern pine (*Pinus* spp.) and Douglas-fir (*Pseudotsuga menziessi*). The Mississippi forest products economic impact report, for example, found employment, value added, and output each fell between 27 and 30% from 2006 and 2010 (Dahal et al. 2013c). Primary milling capacity in Oregon was reduced by 12% from 2006 to 2010, while capacity utilization had fallen below 57% (Gale et al. 2012).

The reshaping of the timber processing and wood and fiber manufacturing sectors following the Great Recession (Woodall et al. 2011a) necessitates updating forest products economic impact analyses. These data can provide interested parties- industry participants (landowners, loggers, mills), advocates (associations and organizations), as well as lawmakers- needed information when involved in policy and decision-making discussions, particularly in regions or communities where the industry's role(s) may not be fully understood.

The purpose of this study was to determine the economic impacts of the forest product industry outputs in Ohio for the year 2011. IMpact Analysis for PLANing (IMPLAN), an economic impact software system, was used to develop a series of input-output models. Models were constructed for the state's timber processing and wood and fiber manufacturing sectors, with their economic multipliers subsequently determined. The total economic impacts of forest products were computed based on these results. Results for 2011 were compared to Hushak's (2005) report of 2001 Ohio forest products industry values.

Methodology

IMPLAN and the Input-Output Model

Impact Analysis for PLANing (IMPLAN) was created to assist in the U.S. Forest Service's reporting requirements for Forest Service land management programs. In 1976, Minnesota IMPLAN Group Inc. designed an economic impact modeling system under the direction of the U.S. Forest Service. Today, IMPLAN is used to quantify the economic impacts of various industries, such as agriculture, tourism, new construction projects, and others. The IMPLAN system is now administered by IMPLAN Group LLC of Charlotte, North Carolina.

The IMPLAN software analyzes economic impacts generated within a predefined region in terms of dollars added in to the economy and jobs produced (IMPLAN Group LLC 2004). Data are obtained from various government sources. One source is household data that is compiled by estimating personal consumption expenditures. These values are estimated by collecting data from the Bureau of Economic Analysis and National Institute of Pension Administrators. Other data sources include the annual survey of manufacturers, census data, import and export data, and capital expenditures. Earlier versions of IMPLAN's input-output model were based on an economy of more than 500 industrial sectors. This has since been reduced to a 440 sector model through sectorial aggregations. Twenty-six of these sectors represent Ohio's forest products industry (Table 1).

Table 1. Individual sectors, aggregated by industry groups, assessed in this study. Each industry group is defined by its associated North American Industry Classification System (NAICS) code.

Industry (NAICS code)	IMPLAN Sectors
Forestry and Logging (113)	Forestry, forest products, and timber tract production; Commercial logging
Wood Products Manufacturing (321)	Sawmills and wood preservation; Veneer and plywood manufacturing; Engineered wood member and truss manufacturing; Reconstituted wood product manufacturing; Wood windows, doors, and millwork manufacturing; Wood container and pallet manufacturing; Manufactured home (mobile home) manufacturing; Prefabricated wood building manufacturing; All other miscellaneous wood product manufacturing
Paper Manufacturing (322)	Pulp mills; Paper mills; Paperboard mills; Coated and laminated packaging paper and plastics film manufacturing; All other paper bag and coated and treated paper manufacturing; Stationery product manufacturing; Sanitary paper product manufacturing; All other converted paper product manufacturing
Wood Furniture Manufacturing (337)	Wood kitchen cabinet and countertop manufacturing; Upholstered household furniture manufacturing; Non-upholstered wood household furniture manufacturing; Institutional furniture manufacturing; Wood television, radio, and sewing machine cabinet manufacturing; Office furniture, custom architectural woodwork, and millwork manufacturing

The IMPLAN system's input-output model defines sectors in an economy and uses its database to model inter-industry linkages, such as sales and purchases between sectors. The model considers resources such as employee labor and property as inputs, while exports and product sales make up final demand. Outputs are determined from the transaction table describing makes and uses. The transaction table separates processing sectors and purchasing sectors. Each sector in the economy is considered to be both a processing and a purchasing sector. Processing sectors are allocated to rows while purchasing sectors are assigned to columns. The table shows how many dollars of a good a sector has purchased from a processing sector along with how many dollars of a good a processing sector has sold to an individual purchasing sector. This illustrates the economic relationships between sectors based upon the value of the commodities bought and sold. Summing each row quantifies an industry's output. Value added and imports are also taken into account within the table and represent part of the "total outlay."

The fixed coefficient production function is then calculated using data from the sectorial interactions contained within the transaction table. The fixed coefficient production function is a representation of the degree to which an industry relies on other industries to produce one unit of output to satisfy final demand. This relationship between output and final demand was first described by Leontief (1936) and is illustrated in Equation 1

$$x = (I - A)^{-1} y \quad [1]$$

where x is the output vector, I is an identity matrix, A is the matrix of fixed coefficient production functions (which is a 440 by 440 matrix relating input to output), and y represents the vector of final demand. This function assumes input and output relationships are constant and occur in fixed proportions, i.e. one dollar of additional output requires one dollar of additional input, with no substitutions.

The term $(I-A)^{-1}$ is the total requirements matrix. Each element of the matrix describes the amount needed from sector i (row) as input to produce one unit of output in sector j (column) to satisfy final demand. Summing the column elements, or the total requirement from each individual sector i, for sector j provides sector j's output multiplier. Employment, labor income, and value added multipliers are also derived from summing a sector's column elements, with each element being an averaged value per unit of output for sector j's total requirement for each sector i's input (Horowitz and Planting 2009).

The IMPLAN input-output model defines employment as the number of both full and part time jobs an industry creates to meet final demand. Value added is composed of labor income, which includes employee compensation and proprietary (self-employed) income, other property type income, and indirect business taxes. Value added is comparable to Gross Domestic (or Gross State) Product, as it represents the value of resources minus the costs of input and labor. Output represents the total value of an industry's production, which is measured as the sum of value-added plus the cost of buying goods and services to produce the product.

Utilizing the economic multipliers in conjunction with an industry's direct contributions, which are the effects generated by a sector's industries to meet final demand for its products, allows for calculating an industry's "spillover" effects, the indirect and induced impacts. Indirect effects result from inter-industry purchasing to meet final demand as described in matrix A. Dividing the direct effect into the sum of the direct and indirect effects produces the Type I multiplier (U.S. Department of Commerce Bureau of Economic Analysis 2013).

Induced effects result from changes in employee spending within the inter-linked industries. Induced effects in an input-output analysis are those assumed to be endogenous to a study region, where the changes in value added inputs (which includes labor income) and consumption are fed back into the economy of interest. Type II multipliers incorporate these effects and are defined as the sum of the direct, indirect, and induced effects divided by the direct effect. Type II multipliers differ by how they define value added and account for any of its potential endogenous components. A particular Type II multiplier, the Type Social Accounting Matrix (SAM) multiplier, considers portions of value added to be both endogenous and exogenous to a study region. Type SAM multipliers are generally the preferred Type II multipliers used in input-output analyses (Tilley and Munn 2007a) and were used in this study to estimate changes in total economic impacts.

Analyses

Economic data for Ohio from 2001 were available from Hushak (2005), while 2011 data (the most recent available at the onset of this study) were obtained from IMPLAN LLC. The 2011 economic database was modified to assure that year's input-output model matched 2001's in terms of industry classifications and economic contributions. For example, the name and representation for certain sectors in IMPLAN have changed since Hushak's (2005) report, as newer versions of the software have been released. Thus, two sectors from 2011, paper mills and paperboard mills, were combined into pulp and paperboard mills, which provided a match to the 2001 data. This left us with 25 individual forest products industrial sectors. The economic database defined each sector's direct impacts. Multiplier reports generated by IMPLAN provided Type SAM economic multiplier data for employment, value added, and output for each sector. Additional models were constructed for five industry groups- Forestry and Logging, Wood Products Manufacturing, Paper Manufacturing, Wood Furniture Manufacturing, and the industry as a whole (here after termed Forest Products Industry).

In order to estimate the total effects of forest products industry outputs in Ohio, we adjusted our Type SAM multipliers to discount forest products sectors' purchases from themselves to meet final demand. Doing so reflected the measured impact of a per unit change in output versus a per unit change to final demand, which paralleled Hushak's (2005) methodology. Calculating this adjustment required dividing each forest-based industry's Type SAM multiplier, the sum of industry j's column elements in the total requirements matrix, by its associated diagonal element a_{jj}, illustrated in Equation 2

$$\text{Adjusted Type SAM Multiplier}_j = \text{Type SAM Multiplier}_j / a_j. \quad [2]$$

The term a_{jj} represents the total input requirements sector j has from itself to produce a unit of its own output to meet final demand. The diagonal element's value is at least 1.00 due to sector j's requirement of itself to produce one unit of output at minimum. Term a_{jj}'s value exceeds 1.00 when sector j's output is required to produce its product. Accounting for this effect resulted in an Adjusted Type SAM Multiplier$_j$ that was less than or equal to the original Type SAM Multiplier$_j$. The magnitude of any reduction was dependent upon sectorial need for its own production in the manufacturing of output.

All 2001 dollar values were adjusted for inflation to 2011 constant dollars using the Producer Price Index for all commodities (U.S. Department of Labor Bureau of Labor Statistics 2014). Forest products 2001 and 2011 sectorial economic data were compared using Wilcoxon signed-rank tests in SAS 9.2 (SAS 2008). The Wilcoxon signed-rank test is a non-parametric statistical test that compares the rankings of all values between two data sets. The p-values associated with the test statistics were evaluated at a significance level of alpha = 0.05. We first compared the direct impacts- employment, value added, and output- of our four industry groups and the Forest Products Industry. We then ran a second set of Wilcoxon tests to test for differences between the two years' Adjusted Type SAM multipliers. Lastly, we compared the total economic impacts for 2001 and 2011, which were the products of the direct contributions multiplied by their associated Adjusted Type SAM multipliers.

Results

Ohio's Forest Products Industry in 2011 has shown both absolute and relative reductions in its direct contributions to the state's economy as compared to 2001. Forest Products Industry employment and value added each contributed less than one percent to its respective state total in 2011 (Table 2). In 2001, the relative contributions of these values were at least 1.04%. Only Forest Products Industry output continued to contribute greater than one percent to state output at 1.40% respectively. However, direct output decreased from $17.49 billion to $13.66 billion in real terms between the two years. Employment in the Forest Products Industry from 2001 to 2011 dropped by -33.5% (Table 3). Also, dollars contributed through value added and output each declined over 20% compared to 2001.

Table 2. Contribution of Ohio's forest products industry employment, value added, and output in 2001 and 2011. For the four aggregated sectors, percentage contribution is based on the forest products industry total. For the forest products industry, percentage contribution is based on Ohio's total economy.

Industry	**Employment**	**Value Added**	**Output**
		Dollar figures are millions of 2011 dollars	
Forestry and Logging in 2001	2,178	$222	$441
Contribution % of Forest Products Industry	3.07%	3.71%	2.52%
Forestry and Logging in 2011	2,273	$34.1	$182
Contribution % of Forest Products Industry	4.82%	0.85%	1.33%
Wood Products Manufacturing in 2001	20,392	$1,147	$3,241
Contribution % of Forest Products Industry	28.7%	19.2%	18.5%
Wood Products Manufacturing in 2011	13,689	$620	$2,245
Contribution % of Forest Products Industry	29.0%	15.5%	16.4%
Paper Manufacturing in 2001	29,808	$3,434	$11,280
Contribution % of Forest Products Industry	42.0%	57.4%	64.5%
Paper Manufacturing in 2011	20,009	$2,317	$9,143
Contribution % of Forest Products Industry	42.4%	57.9%	66.9%
Wood Furniture Manufacturing in 2001	18,613	$1,179	$2,530
Contribution % of Forest Products Industry	26.2%	19.7%	14.5%
Wood Furniture Manufacturing in 2011	11,232	$1,033	$2,086
Contribution % of Forest Products Industry	23.8%	25.8%	15.3%
Forest Products Industry in 2001	70,991	$5,981	$17,493
Contribution % of Ohio's total economy	1.04%	1.10%	1.69%
Forest Products Industry in 2011	47,205	$4,005	$13,656
Contribution % of Ohio's total economy	0.73%	0.80%	1.40%

Table 3. Percentage change of direct impacts in the four aggregated sectors and forest products industry, 2001 and 2011. Changes in value added and output were calculated using 2011 constant dollars.

Industry	Employment	Value Added	Output
Forestry and Logging	4.36%	-84.6%	-58.7%
Wood Products Manufacturing	-32.9%	-45.9%	-30.7%
Paper Manufacturing	-32.9%	-32.5%	-18.9%
Wood Furniture Manufacturing	-39.7%	-12.3%	-17.5%
Forest Products Industry	-33.5%	-33.0%	-21.9%

Changes were also observed for the industry groups' direct contributions in 2001 compared to 2011 (Table 2). Nearly all 2011 absolute values were lower than 2001 values. However, the relative contributions provided by these industry groups to the Forest Products Industry varied between the two years. For example, Wood Furniture Manufacturing declined over $100 million dollars in value added but provided a larger percentage of value added to the Forest Products Industry than in 2001. Paper Manufacturing showed slight increases in all relative contributions to the Forest Products Industry despite absolute declines. The percent contributions of Forestry and Logging and Wood Products Manufacturing to Forest Products Industry employment increased, while value added and output percent contributions decreased.

Employment in Forestry and Logging was the only value to increase between 2001 and 2011 (Table 2). Forestry and Logging showed a 4.36% increase in the amount of full and part time jobs produced in 2011 as compared to 2001 (Table 3). Job declines were more than 30% in Wood Products Manufacturing, Paper Manufacturing, and Wood Furniture Manufacturing between the two years. The largest relative decrease between the two years was observed in total value added of Forestry and Logging, which experienced a decrease of 84.6% (Table 3). Output was also down the greatest percentage in Forestry and Logging, -58.7%, between the two years. Wood Furniture Manufacturing had an employment loss greater than the Forest Products Industry. Wood Products Manufacturing was the only group where output and value added all experienced greater percentage declines than the Forest Products Industry. However, no significant differences were found between these industry contributions for the two years (Table 4).

Table 4. Significance tests comparing the direct impacts of 2001 and 2011.

	p-values		
Industry	**Employment**	**Value Added**	**Output**
Forestry and Logging (n=2)	1.00	1.00	1.00
Wood Products Manufacturing (n=9)	0.38	0.16	0.22
Paper Manufacturing (n=8)	1.00	0.79	0.87
Wood Furniture Manufacturing (n=6)	0.81	1.00	0.69
Forest Products Industry (N=25)	0.59	0.53	0.70

Adjusted Type SAM multipliers for the industry groups are presented in Table 5. The economic multipliers are interpreted as follows using the Forest Products Industry as an example. The Forest Products Industry's 2011 employment multiplier was 2.25, which means the Forest Products Industry employed 1.25 people in additional sectors for every one of its employees. Its value added and output multipliers were 2.13 and 1.60. This means for every one dollar of value added and output generated by the Forest Products Industry, $1.13 and $0.60 of value added and output were generated in other sectors.

Table 5. Adjusted Type SAM multipliers for the aggregated forest products industry groups' 2001 and 2011 economic data.

	Employment		**Value Added**		**Output**	
Industry	*2001*	*2011*	*2001*	*2011*	*2001*	*2011*
Forestry and Logging	1.49	1.57	1.32	2.80	1.30	1.62
Wood Products Manufacturing	1.65	1.83	1.91	2.27	1.63	1.65
Paper Manufacturing	2.18	2.90	1.87	2.28	1.50	1.60
Wood Furniture Manufacturing	1.57	2.11	1.71	1.87	1.63	1.78
Forest Products Industry	1.85	2.25	1.83	2.13	1.54	1.60

The Adjusted Type SAM multipliers for sectors within Paper Manufacturing and all sectors of the Forest Products Industry showed significant increases in employment, value added, and output ($P \leq 0.03$ in all cases, Table 6). The sectors within Wood Products Manufacturing showed significant increases in their value added and output multipliers. Wood Furniture Manufacturing sectors only showed a significant increase in the employment multiplier. The remaining annual multiplier comparisons were not significantly different.

Table 6. Adjusted Type SAM multiplier comparisons for 2001 and 2011 forest products sectorial economic data.

	p-values		
Industry	**Employment**	**Value Added**	**Output**
Forestry and Logging (n=2)	1.00	0.25	0.25
Wood Products Manufacturing (n=9)	0.02	0.02	<0.01
Paper Manufacturing (n=8)	0.03	0.03	0.03
Wood Furniture Manufacturing (n=6)	0.01	1.00	0.05
Forest Products Industry (N=25)	<0.01	<0.01	<0.01

Total economic impacts by forest product industry group for 2001 and 2011 are provided in Table 7. Significant increases in some of the 2011 economic multipliers did not compensate for the large declines in many of that year's direct economic contributions. For example, the total impact Wood Products Manufacturing employment accounted for 8,000 less full and part time jobs in 2011 than in 2001. Similarly, Paper Manufacturing provided 6,900 less while Wood Furniture Manufacturing accounted for 5,500 less full and part time jobs in 2011 than in 2001. The total economic impact of Forest Products Industry employment was 24,700 jobs below the impact of 2001.

Table 7. Total economic impacts for the aggregated forest products industry groups in 2001 and 2011. Value added and output are reported in 2011 constant dollars.

	Employment		**Value Added (2011 $MM)**		**Output (2011$MM)**	
Industry	*2001*	*2011*	*2001*	*2011*	*2001*	*2011*
Forestry and Logging	3,248	3,569	$294	$96.5	$574	$295
Wood Products Manufacturing	33,559	25,052	$2,191	$1,408	$5,291	$3,705
Paper Manufacturing	65,002	58,027	$6,425	$5,282	$16,948	$14,628
Wood Furniture Manufacturing	29,188	23,701	$2,013	$1,932	$4,116	$3,714
Forest Products Industry	130,997	106,211	$10,923	$8,530	$26,930	$21,850

Overall, total economic impact declines were experienced monetarily across industry groups but were less so in Wood Furniture Manufacturing than the other industry groups (Table 7). Forestry and Logging contributed $198 million less in value added in 2011 compared to 2001 while Wood Products Manufacturing and Paper Manufacturing saw declines of at least $780 million respectively. Value added in Wood Furniture Manufacturing, though, declined $81 million. Forestry and Logging was also lower in total output in 2011 by nearly $280 million. Wood Products Manufacturing output was $1.5 billion lower, and Paper Manufacturing output was $2.3 billion lower. Wood Furniture Manufacturing output fell by $400 million. The Forest Products Industry experienced decreases in value added and output of $2.39 and $5.08 billion respectively between 2001 and 2011. Still, no significant differences were observed between years in total economic impacts across all sectors within the industry groups for employment, value added, and output (p≥0.33 in all cases, Table 8).

Table 8. Total economic impact comparisons for forest products sectorial 2001 and 2011 economic data.

	p-values		
Industry	**Employment**	**Value Added**	**Output**
Forestry and Logging (n=2)	1.00	1.00	1.00
Wood Products Manufacturing (n=9)	0.79	0.38	0.33
Paper Manufacturing (n=8)	0.79	0.87	0.87
Wood Furniture Manufacturing (n=6)	0.94	0.94	0.94
Forest Products Industry (N=25)	0.71	0.89	0.85

Discussion

Forest-based industries in Ohio have appeared to change from 2001 to 2011. Despite the absolute and relative differences in our direct contributions, no annual comparison of industry direct impacts was significant (p ≥0.16 in all cases, Table 4). Significant differences were found among the adjusted Type SAM economic multipliers between the two compared years (Table 6). Total impacts, though, did not display any differences (Table 8).

Forest-based industrial declines have not been limited to Ohio since 2001. For example, North Carolina and Virginia, historic leaders in Wood Furniture Manufacturing, employed 62% less 73% less people respectively in 2011 as compared to 2001 (Tilley and Munn 2007a; USDC Census Bureau 2014). Ohio's Wood Furniture Manufacturing sector by comparison lost -39.7% of its employment in 2011 compared to 2001. Value added and output losses from 2002 to 2011 (USDC 2002; 2011) in North Carolina- -57.3% and -52.9%- and Virginia- -61.4% and -55.3%- were also much larger than Ohio's

2001 to 2011 declines. These lower percentages of decline may be partly attributed to Ohio's unique Amish Furniture industry. The Amish Furniture Industry in Ohio is recognized for its economic contributions (Buehlmann and Schuler 2009; Bumgardner et al. 2007). The Ohio Amish Furniture Cluster is an important part of the state's Forest Products industry, as it utilized about 11% of the hardwood lumber produced in Ohio in 2005 (Bumgardner et al. 2007).

Employment declines from 2001 to 2011 in Ohio Wood Products Manufacturing (Table 3) were greater than those experienced by the neighboring state of Kentucky (-20.9%) (USDC Census Bureau 2014). The ten year change was comparable to Pennsylvania (-33.9) (USDC Census Bureau 2014). From 2002 to 2011 value added in these neighboring states declined -35.0% (Kentucky) and -48.0% (Pennsylvania). Ohio by comparison declined -45.9% from 2001 to 2011. However, output decreased slightly less in Ohio (-30.7%) from 2001 to 2011 than in Kentucky (-31.5%); Pennsylvania declined more so (-46.8%) from 2002 to 2011 (USDC 2002; 2011). Dahal et al (2013b) saw a similar change in employment in "Lumber and Wood Products" in the U.S. South, which declined -37.3% from 2001 to 2009.

Paper Manufacturing has decreased regionally as well as locally. Employment losses ranged from -14.9% to -32.9% across the Kentucky-Ohio-Pennsylvania region (USDC Census Bureau 2014), while value added ranged from -17.8% to -35.2%. Output fell between -16.8% and -23.5% (Table 3) (USDC 2002; 2011) Paper Manufacturing in the southern U.S. also declined in employment by -26% from 2001 to 2009. However, value added and output grew by 26.9% and 42.6% respectively over this time period (Dahal et al. 2013b).

Woodall et al. (2011b) found similar employment percentage losses when observing the Northern region of the U.S. Forest Products Industry. Employment fell -28% in the U.S. North Forest Products Industry between 2005 and 2010. This was approximately 5% less than the loss observed in Ohio's Forest Products Industry from 2001 to 2011. Similarly, the number of forest-based employees in the U.S. South in 2009 was 33.9% fewer than in 2001 (Dahal et al. 2013b).

While forest products direct impacts declined in Ohio, the state's adjusted Type SAM economic multipliers showed increases. The significance of these differences was variable. Statistically significant differences ($p < 0.05$) were found within the sectors of Wood Products Manufacturing (value added and output), Paper Manufacturing (all three economic measures), Wood Furniture Manufacturing (employment), and the Forest Products Industry (all three economic measures) (Table 6). Multipliers are calculated through the transaction table that defines industry sectors as buyers and sellers of goods. Higher multipliers in 2011 suggest buying and selling between forest-based industries and external sectors within Ohio had increased in 2011 as compared to 2001. As a result, Ohio's Forest Products Industry has become more integrated into, and dependent upon, Ohio's economy as a whole.

The changes in Ohio Forest Products Industry employment and economic contributions over the 2001 to 2011 period directly coincided with the housing bubble experienced in the U.S. and the Great Recession felt worldwide. Woodall et al. (2011a) discussed the roles globalized manufacturing, electronic media, and the very large decline in housing construction since 2006 played in the restructuring of the Forest Products Industry nationally. While Ohio has unique components within its forest economy, its

Forest Products Industry was largely not resistant to the greater trends occurring regionally and nationally.

Chapter 3

Economic Impacts of Timber Product Outputs in Ohio Across Timber Market Regions

Introduction

Agricultural production via crops, livestock, and timber provides billions of dollars annually to the American economy (McKeever and Howard 1996). Considering wood in the context of national crop production placed the value of harvested timber second only to corn receipts (Haynes et al. 2003). The recent housing collapse and subsequent global recession, though, resulted in a significant downsizing and restructuring of the national forest products industry (Woodall et al. 2011a). Forest-based industries in the U.S. South (Hodges et al. 2011), West (Keegan et al. 2011), and North (Woodall et al. 2011b) alike were not resistant to these changes. Falling demand for hardwood products made this recession the first since World War II where appearance-grade hardwood lumber prices of all species declined (Hardwood Review 2007-2009).

Product prices have since been recovering, but the correlations between Appalachian hardwood lumber prices and sawlog and stumpage prices in Ohio were recently found to have differed following this most recent recession as compared to past recessions (Luppold et al. 2014). These events prompted our recent assessment of the current conditions of forestry and forest products manufacturing in Ohio. Chapter 1 of this thesis found the forest products industry employed 47,200 people and contributed

$13.6 billion of output, including $4.00 billion of value added, directly to Ohio's economy in 2011. Compared to 2001 (Hushak 2005), inflation-adjusted output and value added declined $3.83 and $1.98 billion respectively, while 23,800 jobs were lost.

Economic impacts are often spatially specific regarding timber, varying based on the regionalized structure of the forest products industry and the economic base to which it contributes. For example, the industrial base could be dependent upon whether an area is located in a softwood region, where structural lumber production may predominate, or a hardwood region where value added manufacturing sectors can further process appearance-grade lumber into furniture, flooring, millwork, and other secondary products. Primary processors are often located in rural areas while secondary manufacturers tend to locate nearer population centers. The heterogeneity of a species across its home range also lends itself to different markets and thus pricing. Red oak (*Quercus* spp.) lumber is an exemplar species due to the number of select and non-select species comprising the red oak group as well as the regional differences in physical traits occurring within a species (Luppold 1997).

Cox and Munn (2001) compared the forest products industries of the Pacific Northwest and South, which are dependent upon Douglas-fir (*Pseudotsuga menziessi*) and southern pine (*Pinus* spp.) respectively. Economic impacts in terms of dollars of total output along with the multiplier effects of forest products industries were larger in the South as compared to the Pacific Northwest. Total economic activity per unit of output due to forest products industry demand for Douglas-fir stumpage, however, was 61% more than the impact generated for an equal amount of southern pine. Thus, the shift in softwood timber harvest volumes from the Pacific Northwest to the South resulted in greater losses to the Pacific Northwest than gains by the South due to the regional price differences in costs of inputs.

Forest inventories, timber and site quality, and the costs of harvesting, hauling, and processing are all spatially influenced. While Cox and Munn's (2001) work is beneficial for comparing forested regions on a national scale, the economic feasibility of transporting roundwood dictates timber markets be of a more local nature (Cubbage and Davis 1986). Understanding the economic impacts of timber product outputs across market regions, though, is not a well understood topic. This is true in Ohio, where three distinct timber market regions exist (Figure 1).

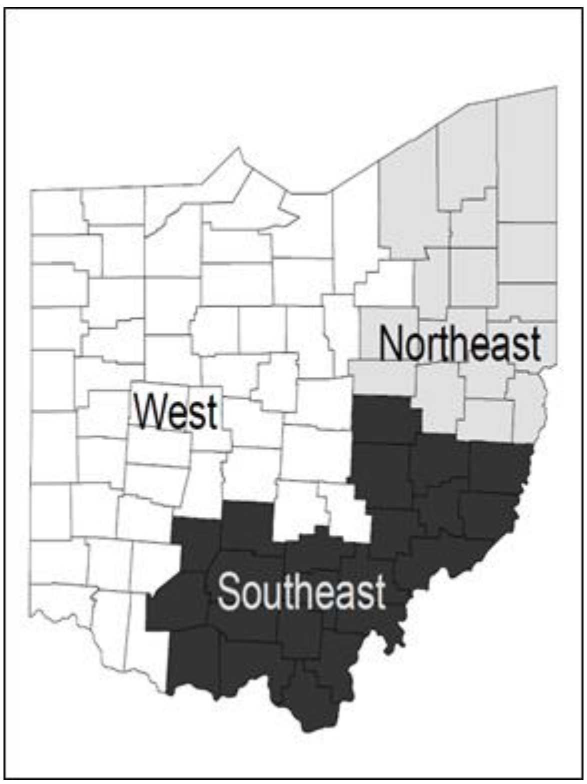

Figure 1. Timber market regions of Ohio.

The Southeast and Northeast regions are the more forested, located south and east of the glacial line in the Appalachian foothills, while a large portion of the land area in the West timber market is glaciated. The Southeast is the most rural of the three and contains no major cities. It does, though, possess the greatest regional concentration of sawmills producing more than 5 million board feet of lumber (MMBF) annually (Wiedenbeck and Sabula 2008). Primary processing is most intensive in this region. The Northeast is also largely rural but is comprised of the greater Cleveland metropolitan area. This region contains the greatest number of sawmills (Wiedenbeck and Sabula 2008) and is also known for its Amish wood producing communities, which are centered in and around Holmes County. Bumgardner et al. (2007) estimated Ohio's Amish furniture industry used over 43 MMBF annually, equivalent to approximately 10% of the hardwood lumber produced in Ohio. The West is mostly farmland but contains several urban areas. It has the fewest primary wood processing facilities, the lowest total timber product consumption, and the lowest average consumption per mill (Wiedenbeck and Sabula 2008).

This study used IMpact Analysis for PLANing (IMPLAN), an economic impact software system, to construct input-output models for the state of Ohio and its three intrastate timber market regions: the Northeast, West, and Southeast (Figure 1). One set of four models calculated the economic impacts of delivered timber products based upon the total output produced by the Commercial Logging sector in each respective area for the year 2012. Timber products were defined here as roundwood harvested and transported to its first point of delivery for the production of consumer and industrial products (McKeever and Howard 1996). This included veneer logs, sawlogs, pulpwood, and other roundwood products (e.g. handle stock). A second set of four models then calculated the associated 2012 economic impacts of timber product outputs on a per-unit of output basis, with one MMBF of delivered hardwood sawtimber representing one unit. Price per unit was developed from the Ohio Timber Price Report (Ohio State University Extension [OSUE] 2012). Economic impacts were evaluated based on three measures- employment, output, and value added.

Methodology

The Input-Output Model

IMPLAN is an economic modeling system that uses input-output analysis to quantify economic contributions of an industry in a predefined region (IMPLAN Group LLC 2004). IMPLAN was designed in 1976 by the Minnesota IMPLAN Group Inc. under the direction of the U.S. Forest Service to help meet the reporting requirements for Forest Service land management programs. IMPLAN is now widely used to quantify the economic impacts of various industries, such as agriculture, tourism, new construction projects, among others. The IMPLAN system is now managed by IMPLAN Group LLC of Huntersville, North Carolina.

IMPLAN quantifies the economic contributions of a predefined region in terms of dollars added in to the economy and jobs produced (IMPLAN Group LLC 2004). Data are obtained from various government sources. For example, household data are estimated from personal consumption expenditures. These values in turn are derived from information compiled by the Bureau of Economic Analysis and National Institute of Pension Administrators. Other data sources include the annual survey of manufacturers, census data, import and export data, and capital expenditures.

The IMPLAN system's input-output model defines 440 sectors in an economy (which are North American Industry Classification System sectors except in some cases where sectors have been aggregated) and uses its database to model inter-sector linkages, such as sales and purchases between forest-based industries and other businesses. Employee labor and property can be considered inputs, while exports and product sales make up final demand. The transactions table quantifies how many dollars each sector makes (processes) and uses (purchases). The table separates processing sectors by rows and purchasing sectors by columns; every sector is considered to be both a processor and producer. Summing each row quantifies an industry's output. Value added and imports are also included within the table and represent part of the total outlay. A sector's economic relationships can be explained from the transactions table by the value of the commodities exchanged between the industry of interest and other sectors.

A sector's fixed coefficient production function represents how dependent an industry is on other industries to produce one unit of its output to satisfy final demand. Leontief (1936) defined the relationship between output and final demand using Equation 1

$$x = (I - A)^{-1} y \qquad [1]$$

where x is the output column vector, I is an identity matrix, A is the matrix of fixed coefficient production functions (which is a 440 by 440 matrix relating input to output), and y represents the final demand column vector. The term $(I - A)^{-1}$ is the total requirements matrix. Each element of the matrix describes the amount needed from sector i (row) as input to produce one unit of output in sector j (column) to satisfy final demand (Horowitz and Planting 2009). The output multiplier for sector j is the sum of its column elements, or sector j's total requirements from each individual sector i. Employment and value added multipliers are also derived from summing the respective column elements.

Employment in IMPLAN is represented as the number of both full and part time jobs an industry creates to meet final demand. Value added is composed of labor income, which includes employee compensation and proprietary (self-employed) income, other property type income, and indirect business taxes. Value added is comparable to Gross Domestic (or Gross State) Product and represents the value of resources minus the costs of input and labor. Output is the sum of value-added plus the cost of buying goods and services to produce the product.

Economic Impacts of Total Timber Product Outputs

First, direct and total economic impacts of timber products were determined by region and for the entire state. For this set of models, we conducted input-output analyses on Ohio's economy, focusing on timber products delivered by the Commercial Logging sector. Four models were constructed, with the direct contributions of the Commercial Logging sector determined from the database. Economic multipliers were used to quantify the spillover effects, the indirect and induced impacts. Here, Type I and Type SAM economic multipliers were applied to describe these effects.

Indirect effects result from inter-industry purchasing to meet final demand. The Type I multiplier defines this linkage, which is described by dividing the direct effect into the sum of the direct and indirect effects (U.S. Department of Commerce Bureau of Economic Analysis 2013). Differences in employee spending within inter-linked industries produce the induced effects. Induced effects are those assumed to be endogenous to a study region, where the changes in value added inputs (which includes labor income) and consumption are fed back into the economy of interest.

Type II multipliers are defined as the sum of the direct, indirect, and induced effects divided by the direct effect. Type II multipliers differ by how they define value added and account for any of its potential endogenous components. A particular Type II multiplier, the Type Social Accounting Matrix (SAM) multiplier, considers portions of value added to be both endogenous and exogenous to a study region. Type SAM multipliers are generally the preferred Type II multipliers used in input-output analysis (Tilley and Munn 2007) and were also used in this study to estimate changes in total economic impacts.

Estimating the effects of timber product outputs in Ohio, we adjusted our Type I and Type SAM multipliers-for employment, output, and value added- to discount Commercial Logging's input of its own output to meet final demand. Doing so reflected the measured impact of a per unit change in timber product output versus a per unit change to final demand, which paralleled Hushak's (2005) methodology. Calculating this adjustment required dividing each of Commercial Logging's multipliers by its associated diagonal element found in the total requirements matrix, which is illustrated in Equation 2

$$\text{Adjusted Multiplier}_{\text{Commercial Logging}} = \text{Multiplier}_{\text{Commercial Logging}} \; / \; a_{\text{Commercial Logging}}. \quad [2]$$

The diagonal element's value, the term $a_{\text{Commercial Logging}}$ here, for any sector is at least 1.00 due to the requirement of itself to produce one unit of output at minimum. The diagonal element exceeds 1.00 when a sector's output is required to produce its product.

Accounting for this effect resulted in Adjusted Type I and Type SAM Multipliers for timber products that were less than or equal to the original multipliers calculated from the total requirements matrix. The magnitude of any reduction was dependent upon the logging sector's need for its own production in the manufacturing of output in each respective region.

<u>Economic Impacts per Unit of Timber Product Output</u>

To calculate the per-unit economic impacts of timber products by market region in Ohio, we first accessed the U.S. Department of Agriculture Forest Service's Forest Inventory and Analysis (USFS FIA) website. We used the Forest Inventory Data Online tool to create reports for sawtimber removals from timberland in 2012 (USFS FIA 2014). We generated four separate reports, one for the entire state and one for each of our three regions (Northeast, West, and Southeast). From each the timberland removals of White Oak (*Quercus alba*), Red Oak (*Quercus rubra*), Hard Maple (e.g. *Acer saccharum*), Soft Maple (e.g. *Acer rubrum*), and Yellow-poplar (*Liriodendron tulipifera*) were obtained. These five species are main drivers of Ohio's timber market, representing approximately 65% of the sawtimber harvest in 2006 (Wiedenbeck and Sabula 2008). The prices obtained for these species are also used in calculating the Ohio Timber Price Indices for a typical stand of hardwood timber (McConnell 2013).

Weights were developed based upon each species' relative contribution to the total sawtimber removals for all five species in each respective area (Table 9). Prices for the five species were obtained from all returned 2012 price surveys for delivered hardwood sawlogs from the Ohio Timber Price Report (OSUE 2012). The prices were reported on a dollars per one thousand board feet of wood basis (MBF, Doyle scale). The surveys were coded by region, thus all of the entries are region specific. From these surveys, we were able to use seven responses from the Northeast, four from the West, and five from the Southeast, and sixteen for the state. We used the reported All Grades sawlog price for all five of our examined species.

Table 9. Weights used to calculate regional delivered sawtimber prices. Weights were based upon each species' relative contribution to the total sawtimber removals for all five species in each respective area and may not sum to 1.00 here due to rounding.

Region	White Oak	Red Oak	Hard Maple	Soft Maple	Yellow-poplar	Average weighted price per MMBF
Northeast	0.09	0.36	0.06	0.30	0.20	$401,000
West	0.22	0.18	0.17	0.11	0.32	$394,000
Southeast	0.28	0.27	0.09	0.04	0.33	$493,000
Ohio	0.20	0.29	0.09	0.13	0.28	$425,000

The weighted price for each survey response was calculated by

$$\sum \text{(Price of species * Species Weight)} = \text{Weighted price.} \quad [3]$$

The weighted prices were then averaged for each area and multiplied by 1,000 to determine an average price per MMBF of delivered sawtimber. Using the regional input-output models and their associated adjusted economic multipliers described previously, we determined the economic impacts per unit of timber product output based upon a change in the regionalized value of one MMBF of hardwood sawtimber delivered by the Commercial Logging sector in 2012.

Results

<u>Economic Impacts of Total Timber Product Outputs</u>

The direct employment, output, and value added produced from harvesting and delivering timber in each Ohio timber market area are displayed in Table 10. Also contained in Table 10 are the relative contributions of timber to total agriculture in each respective area. Timber harvesting employed 1,851 people in Ohio in 2012, while creating $73.4 million in value-added and $162 million in output. Most of these impacts were generated from the more forested Northeast and Southeast regions. The northeast employed 100 less people than the southeast, but produced $11 million more in output and $15 million more in value-added. The highest relative contribution of timber products to total agriculture was in the northeast, where 7.03% of the region's value-added from agricultural products was provided by timber. Timber-related employment, output, and value-added in the northeast and southeast contributed at least 4.88% to the total direct contributions of all agriculture industries; in the west this was only 0.20% or less in all cases. At the state level, between 1.50% and 1.87% of total agricultural employment, output, and value-added was timber-related.

Table 10. Direct impacts of timber products in Ohio by region, and their associated percentage contributions to agriculture as a whole. Employment is reported as the number of full and part time jobs. Output and Value Added are reported in millions of dollars.

Region	Description	Employment	Output	Value Added
Northeast	*Timber Products*	805	$81.5	$42.8
	% of Total Agriculture	4.88%	5.26%	7.03%
West	*Timber Products*	137	$10.3	$3.74
	% of Total Agriculture	0.20%	0.13%	0.13%
Southeast	*Timber Products*	910	$70.7	$26.9
	% of Total Agriculture	5.18%	5.87%	6.56%
Ohio	*Timber Products*	1,851	$162.6	$73.4
	% of Total Agriculture	1.80%	1.50%	1.87%

The unadjusted and adjusted Type I and Type SAM economic multipliers associated with timber products for each region and the state are listed on Table 11. The Type I adjusted multipliers ranged from 1.14 to 1.34. Employment Type I adjusted multipliers ranged from 1.14 to 1.15 across all regions. The highest adjusted Type I multiplier was value added in the West region at 1.34. Both output and value-added adjusted Type I multipliers in the West were higher than those for the state.

Table 11. Type I and Type SAM economic multipliers for each region and each economic measure. Adjusted and unadjusted multipliers are both reported.

	Type I Multipliers		**Type SAM Multipliers**	
Region	*Unadjusted*	*Adjusted*	*Unadjusted*	*Adjusted*
Northeast				
Employment	1.21	1.15	1.70	1.62
Output	1.23	1.17	1.80	1.71
Value Added	1.23	1.17	1.93	1.83
West				
Employment	1.15	1.14	1.45	1.44
Output	1.24	1.23	1.72	1.71
Value Added	1.35	1.34	2.17	2.15
Southeast				
Employment	1.19	1.14	1.43	1.37
Output	1.23	1.18	1.57	1.50
Value Added	1.27	1.21	1.82	1.74
Ohio				
Employment	1.20	1.15	1.62	1.55
Output	1.27	1.21	1.84	1.77
Value Added	1.30	1.24	2.09	2.01

Adjusted Type SAM multipliers ranged from 1.37 to 2.15. The highest individual value was again found in the West (2.15), which was also for value added. This and the adjusted Type SAM employment multiplier in the northeast were higher than their associated state-level multipliers. The Southeast region had the lowest adjusted Type

SAM employment, output, and value added multipliers.

The Type I and Type SAM economic impacts by region and for the state are displayed in Table 12. As expected, the regional level results were higher in the more forested areas of the state. Employment Type I impacts were highest in the Southeast, while output and value added Type I impacts were highest in the Northeast. The total Type I economic impacts for the state were 2,100 jobs and $197 million in output, including $91.4 million in value added. The Northeast had the highest regional Type SAM impacts across all three economic measures. The Northeast and Southeast were over 5 times higher than the West in Type SAM impacts in all cases. The total Type SAM economic contributions for the state of Ohio were $147 million of value added and $287 million of output while creating over 2,800 total jobs.

Table 12. Total contributions of timber product outputs to Ohio's economy in 2012. Contributions were reported by region and for the state as a whole. Employment was the number of full and part time jobs. Output and Value Added are reported in millions of dollars.

Impact type	Employment	Output	Value Added
Northeast		*Million $*	
Direct Impacts	805	$81.5	$42.8
Type I Impacts	928	$95.5	$50.2
Type SAM Impacts	1,305	$139.7	$78.4
West			
Direct Impacts	137	$10.3	$3.74
Type I Impacts	156	$12.7	$5.00
Type SAM Impacts	197	$17.6	$8.05
Southeast			
Direct Impacts	910	$70.7	$26.9
Type I Impacts	1,033	$83.3	$32.6
Type SAM Impacts	1,243	$105.8	$46.8
Ohio			
Direct Impacts	1,851	$162.6	$73.4
Type I Impacts	2,128	$197.2	$91.4
Type SAM Impacts	2,879	$287.1	$147.2

Economic Impacts per Unit of Timber Product Output

Employment, output, and value added economic impacts produced per MMBF of delivered hardwood sawtimber for the state and each market region are listed in Table 13. The average weighted prices entered into these models were regionally specific due to forest composition and the costs associated with harvesting and transporting roundwood. The direct output of the regions and state represented the average weighted delivered price of sawtimber per MMBF. Direct employment represented the number of loggers employed to harvest one MMBF while direct value added was the new wealth generated from that harvest.

Table 13. The per-unit contributions of one million board feet of hardwood sawtimber. Dollar figures were rounded to the nearest ten dollars.

Impact type	**Employment**	**Output**	**Value Added**
Northeast			
Direct Impacts	3.9	$401,000	$209,560
Type I Impacts	4.5	$469,950	$246,000
Type SAM Impacts	6.3	$687,560	$384,400
West			
Direct Impacts	4.8	$394,000	$141,150
Type I Impacts	5.5	$485,980	$188,680
Type SAM Impacts	6.9	$672,120	$303,850
Southeast			
Direct Impacts	6.3	$493,000	$187,450
Type I Impacts	7.2	$580,340	$226,920
Type SAM Impacts	8.6	$737,730	$325,400
Ohio			
Direct Impacts	4.8	$425,000	$191,110
Type I Impacts	5.5	$515,640	$237,770
Type SAM Impacts	7.5	$750,600	$383,220

Sawtimber delivered to market in 2012 was valued highest in the Southeast, $493,000 per MMBF, followed by the Northeast and West. Statewide the value of one

MMBF was $425,000 in 2012. The Southeast also had the highest direct employment per MMBF of output followed by the West and Northeast. The Northeast had the highest direct value added per MMBF.

Type I impacts for employment and output were again highest in the Southeast, with value added also greatest in the Northeast. However, employment and output impacts generated directly and in support of timber resources were higher in western Ohio than in the Northeast. Statewide, each MMBF of timber generated direct and indirect impacts totaling 5.5 jobs and $515,000 in output, including $237,000 in value added. Of those totals the indirect effects of the timber supply chain amounted to 0.7 jobs, $90,000 in outputs, and $46,000 in value added.

Accounting for the Type SAM economic multiplier effects of each MMBF of timber in Ohio resulted in total impacts of 7.5 jobs, $383,000 in value added, and $750,000 in output across the state. This included induced impacts of 2.0 jobs, $235,000 in output, and $145,000 in value added. Each MMBF of timber product output in southeastern Ohio produced more total jobs and output across that region's industries than in western and northeastern Ohio. Western Ohio generated nearly seven total jobs per MMBF, followed by the Northeast at 6.3. On the other hand, per unit total output was greater in the Northeast than in the West. The Northeast was able to capture the greatest amount of value added, followed by the Southeast and West respectively.

Discussion

Hardwood species comprise over 96.0% of the total forest volume in Ohio, and timber production there is almost wholly hardwood-based. In 2012, timber receipts contributed 1.50% to the total output of all agricultural products (Table 10). Much of that occurred in the two regions occupying the unglaciated Appalachian foothills. Timber production in those areas each eclipsed 5.00% of total agricultural output. The farm woodlots of western Ohio contributed very little to regional agricultural receipts.

Describing timber's economic impacts in terms of total output, the effects generated in the Northeast and Southeast were much larger than the West (Table 12). Mills require timber be appropriate, available for harvest within the procurement radius, affordable, and accessible. The availability of large timber volumes in those regions logically explained why approximately 94.0% of the direct, Type I, and Type SAM economic impacts of total timber production outputs were contained in those areas. Of the three, timber generated the greatest economic activity monetarily in Northeast Ohio.

However, the ranking in values in the per-unit analysis varied from those based on total timber product outputs. The West and Northeast were similar in direct output relative to the price per MMBF due to the costs of regional inputs, though both were over $90,000 lower than the Southeast (Table 13). Additionally, the West directly employed almost one more logger, 4.8 per MMBF of timber produced, than the Northeast at 3.9 per MMBF. While timber's contribution to the agricultural economy of western Ohio was small, it was a more labor dependent commodity in the West than in the Northeast. The number of loggers needed in the West to harvest and deliver one MMBF to market in 2012 equaled the number needed in the state as a whole. But timber products in the Northeast had a much higher direct value added per MMBF than the West because of those additional costs of input and labor. Value added per MMBF in the Northeast was in fact the largest of the three intrastate regions.

The adjusted economic multipliers varied by type and region. Type I adjusted multipliers ranged from 1.14 to 1.34. The Type SAM adjusted multipliers ranged from 1.37 to 2.15. Adjusted Type I multipliers describe the inter-industry linkages associated with producing industrial outputs. They represent the direct and indirect relationships between industries in the region, and any change in contributions brought by a change in the production of outputs (Hushak 2005). Type SAM multipliers account for household spending, and they considers parts of value added to be both endogenous and exogenous to a study region.

For both output and value added the adjusted Type I and Type SAM economic multipliers in the West were equal to or greater than those from the more forested timber market regions. Value added is considered a more reliable measure to use in the case of multipliers, as output multipliers tend to double count for the costs associated with doing business (Stevens and Lahr 1988). The West likely had equal or larger adjusted Type I and Type SAM economic multipliers because that area contains more large cities than the other market regions. This provides the opportunity for a greater turnover of dollars associated with timber product outputs in the West before they leak out of the economy. On the other hand, the economic multipliers in the more rural Southeast either tied for or were the lowest of the three timber market regions.

The Southeast region is heavily forested, which may explain its high values for employment and output per MMBF. It consumes the greatest amount of wood of the three regions, as it contains a concentration of large sawmills in the area (Wiedenbeck and Sabula 2008). These large facilities could have been procuring timber more aggressively as lumber prices began rising from their low points in 2009 (Luppold and Baumgras 1998). Delivered sawtimber prices in 2012 were at least 23% higher there than the other regions.

On a per-unit of output basis the Southeast directly employed more loggers in the Southeast than the other regions. Per MMBF the Southeast had the highest Type I employment and output economic impacts, but it trailed slightly behind the Northeast in Type I Value added. The Southeast also had the highest Type SAM employment and output economic impacts per MMBF, but it contributed less than the Northeast in Type SAM value added (Table 13). The Northeast had the lowest Type I employment and output economic impacts per MMBF. The large gains in value added in the Northeast were apparently associated with the less intensive need for labor to produce timber products in that region.

Conclusions

Total economic contributions of timber product outputs varied by market region and impact type. The Northeast region had the highest type SAM impacts in all cases; it also had the highest type I output and value added. The Southeast had the highest type I employment but only accounted for about 100 more jobs than the Northeast. The Southeast and Northeast regions were more productive. A cluster of large sawmills resides in the Southeast and the Northeast contains the greatest number of primary processing facilities. The West was lowest in all cases, even though that region is the largest of the three (Figure 1).

Economic contributions varied on a per-unit basis, but were typically closer between the three regions when compared to total output of the industry. The southeast had the highest employment and output in all three impact types. The Northeast employed the least amount of loggers per MMBF of production. The lesser dependence on labor in the Northeast to harvest and deliver timber products to market contributed to higher value added contributions in that region.

Chapter 4

Conclusions

The forest products industry in Ohio has undergone changes, just as the industry has in other regions of the United States since the recent recession. A comprehensive industry analysis was needed to fully quantify and assess the current state of Ohio's forest economy. First, an economic impact analysis of Ohio's forest products industry was conducted for 2011, and compared to Hushak's (2005) 2001 results in real terms. Next, the 2012 economic impacts of total timber product outputs were calculated for the state as a whole and for each of its timber purchasing regions. Then, the economic impacts of timber product outputs on a per unit of output basis were determined to compare the impacts of meeting the demand for one million board feet of delivered hardwood sawtimber ($/MMBF, Doyle) across the state and each market region.

Overall, Ohio's forest products industry has declined in most areas. While the direct and total economic effects were lower in 2011 compared to 2001, economic multipliers were higher in 2011 compared to 2001 with statistical significance in some cases. In an overall sense, the industry lost direct contributions of jobs and dollars in all cases but one, in real terms. A similar result was found in the total contributions of Ohio's forest economy in 2011 compared to 2001 in real terms. However, differences among major aggregated sectors were not statistically discernible.

From a timber resource perspective, timber delivered to Ohio markets created total economic impacts of 2,879 employees, $147 million in value added, and $287 million in outputs. Indirect effects totaled 2,128 jobs, $91 million in value added, and $197 million in output. The more forested northeast and southeast regions logically had higher total contributions than the west. On a per unit of output basis, though, timber in Ohio provided variable impacts based on the region that was observed. The northwest and west regions were similar in direct per-unit output, but were both over $90,000 less than the southeast. Timber prices have been rising for over three consecutive years since 2011. Perhaps the large sawmills in the southeast were more aggressively competing for timber as lumber markets improved coming out of the 2007 to 2009 recession.

Updated information on the forest products industry's current status can give industry executives, trade associations, landowners, and even policymakers a better understanding of the next steps in sustainably managing forests and supplying wood and fiber to an increasingly diversifying industry. With the 2011 and 2012 economic data presented here, stakeholders will gain a better understanding of Ohio's forest products industry. These data, with continued efforts, could be used later in association with newer data as it becomes available to identify trends and update the forest products industry's economic impacts over time.

Recommendations for Future Research

The methodology used here has the potential to estimate the impacts of industrial economic losses from invasive species (from them killing trees), though it would still only provide a "snapshot" of those effects. This could be looked at from two perspectives. One could be the loss of value through salvaging, and the second could be from the effect of additional imports of raw materials into the study area to sustain demand for stumpage. Data for timber prices would need to be relevant to that area's timber species and associated prices. Still, this would likely be considered a low end estimate because it would not include the aesthetic value of trees, ecological benefit, outdoor recreation benefits and other such realized values that trees provide. However, it does include many other types of economic values such as industry sales and purchasing.

This application could be especially useful in accounting for harm already done by the invasive Emerald Ash Borer (*Agrilus planipennis*) or the more recently found Walnut Twig Beatle (*Pityophthorus juglandis)* and its associated fungus (*Geosmithia morbida*) that causes Thousand Cankers Disease which was found in Southwest Ohio in 2012 and 2013 (Ohio Department of Agriculture, 2013). In addition, the invasive Asian Longhorned Beetle has already been found in cities near Chicago and New York City in (Nowak et al. 2001). As a generalist borer species, the Asian Longhorned beetle has the potential to affect many different species of trees in Ohio, and surrounding areas. In the quarantined area of Clermont County, this is already occurring. Providing information on the impacts of these losses would be beneficial to many parties in the affected communities.

Limitations

IMPLAN is a modeling system, and all models are only as good as the information provided to them. One commonly pointed out limitation of IMPLAN is that it models economies by interactions, categorizing each industry into one of 440 sectors. Earlier versions detailed an economy of over 500 sectors. While the IMPLAN modeling system does encompass many specific sectors, it often aggregates certain, often smaller, related industries together. This is the case for many individual forest-based businesses.

Economic impact assessments with IMPLAN can only provide a snapshot of dollars generated. Further, defining the true impact of a rural industry such as forestry and forest products manufacturing can be problematic. First, the data utilized when constructing the input-output model in IMPLAN are based on government estimates of industrial sectors. Second, companies within the forest products industry can be, and often are, classified into various other sectors. Logging firms, for example, can often be found in other sectors, such as Truck Transport and Support Services for Forestry (Greene et al 1998; Santos et al. 2011).

IMPLAN software allows the user to easily customize data for his/her study region as appropriate, given the means by which the data are obtained. A study by Lazarus et al. (2002), for example, highlighted regional purchase coefficients as a potential issue because IMPLAN assigns constant values, which may not always be correct. They attempted to correct this by adding in primary survey data which they collected. While not always feasible or possible, researchers should be encouraged to gather primary survey data to verify and augment the data provided by IMPLAN, particularly in more rural study areas.

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