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Economic Contribution of Ohio's Wood Industry Cluster: Identifying Opportunities in the Appalachian Region*

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Abstract: Ohio's wood industry cluster contributes nearly \$25 billion and 116,321 jobs to the state's economy, yet most of this value-added impact occurs outside of the heavily forested Appalachian Ohio region. This research, conducted as part of a Small Business Administration Regional Innovation Cluster grant, includes a multi-industry economic contribution analysis to document wood industry impacts to the entire State of Ohio and the 32-county Appalachian Ohio region. Findings indicated that Appalachian Ohio contained lower paying and lower on the value chain sectors compared to the state. This paper highlights these metrics and presents recommendations to improve investment and value-added industry opportunities in the wood industry cluster to support Appalachian Ohio.

Keywords: wood industry, clusters, economic contribution, input-output, rural, Appalachian

JEL Codes: L73, R15, R58

1. INTRODUCTION

This study investigates the State of Ohio's wood and forest products cluster and the economic impact of this industry to both Ohio and the Appalachian Ohio region. This research was conducted as part of a U.S. Small Business Administration (SBA) Regional Innovation Cluster (RIC) grant funded by the federal Partnerships for Opportunity and Workforce and Economic Revitalization (POWER) Initiative. The federal POWER Initiative is specifically designed to help communities and regions, such as Appalachian Ohio, impacted by the recent

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decline in coal jobs. As such, this research is tasked with enhancing the wood industry cluster with workforce training, connecting firms with suppliers and export opportunities, and developing new markets to provide an alternative to the legacy of coal industry employment in the region. We focus exclusively on the wood industry in Ohio as a key cluster under the SBA RIC program and attempt to highlight its unique influence on the regions economy.

Despite containing most of the state's forest resources, including high-value hardwoods, Appalachian Ohio is anecdotally considered to have lower paying and lower on the value chain industry sectors compared to the rest of the state. For instance, a majority of Ohio's commercial logging activity occurs in Appalachian Ohio, while most higher-value wood processing and manufacturing occurs outside of the region. Thus, our research examines the extent to which these lower paying and value chain sectors exist in the rural, Appalachian region, as compared to their performance and economic contribution in other parts of the state. By investigating the sector mix and influence of Appalachian Ohio's wood industry, as well as its overall statewide impact, we aim to provide updated and more robust data on the wood industry by geography. This, in turn, can assist policymakers, industry leaders, and economic development practitioners alike in making better-informed decisions about strategies to enhance Ohio's wood industry cluster in the region.

We focus on wood and forest products as a key industry since it may serve as an alternative to the traditional extractive industries in the Appalachian region such as natural gas and coal. Historically, in these fossil fuel energy industries, resource extraction booms have been followed by subsequent busts and a failure to capture long-term value locally. This natural resource curse, especially in coal-dependent communities nationally (James and Aadland, 2011) and in Appalachia (Deaton and Niman, 2012), has been well documented in the academic literature. Resource extraction has specifically plagued the economic and environmental well-being of the Appalachian Ohio region, creating poverty and negative outcomes in public health, welfare, and others. Haphazard approaches to mitigate the destructive effects of such boom-and-bust cycles have generally been unsuccessful. The wood products industry has historically been important to Ohio's economy, and, thus, may be a key focus to build a more environmentally friendly, sustainable, and resilient regional economy in the future that can endure the shock of busts in other local industries.

For this research, we used 2014 data and focused on 30 distinct wood-related industry sectors in our models, categorized into 13 associated industry groupings. This collective analysis approach offered the advantage of understanding how the surface-level groups were performing relative to others, while also allowing the assessment of the direct effects of the respective 30 wood industry sectors through the input-output (IO) modeling. The following sections of this paper first provide an overview of industry cluster analysis, a review of Ohio's wood and forest products industry cluster and prior studies, and then present the findings from the economic contribution analysis methodology employed. Our findings indicate the need to improve investment and value-added industry opportunities in the Appalachian region, which are discussed in the conclusions. This is specifically important since identifying and enhancing value-added production opportunities in the wood cluster provides employment options for low and middle-income individuals in the region (Marcouiller et al., 1996).

2. OHIO'S WOOD INDUSTRY CLUSTER

Industry cluster analysis is a commonly used approach to understand and implement strategies to enhance existing clusters in an economy or create new ones. Porter (2003) on page 562 defined industry clusters as a "geographically proximate group of interconnected companies, suppliers, service providers and associated institutions in a particular field, linked by externalities of various types." Porter's cluster analysis serves as the framework for the U.S. Cluster Mapping Project, which is a platform that groups (on a mutually exclusive basis) over 1,000 six-digit North American Industry Classification System (NAICS) codes into 51 traded clusters and 16 local cluster categories (U.S. Cluster Mapping Project, 2014). Traded clusters are primarily export oriented and sell products outside of a local market, while local clusters primarily serve a local market. The U.S. Cluster Mapping Project is a respected resource commonly used for cluster identification and analysis in nearly any industry. This tool offers strong high-level data on employment and wages, as well as abundant data visualization tools, at the regional level.

Other common approaches to cluster definitions include the use of templates to group six-digit NAICS codes in a non-mutually exclusive fashion (e.g., Feser and Bergman (2000); Kelton et al. (2008)). These inter-industry linkages have been supplemented with participatory approaches to incorporate local stakeholder preferences into cluster identification and targeting (Brun and Jolley, 2011). However, due to data suppression issues in rural geographies, especially in Appalachia, most common cluster definitions fail to provide industry- and county-level data on the number of firms, employees, and other economic metrics (Michaud and Jolley, 2017). This, in turn, sometimes prohibits researchers from conducting industry cluster analyses and economic impact analyses in smaller, rural geographies (e.g., counties) with tools such as the U.S. Cluster Mapping Project, meaning other methods must often be employed.

Ohio's wood products industry cluster has historically been an important sector in terms of the state's employment and economic development impacts. According to Coronado et al. (2015), using 2001 economic data, the "total economic contributions of forest products [in Ohio] when accounting for the industry's multiplier effects were 131,000 employees, \$7.29 billion in value added, and \$18.0 billion in outputs" (p. 2). Later, Letson et al. (2006) found that Ohio's wood industry's output "increased \$7.3 billion since 2005" (as cited in McConnell (2013) on page 7). For some added perspective, taken as a whole, Ohio's wood industry employs more than General Motors, Kroger, Delphi Automotive, and the Wright-Patterson Air Force Base combined, which were the top four employers in the state at the time with a total count of 97,080 employees (Ohio Development Services Agency, 2000). Moreover, wood's employment in Ohio was also more than the information, education, and entertainment industries in the state which had employment counts of 105,530, 74,497, and 68,642, respectively (Ohio Labor Market Information, 2018).

The businesses in Ohio's wood industry represent important regional economic drivers, particularly within the pulp & paper, millwork, and wood furniture manufacturing sectors. Specifically, Ohio's wood products industry contains three key traded clusters (i.e., export-oriented sectors): Forestry, Furniture, and Wood Products. Generally, this refers to growing and harvesting trees, the manufacturing of furniture and cabinets, and upstream wood ma-

terials establishments (e.g., sawmills), respectively.

Due to the wide variety of wood-related activity involved in both Ohio's traded and local clusters, we opted to utilize a relatively narrow set of industries for this analysis as discussed in Section 4. In essence, these industries represented the central types of establishments where local economic development organizations provide business services to enhance the wood industry. The approach also differs from Feser and Bergman (2000) and Kelton et al. (2008)'s alternative to Porter's industry cluster definitions that uses a scoring methodology to determine the strength of inter-industry linkages. In other words, making the industries to analyze in this study mutually exclusive helped mitigate employment and wage data suppression issues, allowed us to specifically discern industry contributions independent of one another, and, more generally, offered the ease of analysis.

2.1. LITERATURE REVIEW

The phrase 'industry clusters' is widely acknowledged in prior literature. Clusters have been defined as associated industry concentrations in a specific geography (Porter, 1998) that are "linked by similar needs such as production inputs, specialized labor, and technology" (Hagadone and Grala (2012) page 16). Put another way, industry clusters represent a geographic concentration of interrelated businesses, vendors, service providers, academic institutions, and other relevantly affiliated organizations surrounding a specific industry (Feser and Bergman, 2000; Morgan, 2007; Slaper and Ortuzar, 2015). These clusters sometimes interact via public-private partnerships (Matoon and Wang, 2014) which may breed job creation, entrepreneurial development, and other economic development related activities such as competitive advantages and increased earnings (Brun and Jolley, 2011).

There are a number of key actors and drivers that play a role in the operations and progress of an industry cluster. To exemplify, inter-dependent firms must often work together due to the inability of independent firms to produce a finished product in isolation (Kuah, 2002). Mottiar and Ingle (2007) further indicated flexibility, viability, and geographic proximity as drivers of successful clusters. Finally, there must be high competitive success in a particular field (Rosenthal and Strange, 2004), as well as local demand for a product, to produce a regional industry cluster Boari (2001). In the Appalachian context, prior studies have found that clustering among firms leads to new business formation, particularly in the technology sector, but not necessarily employment growth (Feser et al., 2008).

An example of an influential cluster in Ohio is its wood and forest products industry. Ohio has noteworthy operations in commercial logging, sawmill, pulp and paper, and the wood manufacturing sector, among others. In fact, Ohio's wood furniture industry has performed relatively well despite a steep decline in manufacturing of wood household furniture in the U.S over the past decade (Bumgardner et al., 2011). According to Bumgardner and Luppold (2008), Ohio's success, in part, stems from a competitive advantage in finely crafted Amish wood manufacturing in the north and eastern parts of the state. To illustrate, Holmes County, Ohio has a large Amish population and a prominent wood furniture manufacturing cluster, including localized assembly and production, as well as distribution networks to larger manufacturing centers in Ohio, Indiana, and Pennsylvania (Bumgardner and Luppold, 2008).

Very few academic or white paper reports have quantitatively assessed the impact of the wood industry to Ohio's economy. In one of the first relevant studies, Letson et al. (2006) found that Ohio's forest products industry contributed \$15.1 billion to Ohio's economy (2.5% of the state's total GDP) and employed over 119,000 people with annual payrolls of \$4 billion. More recently, McConnell (2012) calculated, using 2010 data, this industry contribution at \$22.05 billion, with approximately 118,000 jobs and "wages and benefits amounting to \$5.69 billion" (p. 1).

In 2015, Coronado et al. (2015) determined that the total wood economic impacts amounted to \$21.9 billion with 106,000 employees in 2011. To compare, Ohio's shale industry, another natural resource-based industry that has a more robust regional rhetoric and has been thriving recently due to the rapid growth of hydraulic fracturing techniques, contributed \$27.48 billion to the state in 2015, with 157,862 jobs and \$8.06 billion in wages and benefits, and an employment multiplier of 1.72 (Michaud, 2018). Nevertheless, the United States Forest Service (2010) ranked Ohio in the top 10 of states nationally in terms of wood-related production and employment figures (for furniture, wood container and pallet manufacturing, millwork, and others). Taken as a whole, these studies have indicated that the wood industry is a significant aspect of Ohio's economy, particularly in the Appalachian region of the state where economic contributions from wood account for over 50% of several counties' gross regional product.

3. METHODS AND DATA

This paper aims to investigate the economic impact of the wood industry in both Ohio and Appalachian Ohio. To do this analysis, we utilize IMPLAN (Impact Analysis for Planning) version 3.1, an input-output (IO) economic development modeling software that contains regionally specific social accounting matrices and multiplier models, among other data. This methodology was chosen due to adaptability of the model parameters and ability to target local geographies, in addition to researcher experience using the software. We specifically executed a multi-industry economic contribution analysis, first customizing the model so that each sector in the analysis made 100% of its primary commodity. This was done so that the commodity value would not be changed by another industry that may produce the wood industry's primary product as a byproduct. Trade flows were also customized so that the local use ratio for each sector was zero. This was completed so that no purchases from these industries were allowed beyond the amount specified in the analysis, which is the direct effect of each industry.

The data for this research came directly from IMPLAN, which has yearly records that contain regionally specialized economic statistics such as employment, wages, industry sales, and others at the state, county, and zip code levels. These data can be used to specifically analyze a regional or local economy, or changes in an economy's activity, since they are not estimated from national averages. IMPLAN data is based on the U.S. Bureau of Labor Statistics' Quarterly Census of Employment and Wages (ES-202) and the Bureau of Economic Analysis' Regional Economic Information System. We used 2014 data, as this was the most recent data available at the time of this research. The key input used for the IO model was industry sales per sector, as derived directly from the IMPLAN software.

Figure 1: Thirty-Two Appalachian Ohio Counties

Note: Green counties represent the ARC-designated Appalachian Ohio region used as the research study area. Figure developed by author.

IMPLAN is a common IO software created in partnership with the U.S. Forest Service (Day, 2011). IO modeling software, such as IMPLAN, have been prominently featured in the economic and regional science literature to project or assess the economic impact of a variety of agricultural uses, including economic contribution (Tytus et al., 1996), biofuels production (De La Torre Ugarte and Jensen, 2007; Bailey et al., 2011), and dairy industry impacts (Jafri and Buland, 2016), among others. IMPLAN has also been specifically and extensively used to measure the economic impact of forestry and wood products across a variety of sectors, including biofuels production from wood sources (Joshi et al., 2012; Lester et al., 2015), wood pellet production (Joshi et al., 2012; Lester et al., 2015; Henderson et al., 2016; Scouse et al., 2017), woody biomass (Joshi et al., 2012; Jackson et al., 2018), and wood furniture production (LaBissoniere and Bowe, 2006; Lester and Brun, 2015). IMPLAN has also been used in studies similar to this one to capture sector-wide changes in economic contribution of the forestry industry across a multi-state region (Aruna et al., 1997; Tilley and Munn, 2017a,b).

We used an economic contribution analysis method to assess the portion of a region's economy (in terms of jobs, labor income, taxes, etc.) that can be attributed to an existing business, industry, event, policy, or program. It was appropriate to conduct a multi-industry economic contribution analysis for this research since more than one industry is being examined as part of the same activity. As noted by Henderson et al. (2016) on page 112, an 'economic contribution analysis estimates the relative importance' of the existing wood industry cluster, with outputs of jobs, labor income, value added, and total output. We

build off the methods proposed by Henderson et al. (2016) for a wood products economic contribution analysis that specifically involved a two-step process. First, we organized wood industry firms into 30 distinct sectors using their NAICS codes and corresponding IMPLAN codes, and then 13 cluster group categories. Next, we conducted a multi-industry economic contribution analyses using IMPLAN and the IO methodology to determine the impact of the wood industry cluster within the 88-county State of Ohio region, and then the 32-county Appalachian Regional Commission (ARC) designated Appalachian Ohio region. These economic contributions were also split out by wood industry cluster grouping.

The 32-county Appalachian Ohio area used in our study ranges from Ashtabula County in the far Northeast, all the way to Clermont in the Southwest, as illustrated in Figure 1. Once more, we grouped the 30 distinct industry sectors into 13 related groups. While some groups inherently have more industries than others (e.g., Pulp & Paper), the group analysis approach offers the advantage of understanding how the surface-level groups are performing relative to others. These groupings are displayed in Table 1.

4. DATA ANALYSIS

This section details the results of the multi-industry economic contribution analysis of the wood industry for both the entire State of Ohio, as well as the 32 Appalachian Ohio counties as a single region. Economic contribution by sector follows the broad-level results.

As displayed in Table 2, the total economic impact, or the total output or value of production, of the wood industry in Ohio was \$24,979,730,630 in 2014. The total value-added for the industry was \$9,114,183,475, and 116,321 average annual jobs were supported. Table 2 also details the direct, indirect, induced, and total effects of the industry on Ohio, along with multipliers that indicate how many additional jobs are supported by one job in the industry. For instance, in the case of employment, each additional job in the wood industry supports 1.20 other full- or part-time positions (one must subtract one to accommodate for the additional job created). Direct jobs refer to those directly employed in the industry, indirect jobs refer to jobs in the broader supply chain, and induced jobs refer to those arising from labor income spending from direct and indirect employment.

Next, Table 3 shows the tax impacts of the wood industry in Ohio. The data shows that the jobs in this industry generated a total (i.e., direct, indirect, and induced) of \$712,477,496 of tax revenue to state and local government from all sources. Household taxes are comprised of personal income tax, motor vehicle license, non-tax fines and fees, property taxes, and other taxes. Tax on production and imports includes motor vehicle license, property tax, sales tax, severance tax, S/L non-taxes, and other taxes. Federally, \$1,327,996,130 of tax revenue is generated to the federal government. Proprietor incomes specifically generated \$32,037,042 from employee contributions, as shown below. Impacts of corporations is comprised of only profit tax, federally.

Table 4 illustrates that the total economic impact or contribution of the wood industry specific to the 32 Appalachian Ohio county region (as highlighted in Figure 1) was \$5,226,441,440 in 2014. The total value-added for the industry was \$1,655,970,972, and 26,052 average annual jobs were supported. For this geography, each additional job in the

Table 1: Ohio Wood Cluster Industry Groups

Industry Group	Sector (IMPLAN Number)
Resources	Forestry, forest products, and timber tract production (15)
Commercial Logging	Commercial logging (16)
Pulp & Paper	Pulp mills (146); Paper mills (147); Paperboard mills (148); Paperboard container manufacturing (149); Paper bag and coated treated paper manufacturing (150); Stationary product manufacturing (151); Sanitary paper product manufacturing (152); All other converted paper product manufacturing (153)
Sawmill	Sawmills (134); Cut stock, resawing lumber, and planning (140)
Wood Container & Pallet	Wood container and pallet manufacturing (142)
Engineered Wood Member & Truss	Engineered wood member and truss manufacturing (137)
Reconstituted Wood Products	Reconstituted wood product manufacturing (138)
Veneer & Plywood	Veneer and plywood manufacturing (136)
Millwork	Custom architectural woodwork and millwork (374); Wood kitchen cabinet and countertop manufacturing (368); Showcase, partition, shelving, and locker manufacturing (376); Wood windows and door manufacturing (139); Other millwork, including flooring (141); All other miscellaneous wood product manufacturing (145); Burial casket manufacturing (393)
Wood Furniture	Non-upholstered wood household furniture manufacturing (370); Institutional furniture manufacturing (372); Wood office furniture manufacturing (373)
Upholstered Household Furniture	Upholstered household furniture manufacturing (369)
Manufacturing Services	Wood preservation (135)
Manufactured Housing	Manufactured home (mobile home) manufacturing (143); Prefabricated wood building manufacturing (144)
Note: IMPLAN's old sectors combined "Sawmills and wood preservation" into one category, whereas their new sectors separate these out into "Sawmills" (134) and "Wood preservation" (135).	

industry supports 0.71 other full- or part-time positions, less than the entire State of Ohio figures suggest. Roughly one-fifth of the total economic contribution of the wood industry throughout the state comes from the Appalachian Ohio region.

Finally, Table 5 displays the tax impacts of the wood industry in Appalachian Ohio. In this instance, from all sources, the wood industry employment generated a total of \$165,893,323 of tax revenue to state and local government and an extra \$286,824,545 to the federal government.

4.1. Economic Contribution by Wood Cluster Industry Group

We also utilized the 13 industry sector groupings outlined in Table 1 to better understand the economic contribution per group. Figure 2 displays the results of the wood industry

Table 2: Contribution Summary of the Wood Industry in Ohio, 2014

Impact Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	52,890	\$3,021,033,719	\$3,555,271,892	\$14,900,770,640
Indirect Effect	30,606	\$1,858,523,976	\$3,006,423,965	\$5,669,191,289
Induced Effect	32,825	\$1,397,759,149	\$2,552,487,618	\$4,409,768,702
Total Effect	116,321	\$6,277,316,844	\$9,114,183,475	\$24,979,730,630
Multiplier	2.20	2.08	2.56	1.68

Table 3: Tax Impacts of the Wood Industry in Ohio, 2014

Total Tax	Employee Compensation	Proprietor Income	Tax on		
			Production and Imports	Households	Corporations
State and Local	\$18,543,440	\$0	\$516,114,908	\$171,500,667	\$6,318,481
Federal	\$639,018,912	\$32,037,042	\$71,637,824	\$417,072,928	\$168,229,424

Table 4: Contribution Summary of the Wood Industry in Appalachian Ohio, 2014

Impact Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	15,261	\$745,695,030	\$888,819,280	\$3,762,253,062
Indirect Effect	5,687	\$255,018,358	\$435,707,333	\$874,545,117
Induced Effect	5,106	\$172,835,099	\$331,444,360	\$589,643,261
Total Effect	26,052	\$1,173,548,489	\$1,655,970,972	\$5,226,441,440
Multiplier	1.71	1.57	1.86	1.39

Table 5: Tax Impacts of the Wood Industry in Ohio, 2014

Total Tax	Employee Compensation	Proprietor Income	Tax on		
			Production and Imports	Households	Corporations
State and Local	\$5,011,657	\$0	\$124,071,421	\$35,529,611	\$1,280,634
Federal	\$139,285,880	\$10,512,149	\$17,164,060	\$85,765,600	\$34,096,856

Figure 2: Ohio Wood Industry: Economic Contribution by Sector, 2014

contribution per group (the top five) for the entire State of Ohio. Pulp & Paper, which contains the largest number of specific industry sectors (eight), contributed the most to the state's economy, followed by Millwork, Wood Furniture, and Sawmill, respectively.

Figure 3 displays these same per-group results for the Appalachian Ohio region. Pulp & Paper also emerged here as the key economic contributor to the region, though to a lesser dollar and percentage extent. Millwork was a distant second at roughly \$850 million, and Sawmill was the third-highest contributor. The commercial logging industry group also appeared in the Appalachian Ohio analysis, suggesting that a lot of the timber extraction activity occurs in the region.

The detailed results of each of the economic contributions per the 13 industry groups, including employment, labor income, value added, and output, for all effect categories, are found in the Appesndix. Table 6 shows a higher level of detail around the industry group contributions, yet, more importantly, displays the percentage of economic impact specifically from Appalachian Ohio in each of the groups. A majority (over 50%) of the contributions from Commercial Logging, Sawmill, Manufacturing Services, and Manufactured Housing came from the Appalachian Ohio region.

Taking the labor income value and dividing by employment, we also developed wage rankings by industry grouping, both in the Ohio and Appalachian Ohio (Table 7) geographies. The Pulp & Paper industry group paid the highest wages across the board. Manufactured Housing paid the second highest wages in Appalachian Ohio. There were no individuals working in Reconstituted Wood Products in Appalachian Ohio, explaining the \$0 amount. Taken as a whole, wood industry employees made less in Appalachian Ohio compared to the entire state (\$42,539.00 compared to \$47,458.52) in 2014.

**Figure 3: Appalachian Ohio Wood Industry:
Economic Contribution by Sector, 2014**

Overall, Tables 6 and 7 reveal that the wood industries with the highest wages and most value-added contributions are concentrated outside of Appalachian Ohio (e.g., household/wood furniture manufacturing, etc.). Marcouiller et al. (1996) found that value-added wood production offers the most benefits for individuals in lower and middle-income levels, which characterizes much of the Appalachian Ohio population. To illustrate, in 2012, the region's poverty rate of 21.5% greatly outpaced the statewide rate of 16.3% (WOUB, 2015). Economic development strategies, such as capital access, workforce training, and cooperative efforts for small forestry operations and sawmills, are required to bring these value-added operations to Appalachian Ohio.

5. CONCLUSIONS

The wood industry in the State of Ohio represents a historically large, and still prominent, industry cluster, as evidenced in the nearly \$25 billion it contributes to Ohio's economy and more than 115,000 it employs per our analysis. Continual support and enhancement of this cluster may breed additional job creation and other economic development activities and benefits.

The Appalachian region of Ohio has a specific competitive advantage in high quality hardwoods, which seem to be harvested and shipped domestically elsewhere in the state and region for higher value-added and higher paying activities. For instance, no activity in the Reconstituted Wood Products group and only 16.4% of the Wood Furniture Manufacturing occurs in the 32-county Appalachian Ohio region, yet these groups pay the second and third highest wages in the state, respectively. This study helps to quantify the limited value-added

Table 6: Industry Group Contributions

	Ohio	Appalachian Ohio	Percent
Commercial Logging	\$499,834,940	\$371,170,718	74.3
Sawmill	\$1,160,438,234	\$710,990,589	61.3
Manufacturing Services	\$145,315,909	\$78,093,209	53.7
Manufactured Housing	\$189,306,422	\$100,949,049	53.3
Resources	\$14,662,813	\$4,191,772	28.6
Upholstered Household Furniture	\$130,739,782	\$36,620,096	28.0
Millwork	\$3,822,447,050	\$850,951,750	22.3
Engineered Wood Member & Truss	\$340,522,563	\$63,944,636	18.8
Wood Container & Pallet	\$1,051,159,495	\$191,148,169	18.2
Wood Furniture	\$1,552,318,899	\$255,191,266	16.4
Pulp & Paper	\$15,591,469,337	\$2,525,413,377	16.2
Veneer & Plywood	\$287,307,649	\$37,776,809	13.1
Reconstituted Wood Products	\$194,207,535	0	0.0
Total/Average	\$24,979,730,628	\$5,226,441,440	20.9

activity occurring in Appalachian Ohio, which provides additional supporting evidence for the need for cluster enhancement activities in the region. For instance, large hardwood lumber mills in the Appalachian region of the U.S. are more likely to engage in export activities (Naka et al., 2009). Naka et al. (2009) found larger lumber mills with sufficient resources for marketing, managing the export process, and manufacturing (including dry kilns) were more likely to export. The Appalachian Ohio region is largely comprised of small sawmills. Studies of softwood sawmills in the U.S. found that Southern sawmills (which are both culturally similar and geographically proximate to Appalachian Ohio) are less likely to participate in international commerce and, if they do so, use intermediate firms for exporting (Sasatani and Eastin, 2015). Building the dry kiln investments, managerial capacity, and tied to export markets are deliberate strategies of the SBA cluster approach. Economies of scale and cooperative models (e.g., a dry kiln cooperative to collectively dry hardwood lumber for furniture making and flooring) may help keep some of the higher end of the value chain impacts in the Appalachian region.

The Appalachian Ohio region has an advantage in finely crafted Amish wood manufacturing in the Ohio Mid-Eastern Governments Association region, such as in Holmes County. Enriching education about this cluster, both for potential workers as well as for policymakers and business stakeholders, may help contribute to its future growth. Workforce training for individuals and businesses may be another strategy to improve the economic competitiveness of the wood industry cluster, especially in the Appalachian part of the state. Additional technical assistance from key regional partners and economic development organizations in the region, and throughout the state, could further help wood business growth, and perhaps enlarge the number of firms exporting as traded clusters.

Overall, the wood industry cluster is a strong contributor to the State of Ohio. The Pulp & Paper and Millwork industries employ roughly 80,000 people alone, and collectively

Table 7: Wage Ranking by Industry Grouping

	Ohio	Appalachian Ohio
Pulp & Paper	\$75,642.26	\$72,730.24
Reconstituted Wood Products	\$59,361.24	\$0.00
Wood Furniture	\$50,178.63	\$38,950.07
Commercial Logging	\$49,175.80	\$49,006.02
Resources	\$49,011.56	\$23,819.97
Manufactured Housing	\$48,322.84	\$54,226.57
Millwork	\$47,846.73	\$42,663.18
Engineered Wood Member & Truss	\$43,906.88	\$45,602.60
Veneer & Plywood	\$43,607.88	\$48,616.76
Wood Container & Pallet	\$40,069.77	\$35,715.92
Sawmill	\$38,243.27	\$37,886.36
Upholstered Household Furniture	\$36,571.63	\$30,276.91
Manufacturing Services	\$35,022.27	\$30,973.40
Average	\$47,458.52	\$42,539.00

contribute over \$19 billion to the states economy. Informed stakeholders in the heavily forested Appalachian region of Ohio should strive to retain and grow the regional workforce in this cluster to meet future demands of the industry. Certain strategies may be able to help improve investment and value-added industry opportunities in the Appalachian wood cluster by attracting more household and wood products manufacturing firms. Understanding, supporting, and enhancing the wood products industry cluster will help strengthen the state and region's economic, labor force, and overall development opportunities. Integrated and innovative strategies in Ohio's wood products cluster, as part of a diversified local economy strategy, can mitigate the pending departure of the natural gas and coal industries and ensure that capital investments and workforce training programs continue to augment the socio-economic welfare of those living in the Appalachian region of the state.

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APPENDIX: Detailed Economic Contribution by Wood Cluster Industry Group**RESOURCES****OHIO**

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	81	\$3,969,936	\$4,240,413	\$8,172,894
Indirect Effect	34	\$908,917	\$1,279,557	\$2,167,478
Induced Effect	32	\$1,370,597	\$2,501,566	\$4,322,441
Total Effect	147	\$6,249,451	\$8,021,536	\$14,662,813
Multiplier	1.81	1.57	1.89	1.79

APPALACHIAN OHIO

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	35	\$833,699	\$994,158	\$2,673,037
Indirect Effect	24	\$318,787	\$429,142	\$838,173
Induced Effect	6	\$199,374	\$382,613	\$680,562
Total Effect	65	\$1,351,861	\$1,805,912	\$4,191,772
Multiplier	1.86	1.62	1.82	1.57

COMMERCIAL LOGGING**OHIO**

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	3,093	\$152,100,742	\$163,571,495	\$294,589,264
Indirect Effect	405	\$18,573,207	\$30,616,554	\$54,241,793
Induced Effect	1,129	\$47,882,961	\$87,390,918	\$151,003,883
Total Effect	4,626	\$218,556,911	\$281,578,967	\$499,834,940
Multiplier	1.50	1.44	1.72	1.70

APPALACHIAN OHIO

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	2,676	\$131,140,101	\$140,946,540	\$254,329,300
Indirect Effect	409	\$11,110,734	\$16,976,721	\$32,431,637
Induced Effect	733	\$24,707,812	\$47,466,588	\$84,409,781
Total Effect	3,818	\$166,958,647	\$205,389,849	\$371,170,718
Multiplier	1.43	1.27	1.46	1.46

PULP & PAPER**OHIO**

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	19,678	\$1,488,488,340	\$1,871,628,902	\$9,558,322,826
Indirect Effect	18,908	\$1,169,007,118	\$1,907,068,436	\$3,626,614,723
Induced Effect	17,910	\$762,779,286	\$1,392,975,604	\$2,406,531,788
Total Effect	56,516	\$3,420,274,743	\$5,171,672,943	\$15,591,469,337
Multiplier	2.87	2.30	2.76	1.63

APPALACHIAN OHIO

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	3,279	\$238,482,445	\$322,006,855	\$1,851,514,280
Indirect Effect	2,586	\$125,496,018	\$224,460,270	\$459,373,719
Induced Effect	1,856	\$62,897,914	\$120,577,630	\$214,525,378
Total Effect	7,722	\$426,876,377	\$667,044,755	\$2,525,413,377
Multiplier	2.35	1.79	2.07	1.36

SAWMILL**OHIO**

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	2,737	\$104,671,838	\$122,421,617	\$674,276,245
Indirect Effect	1,692	\$102,878,122	\$166,830,752	\$298,942,919
Induced Effect	1,394	\$59,343,348	\$108,366,541	\$187,219,070
Total Effect	5,823	\$266,893,308	\$397,618,910	\$1,160,438,234
Multiplier	2.13	2.55	3.25	1.72

APPALACHIAN OHIO

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	2,055	\$77,856,470	\$92,240,895	\$506,027,389
Indirect Effect	885	\$41,090,592	\$69,362,806	\$135,031,081
Induced Effect	605	\$20,502,407	\$39,307,293	\$69,932,119
Total Effect	3,545	\$139,449,469	\$200,910,994	\$710,990,589
Multiplier	1.73	1.79	2.18	1.41

WOOD CONTAINER & PALLET

OHIO

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	4,636	\$185,763,468	\$201,462,100	\$597,810,303
Indirect Effect	1,155	\$73,218,257	\$116,869,045	\$219,562,332
Induced Effect	1,740	\$74,103,044	\$135,321,750	\$233,786,859
Total Effect	7,531	\$333,084,769	\$453,652,896	\$1,051,159,495
Multiplier	1.62	1.79	2.25	1.76

APPALACHIAN OHIO

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	1,096	\$39,144,651	\$42,672,361	\$136,388,779
Indirect Effect	174	\$8,194,248	\$13,351,775	\$26,934,009
Induced Effect	241	\$8,158,071	\$15,639,840	\$27,825,381
Total Effect	1,510	\$55,496,970	\$71,663,976	\$191,148,169
Multiplier	1.38	1.42	1.68	1.40

ENGINEERED WOOD MEMBER & TRUSS

OHIO

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	1,071	\$47,024,267	\$51,012,756	\$193,921,371
Indirect Effect	456	\$28,376,274	\$43,885,627	\$78,503,314
Induced Effect	507	\$21,584,642	\$39,416,939	\$68,097,879
Total Effect	2,034	\$96,985,184	\$134,315,323	\$340,522,563
Multiplier	1.90	2.06	2.63	1.76

APPALACHIAN OHIO

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	249	\$11,355,048	\$12,281,394	\$45,458,122
Indirect Effect	69	\$3,196,214	\$5,106,628	\$9,934,120
Induced Effect	74	\$2,507,490	\$4,807,036	\$8,552,394
Total Effect	392	\$17,058,752	\$22,195,058	\$63,944,636
Multiplier	1.57	1.50	1.81	1.41

RECONSTITUTED WOOD PRODUCTS

OHIO

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	244	\$14,484,143	\$21,234,990	\$119,264,259
Indirect Effect	208	\$12,879,229	\$23,970,348	\$50,231,389
Induced Effect	184	\$7,832,810	\$14,303,920	\$24,711,887
Total Effect	636	\$35,196,182	\$59,509,257	\$194,207,535
Multiplier	2.61	2.43	2.80	1.63

APPALACHIAN OHIO

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	0	\$0	\$0	\$0
Indirect Effect	0	\$0	\$0	\$0
Induced Effect	0	\$0	\$0	\$0
Total Effect	30	\$0	\$0	\$0
Multiplier	0.00	0.00	0.00	0.00

VENEER & PLYWOOD

OHIO

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	637	\$27,778,218	\$33,617,747	\$165,481,750
Indirect Effect	381	\$24,277,270	\$40,079,294	\$74,798,987
Induced Effect	350	\$14,905,797	\$27,220,541	\$47,026,912
Total Effect	1,367	\$66,961,286	\$100,917,582	\$287,307,649
Multiplier	2.15	2.41	3.00	1.74

APPALACHIAN OHIO

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	101	\$4,910,293	\$5,844,823	\$26,699,638
Indirect Effect	41	\$1,972,813	\$3,506,653	\$7,028,870
Induced Effect	35	\$1,186,786	\$2,275,503	\$4,048,301
Total Effect	177	\$8,069,892	\$11,626,979	\$37,776,809
Multiplier	1.75	1.64	1.99	1.41

MILLWORK

OHIO

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	13,445	\$643,299,303	\$702,652,185	\$2,150,113,339
Indirect Effect	4,928	\$284,509,850	\$445,639,809	\$834,480,880
Induced Effect	6,236	\$265,571,245	\$484,971,608	\$837,852,832
Total Effect	24,610	\$1,193,380,398	\$1,633,263,602	\$3,822,447,050
Multiplier	1.83	1.86	2.32	1.78

APPALACHIAN OHIO

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	3,651	\$155,763,274	\$175,614,925	\$601,720,253
Indirect Effect	991	\$41,925,591	\$66,939,320	\$133,038,496
Induced Effect	1,005	\$34,066,787	\$65,308,505	\$116,193,001
Total Effect	5,647	\$231,755,652	\$307,862,750	\$850,951,750
Multiplier	1.55	1.49	1.75	1.41

WOOD FURNITURE

OHIO

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	5,969	\$299,516,233	\$320,932,448	\$864,693,909
Indirect Effect	1,830	\$107,161,467	\$171,410,100	\$320,254,750
Induced Effect	2,734	\$116,443,147	\$212,644,342	\$367,370,240
Total Effect	10,533	\$523,120,846	\$704,986,890	\$1,552,318,899
Multiplier	1.76	1.75	2.20	1.80

APPALACHIAN OHIO

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	1,416	\$55,153,298	\$59,504,693	\$179,108,702
Indirect Effect	276	\$11,364,098	\$18,787,575	\$36,951,357
Induced Effect	339	\$11,471,147	\$21,995,438	\$39,131,207
Total Effect	2,031	\$77,988,544	\$100,287,706	\$255,191,266
Multiplier	1.43	1.41	1.69	1.42

UPHOLSTERED HOUSEHOLD FURNITURE

OHIO

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	445	\$16,274,375	\$17,231,485	\$76,905,029
Indirect Effect	155	\$9,697,856	\$16,086,009	\$30,380,334
Induced Effect	175	\$7,434,255	\$13,576,050	\$23,454,418
Total Effect	774	\$33,406,486	\$46,893,543	\$130,739,782
Multiplier	1.74	2.05	2.72	1.70

APPALACHIAN OHIO

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	162	\$4,904,860	\$5,210,311	\$26,912,296
Indirect Effect	36	\$1,682,966	\$2,884,313	\$5,834,291
Induced Effect	34	\$1,135,607	\$2,177,220	\$3,873,509
Total Effect	231	\$7,723,433	\$10,271,844	\$36,620,096
Multiplier	1.43	1.57	1.97	1.36

MANUFACTURING SERVICES

OHIO

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	202	\$7,074,498	\$9,595,163	\$86,357,620
Indirect Effect	220	\$13,654,890	\$22,238,477	\$40,268,084
Induced Effect	139	\$5,924,340	\$10,818,265	\$18,690,205
Total Effect	561	\$26,653,728	\$42,651,905	\$145,315,909
Multiplier	2.78	3.77	4.45	1.68

APPALACHIAN OHIO

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	137	\$4,243,356	\$5,906,316	\$57,789,169
Indirect Effect	100	\$4,715,623	\$7,784,187	\$15,033,481
Induced Effect	46	\$1,545,032	\$2,962,558	\$5,270,559
Total Effect	282	\$10,504,012	\$16,653,061	\$78,093,209
Multiplier	2.06	2.48	2.82	1.35

MANUFACTURED HOUSING					
OHIO					
Impact Type	Employment	Labor Income	Value Added	Output	
Direct Effect	633	\$30,588,358	\$35,670,591	\$110,861,831	
Indirect Effect	235	\$13,381,517	\$20,449,955	\$38,744,305	
Induced Effect	296	\$12,583,676	\$22,979,572	\$39,700,286	
Total Effect	1,162	\$56,553,552	\$79,100,118	\$189,306,422	
Multiplier	1.84	1.85	2.22	1.71	
APPALACHIAN OHIO					
Impact Type	Employment	Labor Income	Value Added	Output	
Direct Effect	404	\$21,907,535	\$25,596,009	\$73,632,097	
Indirect Effect	96	\$3,950,674	\$6,117,943	\$12,115,883	
Induced Effect	132	\$4,456,672	\$8,544,136	\$15,201,069	
Total Effect	632	\$30,314,880	\$40,258,088	\$100,949,049	
Multiplier	1.56	1.38	1.57	1.37	