JOURNAL OF FOREST BUSINESS RESEARCH

Peer-reviewed research article

Journal of Forest Business Research 5(1), 32-60, 2026

Post-pandemic structural change in West Virginia forest products industry: Evidence from 2019-2024 IMPLAN data

Kathryn Gazal, [a,*] Jason Hubbart, [a] John Deskins, [a] Ben Spong [a]

a: West Virginia University, Davis College of Agriculture and Natural Resources, Morgantown, WV, USA.

**Corresponding author: E-mail: Kathryn.Arano@mail.wvu.edu*

Keywords

economic contribution analysis, forest products industry, IMPLAN, input-output model, labor productivity

Citation

Gazal K, Hubbart J, Deskins J, Spong B. 2026. Post-pandemic structural change in West Virginia forest products industry: Evidence from 2019-2024 IMPLAN data. J.For.Bus.Res. 5(1): 32-60. https://doi.org/10.62320/jfbr.v5i1.91

Received: 10 April 2026
Accepted: 10 May 2026
Published: 12 June 2026

Copyright: © 2026 by the authors.

Licensee Forest Business Analytics, Łódź, Poland. This open access article is distributed under a Creative Commons Attribution 4.0 International License (CC BY).

ABSTRACT

The forest products industry (FPI) is a key component of West Virginia's economy, yet its response to the COVID-19 pandemic and subsequent recovery remains only partially understood. This study examines the economic contributions and structural evolution of West Virginia's FPI from 2019 to 2024 using IMPLAN input–output analysis. Economic contributions are evaluated in terms of employment, output, value added, and labor income across seven major sectors spanning upstream (forestry and logging) and downstream (wood manufacturing, furniture, and paper-related industries) activities. Results indicate that the industry experienced a strong post-pandemic recovery in output and value added, exceeding pre-pandemic levels by 2022–2023, while employment continued to decline through 2024. Direct employment decreased by 18.3%, whereas direct value added increased by approximately 36%, accompanied by substantial gains in labor productivity. These trends suggest a structural shift toward more capital-intensive and efficiency-driven production. Sector-level analysis reveals divergent trajectories across the value chain. Downstream sectors, particularly primary and secondary solid wood products, drove growth and productivity gains, while upstream sectors exhibited persistent contraction, raising concerns about long-term supply chain capacity. Paper-related industries showed high productivity but declining economic scale, reflecting ongoing structural changes in product demand. Overall, the findings indicate that the post-pandemic evolution of the FPI reflects structural reorganization rather than a simple return to pre-pandemic conditions. The results highlight the importance of supporting both downstream innovation and upstream capacity, as well as workforce development, to sustain long-term competitiveness in the industry.

INTRODUCTION

The forest products industry (FPI) plays a critical role in West Virginia's economy. Located within the Appalachian region of the eastern United States (Figure 1), West Virginia accounted for approximately 0.36% of total U.S. gross domestic product (GDP) in 2025 (U.S. Bureau of Economic Analysis 2026).

Figure 1. Geographic location of West Virginia , USA (Source: Adapted from WorldAtlas.com).

The state contains more than 12 million acres[1] of forestland covering approximately 78 percent of the state (USDA Forest Service 2021). West Virginia is among the most heavily forested states in the United States and supports a diverse forest-based economy. In 2018, based on a survey of primary wood-using mills, the state produced 138,701 thousand cubic feet[2] (MCF) of timber products (USDA Forest Service 2024). The state is also the second leading hardwood producer in the U.S., with approximately 75 billion board feet[3] of timber inventory (West Virginia Economic Development 2021). Forest products manufacturing and related activities generate employment and income across all 55 counties and contributed approximately 15,000 jobs in 2022 (Gazal et al.

[1] One acre is equal to ca. 0.405 hectares.
[2] 1 MCF is approximately 28.3168 cubic meters (m^3).
[3] One board foot (BF) is a unit of volume in the lumber industry measuring 1 foot by 1 foot by 1 inch. 1BF is equal to 0.00236 m^3

2024). The industry also serves as a key source of exports for the state, and yields a wide range of products, including lumber, flooring, furniture, paper products, and other value-added wood materials. As a result, the performance of the forest products industry has important implications for economic development, particularly in rural communities where forestry-related employment remains an important source of livelihood.

The forest products industry is also an important economic driver at the global and national levels, generating substantial employment, value added, and economic activity throughout supply chains. Globally, the forest sector directly employs more than 18 million people and supports over 45 million jobs in total (Li et al. 2019). Direct value added from the sector exceeds US$539 billion, with total contributions to global gross domestic product estimated at approximately US$1.3 trillion. These figures highlight the substantial multiplier effects generated by forest-based industries and their broader role in supporting economic activity across related sectors. In the United States, the forest products industry likewise represents a significant component of regional and national economies. The FPI generates more than half a trillion dollars in forest products output. When accounting for broader economic effects, the industry supports over 3.84 million jobs and contributes approximately US$290 billion in annual payroll (Poudel and Dahal 2025).

The forest products industry has historically been sensitive to major economic disruptions and structural changes in the broader economy. Previous studies have documented how global competition, technological change, and shifts in housing markets have influenced the performance of forest-based industries in the United States and globally (Woodall et al. 2012, Stordal et al. 2021, Kuzman et al. 2022). Economic downturns, such as the Great Recession, led to substantial declines in production and employment across many forest product sectors, particularly those linked to construction and housing markets. In West Virginia, earlier research has shown that the forest products industry has experienced significant fluctuations in economic contributions over time due to macroeconomic events, market changes, and evolving industry structure (Gabbert et al. 2020). For example, between 2006 and 2010, the industry's direct economic contributions declined by more than 35%, largely as a result of the 2008 housing market collapse.

More recently, the COVID-19 pandemic delivered a major economic shock, disrupting global supply chains, altering consumer demand patterns, and triggering labor shortages across many sectors of the economy. Recent studies have examined the pandemic's economic impacts on the

forest products industry, given the sector's significant role in regional and national economies and its vulnerability to global disruptions (Gazal et al. 2024, Jayasundara et al. 2024). Studies examining the effects of the pandemic on the forest sector have reported mixed impacts across industry segments. Some sectors experienced supply chain disruptions, labor shortages, and production slowdowns, while others benefited from increased demand associated with home improvement activities, packaging materials, and hygiene-related products (Conrad et al. 2024, FAO 2020, Gagnon et al. 2022, Prestemon 2022, Stanturf and Mansuy 2021). Empirical research in the United States has also shown that although the pandemic initially disrupted forest product supply chains, the sector demonstrated considerable resilience due to strong consumer demand and its designation as an essential industry (Chizmar et al. 2024).

Recent national-level analyses suggest that the forest products industry has shown resilience amid economic shocks. In the United States, total value added from forest products increased by approximately 14.5 percent from the pre-COVID period to 2022, even as direct employment declined slightly (Poudel and Dahal 2025), indicating increasing productivity and structural change in the sector. The pandemic's effects on product demand, pricing volatility, and labor availability have underscored the sector's economic significance and sensitivity to market disruptions (Deb et al. 2023, Prestemon 2022). Despite the growing body of research, an important knowledge gap remains regarding the comprehensive economic impacts of COVID-19 on the FPI, particularly regarding longer-term recovery patterns and potential structural changes within the sector. Furthermore, contrasting findings regarding price volatility and supply chain disruptions highlight ongoing debates about the magnitude and duration of the pandemic's impact on the sector.

Recent research focusing specifically on West Virginia examined trends in the state's forest products industry during the COVID-19 period by analyzing economic contributions from 2019 through 2022 (Gazal et al. 2024). The industry experienced declines across several economic indicators during the pandemic's peak in 2020, particularly in output and employment. However, recovery began quickly, with improvements observed in output and value added by 2021 and continuing into 2022. While these changes coincided with the economic disruptions associated with the COVID-19 period, broader macroeconomic conditions, supply chain disruptions, labor shortages, technological change, and evolving market dynamics may also have influenced industry performance during this time. Despite improvements in output and value added, employment

levels remained below pre-pandemic levels, suggesting possible structural adjustments within the industry.

Although early recovery patterns have been documented, less is known about how the industry has performed in the years following the initial post-pandemic rebound. This study extends earlier work by examining the economic contributions of West Virginia's FPI using IMPLAN data through 2024, allowing for an assessment of whether the industry's recovery has continued and whether longer-term structural changes have emerged following the COVID-19 pandemic. In many industries, the pandemic accelerated longer-term structural trends including automation, digitalization, and supply chain restructuring (Kuzman et al. 2022). In the forest products industry, these changes may influence employment patterns, productivity, and the distribution of economic activity across upstream and downstream sectors. Understanding whether the forest products industry has continued to recover or has transitioned into new structural trends is therefore important for policymakers, industry stakeholders, and researchers interested in the long-term competitiveness of the forest sector.

This study extends previous research on the economic contributions of West Virginia's FPI in several important ways. First, it incorporates newly available IMPLAN data through 2024, reallowing for a more comprehensive assessment of the industry's post-pandemic trajectory. Second, the study explicitly examines differences between upstream and downstream sectors within the forest products industry. Third, this study provides updated sector-specific recovery patterns and structural changes across the forest products value chain. Finally, the study examines labor productivity within West Virginia's FPI, providing additional insight into how economic output and workforce dynamics have evolved across sectors over time. These analyses provide a clearer understanding of the changing structure and economic role of forest-based industries in regional economic development.

Using IMPLAN data from 2019 through 2024, the study addresses the following research questions:

1. How have the industry's economic contributions evolved from the pre-pandemic period through 2024? And,
2. What sector-level trends emerged during the post-pandemic recovery?

DATA AND METHODS

Economic contribution analysis and IMPLAN

Input–output (I–O) analysis is widely used to estimate the economic contribution of industries within regional economies. Originally developed by Wassily Leontief in the 1930s, I–O models describe the economic relationships among industries by capturing how sectors both supply inputs to and demand inputs from one another (Miller and Blair 2009). These interindustry linkages allow researchers to trace how economic activity in one sector generates additional economic activity throughout the broader economy. By quantifying these relationships, I–O models can estimate the level of production required across industries to satisfy final demand for goods and services (Berman and Plemmons 1979).

This study uses IMPLAN (Impact Analysis for Planning), a widely applied I–O modeling system, to estimate the economic contributions of the forest products industry in West Virginia. IMPLAN enables researchers to construct regional economic models and evaluate the economic effects associated with existing industries, policy changes, or other economic events within a defined geographic region. The modeling framework is based on a Social Accounting Matrix (SAM), which extends the traditional I–O framework by incorporating both market transactions among industries and institutional transactions involving households, governments, and other entities (Nealy 2023). By accounting for these institutional relationships, the SAM framework captures not only the interindustry effects generated through supply chains but also the economic activity resulting from households' and other institutions' income spending.

Economic contributions estimated using IMPLAN are reported as direct, indirect, and induced effects. Direct effects represent the economic activity generated by the industry itself as it produces goods and services to meet final demand. Indirect effects reflect economic activity generated by supplier industries that provide inputs to the primary industry. Induced effects arise from household spending of income earned by employees and business owners in both the direct and indirect industries. The sum of these three components represents the industry's total economic contribution to the regional economy.

Economic contributions in this study are reported using four commonly applied measures:

- Employment – The number of full-time and part-time jobs supported by the industry.
- Labor Income – Total wages, salaries, and benefits paid to workers, including payroll taxes (includes social security and employment taxes).
- Output – The total value of production or sales generated by the industry within the region.
- Value Added – The contribution of the industry to gross regional product, calculated as the difference between industry output and the cost of intermediate inputs. Value added consists of employee compensation, proprietor income, indirect business taxes, and other property-type income.

Data

State-level IMPLAN datasets for West Virginia were used in this study. The analysis incorporates data for 2019 through 2024 to examine changes in the economic contributions of the forest products industry before, during, and after the COVID-19 pandemic. The 2019 data represent pre-pandemic conditions, while the 2020 dataset reflects the initial economic disruptions associated with the pandemic. However, caution should be taken when interpreting and comparing economic data with other years due to the unprecedented structural disruptions associated with the pandemic, including changes in household spending, government stimulus programs, industry shutdowns, and labor market adjustments (IMPLAN 2021). Subsequent years capture the recovery and post-pandemic period. Extending the analysis to include data through 2024 provides a more comprehensive assessment of the forest products industry's trajectory beyond the immediate pandemic disruption. While our earlier study largely focused on the initial impacts of COVID-19 and the early stages of recovery, the inclusion of additional years allows for evaluation of whether the industry's recovery has continued and whether longer-term structural adjustments have emerged. Compared with previous analyses that examined the economic contributions of West Virginia's forest products industry through 2022, the expanded dataset enables a more complete assessment of post-pandemic trends in employment, output, value added, and labor income across the forest products value chain.

IMPLAN's national data are primarily derived from the Bureau of Economic Analysis (BEA) benchmark input (i.e., output tables and other federal economic datasets).

Analysis

The economic contributions of the West Virginia forest products industry were estimated using the cloud-based IMPLAN modeling platform. Specifically, the industry contribution analysis function was used to measure the economic activity generated by the industry and its associated supply chain linkages within the state economy. This approach estimates the magnitude of economic activity attributable to an existing industry within a defined region. The West Virginia forest products industry was represented by seven major sectors:

1. forestry;
2. logging;
3. primary solid wood products manufacturing;
4. secondary solid wood products manufacturing;
5. wood furniture manufacturing;
6. pulp, paper, and paperboard manufacturing; and
7. secondary paperboard and other paper products manufacturing.

These sector classifications follow those used in prior studies of the West Virginia FPI (Gabbert et al. 2020, Gazal et al. 2024) and are consistent with broader industry definitions proposed in the literature (Joshi et al. 2017). Each sector's definition corresponds to specific IMPLAN industry codes, largely aligned with the NAICS-based definitions. The seven categories were constructed by aggregating thirty individual IMPLAN sectors representing forest-based production and manufacturing activities (Table 1). Consistent with the approach used by Gabbert et al. (2020), Sector 19 (support activities for agriculture and forestry) was adjusted to include only forestry-related activities. The seven sectors were also grouped in the context to their position in the forest products value chain. Forestry and logging were classified as upstream sectors, representing raw material production and extraction, while all remaining sectors were classified as downstream, reflecting processing and manufacturing activities that convert raw timber into higher-value products.

Table 1. FPI major sectors included in IMPLAN analysis. Model sector abbreviations and IMPLAN sector numbers are in parentheses.

FPI Model Sectors	2024 IMPLAN Sectors
Upstream Sectors	
Forestry (F)	(15) Forestry, forest products, and timber tract production; (19) Support activities for agriculture and forestry
Logging (L)	(16) Commercial logging
Downstream Sectors	
Primary Solid Wood Products (PSWP)	(124) Sawmills; (125) Wood preservation; (126) Veneer and plywood mfg.; (128) Reconstituted wood product mfg.
Secondary Solid Wood Products (SSWP)	(127) Engineered wood member and truss mfg.; (129) Wood windows and doors mfg.; (130) Cut stock, resawing lumber, and planing; (131) Other millwork, including flooring; (132) Wood container and pallet mfg.; (133) Manufactured home (mobile home) mfg.; (134) Prefabricated wood building manufacturing (135) All other miscellaneous wood product mfg.
Wood Furniture (WF)	(348) Wood kitchen cabinet and countertop mfg.; (349) Upholstered household furniture mfg.; (350) Non-upholstered wood household furniture mfg.; (352) Institutional wood furniture mfg.; (353) Wood office furniture mfg.; (354) Custom architectural woodwork and millwork mfg.; (356) Showcase, partition, shelving, and locker mfg.
Pulp, Paper, and Paperboard (PPP)	(136) Pulp mills; (137) Paper mills; (138) Paperboard mills.
Secondary Paperboard and other Paper Products (SPOP)	(139) Paperboard container mfg.; (140) Paper bag and coated and treated paper mfg.; (141) Stationery product mfg.; (142) Sanitary paper product mfg.; (143) All other converted paper product mfg.

The analysis was conducted using the cloud-based IMPLAN platform. Economic contributions were estimated using IMPLAN's built-in industry contribution analysis function, which evaluates the economic role of an industry or group of industries within a regional economy by capturing backward inter-industry linkages. Unlike traditional economic impact analysis, contribution analysis estimates the relative magnitude and economic significance of existing industries within the study area (IMPLAN 2023). Calculations followed Method 1 described by Parajuli et al. (2018) for conducting economic contribution analyses. Economic contributions were estimated for each of the seven major sectors individually, as well as for the forest products industry (FPI) as a whole. Because separate industry contribution analyses were conducted for each sector, the resulting estimates are not additive. Summing sector-level contributions would lead to double-counting of inter-industry linkages captured within IMPLAN's input–output framework. Therefore, total FPI contributions are reported independently and should not be interpreted as the sum of individual sector estimates. All economic values are reported in 2026 constant U.S. dollars, and results are presented in terms of employment, output, labor income, and value added.

To provide additional insights into industry structural change, supplementary indicators were calculated. Labor productivity was approximated using value added per worker, calculated as the ratio of direct value added (GDP contribution) to direct employment. This measure is commonly used in productivity and structural change analyses as a proxy for labor productivity (Azenui et al. 2025, BenDor et al. 2015, Herrendorf et al. 2022, Pelkki and Guitierrez, n.d.).

RESULTS

Overview of FPI trends

The economic contribution of West Virginia's FPI is presented in Table 2. Results indicate a post-pandemic recovery characterized by increasing output and value added alongside declining employment.

Table 2. Economic contribution of the WV FPI: 2019-2024. Dollar amounts reported in 2026 constant dollars.

Contribution Type	2019	2020	2021	2022	2023	2024
Direct						
Employment	9,545	8,867	9,172	9,127	8,506	7,798
Output ($MM)	2,112	1,907	2,276	2,995	2,956	2,736
Value Added ($MM)	611	597	848	940	943	830
Labor Income ($MM)	546	536	525	529	520	531
Total						
Employment	15,591	14,304	14,319	15,120	13,759	13,143
Output ($MM)	3,133	2,800	3,152	4,127	4,014	3,835
Value Added ($MM)	1,142	1,066	1,299	1,513	1,526	1,433
Labor Income ($MM)	858	828	791	854	846	860

Direct employment declined steadily from 9,545 jobs in 2019 to 7,798 in 2024, representing an 18.3% reduction over the study period. The most notable decline occurred after 2022, indicating that employment losses persisted even as broader economic conditions in WV improved. In contrast, direct output increased from $2.11 billion in 2019 to a peak of $2.99 billion in 2022, before slightly decreasing to $2.74 billion in 2024. Despite this slight decline after 2022, output levels in 2024 remained substantially higher than pre-pandemic levels. A similar pattern is observed for direct value added, which increased from $610.9 million in 2019 to $940.1 million in 2022 and remained elevated at $943.0 million in 2023 before declining to $830.3 million in 2024. This represents an overall increase of approximately 36% relative to 2019. In contrast, direct labor income remained relatively stable over the period, fluctuating within a narrower range, from $545.7 million in 2019 to $531.4 million in 2024.

In terms of total effect, which consists of direct, indirect, and induced effects, similar trends emerge. The FPI's total employment impact declined from 15,591 jobs in 2019 to 13,143 in 2024 (–15.7%), with a temporary increase in 2022 before resuming its downward trend. The total output impact increased from $3.13 billion in 2019 to $4.13 billion in 2022, followed by a modest decline to $3.84 billion in 2024. The total value added impact rose from $1.14 billion in 2019 to a peak of $1.53 billion in 2023 and remained relatively close to the 2023 value in 2024. Total labor income

followed a relatively stable trajectory, declining slightly between 2019 and 2021 before increasing to $865.0 million in 2024.

Direct value added per worker in West Virginia's forest products industry shows a clear upward trend over the 2019–2023 period, followed by a modest decline in 2024 (Figure 2). Productivity increased from approximately $63,000 per worker in 2019 to over $110,000 in 2023, indicating substantial gains in output generated per employee. The most notable increase occurred between 2020 and 2021, suggesting a period of rapid adjustment and efficiency gains following the initial impacts of the COVID-19 pandemic. Despite a slight dip in 2024, productivity levels remained well above pre-pandemic levels. This pattern aligns with broader sectoral trends, in which output and value added recovered more quickly than employment.

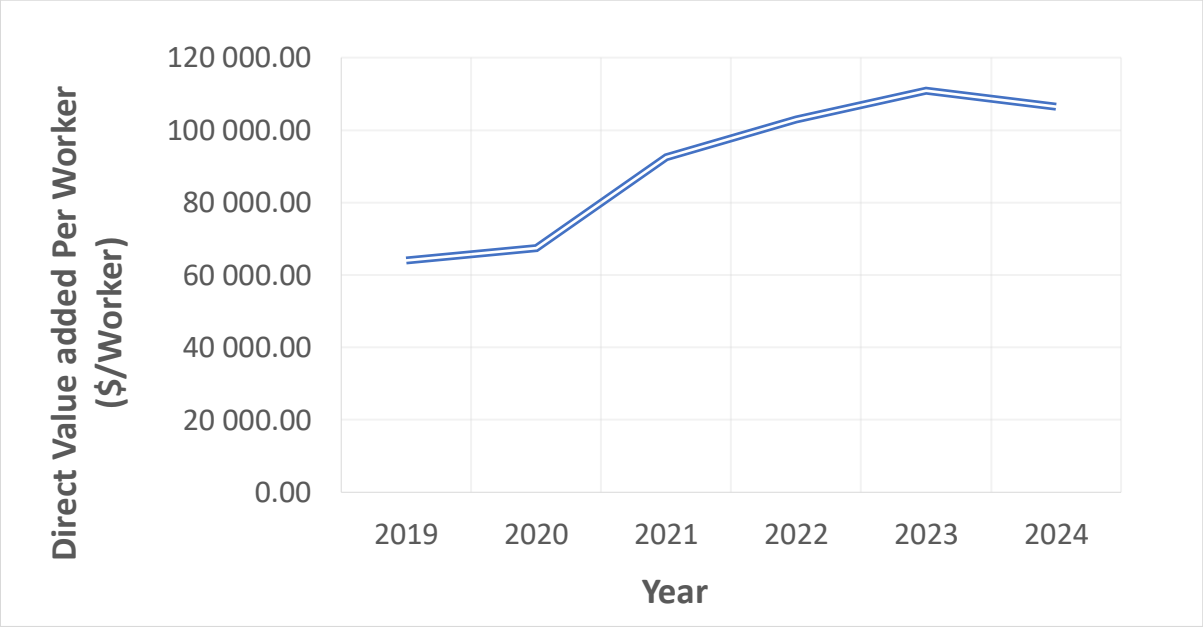

Figure 2. Labor productivity in WV's FPI as measured by direct value added per worker, 2019-2024.

Upstream sectors

The economic contributions of the upstream sectors, comprising forestry (F) and logging (L), are presented in Table 3. Overall, the results indicate that upstream activities experienced persistent employment contraction alongside fluctuating output and value added, reflecting structural challenges in the resource extraction segment of the forest products value chain.

Table 3. Economic contribution of the FPI upstream sectors: 2019-2024. Dollar amounts reported in 2026 constant dollars.

Year and Sector	Output ($MM)		Employment		Value Added ($MM)		Labor Income ($MM)	
	Direct	Total	Direct	Total	Direct	Total	Direct	Total
2019								
F	36	62.0	996	1,160	27	41	33	41
L	163	302	1,551	3,091	110	189	135	185
2020								
F	25	43	923	1,036	23	33	30	35
L	160	272	1,444	2,835	113	159	117	159
2021								
F	30	53	987	1,130	26	39	34	41
L	150	260	1,450	2,809	97	140	98	140
2022								
F	39	63	910	1,054	32	45	33	40
L	152	256	1,406	2,562	98	125	89	125
2023								
F	24	38	738	814	21	31	21	25
L	133	194	1,303	1,721	128	165	93	113
2024								
F	28	45	733	827	27	38	27	32
L	127	212	1,145	1,852	107	158	103	132

Logging accounted for the majority of upstream economic activity. In 2019, logging generated $163.1 million in direct output, compared to $36.5 million in forestry, and supported 1,551 direct jobs, compared to 996 in forestry. This pattern remained consistent throughout the study period, with logging contributing approximately four to five times more output than forestry.

Both sectors experienced notable declines following 2019. In forestry, direct output decreased from $36.5 million in 2019 to $25.2 million in 2020 before recovering to $39.0 million in 2022 and declining again to $27.6 million in 2024. Direct employment followed a downward trend, falling from 996 jobs in 2019 to 733 jobs in 2024 (–26.4%). Direct value added exhibited similar

variability, increasing to $32.0 million in 2022 before declining to $20.9 million in 2023 and partially recovering to $26.7 million in 2024. Total effects mirrored these patterns, with total output declining from $62.0 million in 2019 to $44.7 million in 2024 and total employment decreasing from 1,160 to 827 jobs.

The logging sector exhibited a more consistent decline in output and employment, although value added fluctuated more substantially. Direct output decreased from $163.1 million in 2019 to $127.5 million in 2024, while direct employment declined from 1,551 to 1,145 jobs (–26.2%). Total direct output followed a similar trajectory, declining from $301.9 million in 2019 to $212.2 million in 2024. Despite this contraction, direct value added increased to $127.7 million in 2023, then declined to $107.1 million in 2024, suggesting short-term gains in efficiency or market conditions. Labor income in logging declined from $134.7 million in 2019 to $103.2 million in 2024, although temporary increases were observed in 2023.

Labor productivity trends for the upstream sectors are presented in Figure 3.

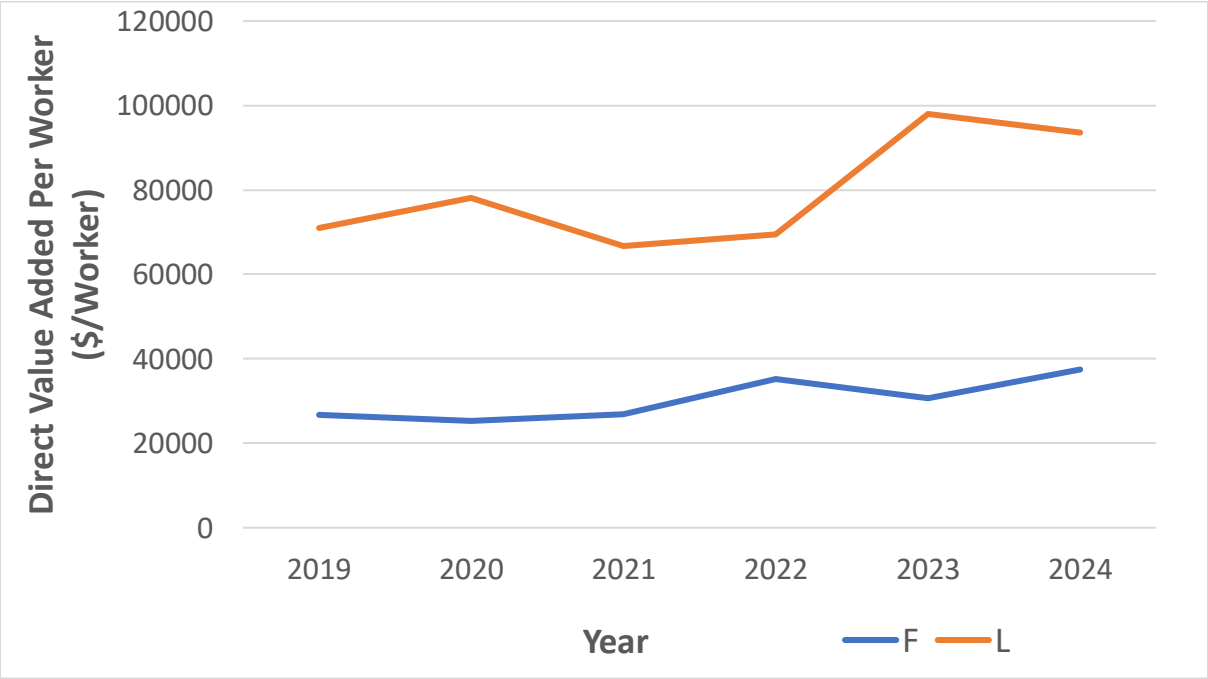

Figure 3. Labor productivity in WV's FPI upstream sectors as measured by direct value added per worker, 2019-2024.

Overall, both forestry (F) and logging (L) exhibited increases in productivity over the study period, although the magnitude and consistency of these gains differed substantially between the two sectors. Forestry maintained the lowest productivity levels throughout the period. Direct value

added per worker fluctuated within a relatively narrow range, increasing from approximately $26,700 per worker in 2019 to $35,200 in 2022, before declining slightly in 2023 and reaching $37,500 in 2024. These modest gains suggest gradual improvements in efficiency. In contrast, logging consistently exhibited higher productivity levels, though with greater variability over time. Productivity increased from approximately $70,900 per worker in 2019 to $78,100 in 2020, before declining to $66,700 in 2021. Following this dip, productivity rose steadily, reaching a peak of nearly $98,000 per worker in 2023 before declining slightly to $93,500 in 2024.

Downstream sectors

Economic contributions of the downstream sectors are presented in Table 4. Overall, these sectors exhibited stronger recovery dynamics and higher economic activity than upstream sectors, with growth concentrated in primary and secondary solid wood products. However, trends varied across sectors, particularly between solid wood manufacturing and paper-related industries. A consistent pattern emerges across all sectors. Output and value added generally increased or remained stable while employment declined, and employee compensation did not increase proportionally, indicating rising productivity alongside a shift toward more capital-intensive production.

Among all downstream sectors, primary solid wood products (PSWP) consistently represented the largest contributor to economic activity. Direct output increased from $879.1 million in 2019 to a peak of $1.48 billion in 2023 before declining to $1.27 billion in 2024, while total output followed a similar trajectory, rising from $1.48 billion to over $2.10 billion in 2023 and $1.88 billion in 2024. Direct value added increased substantially from $208.4 million in 2019 to $395.0 million in 2023 before declining to $318.2 million in 2024. In contrast, direct employment declined from 2,720 jobs in 2019 to 2,118 jobs in 2024 (–22.1%), indicating significant labor contraction despite strong output growth. Employee compensation remained relatively stable, increasing only slightly from $139.0 million in 2019 to $142.6 million in 2023 before declining to $135.8 million in 2024.

Table 4. Economic contribution of the FPI downstream sectors: 2019-2024. Dollar amounts reported in constant 2026 dollars.

Year and Sector	Output ($MM)		Employment		Value Added ($MM)		Labor Income ($MM)	
	Direct	Total	Direct	Total	Direct	Total	Direct	Total
2019								
PSWP	879.1	1,480.1	2,720	6,806	208.4	535.9	139.0	378.1
SSWP	533.1	880.1	2,393	4,362	165.0	332.5	123.5	231.9
WF	208.6	332.8	1,418	2,136	54.1	116.6	75.2	113.2
PPP	180.8	300.5	231	840	26.1	84.0	21.9	58.3
SPOP	110.7	147.3	234	434	20.6	39.6	18.2	29.5
2020								
PSWP	687.3	1,183.9	2,485	5,902	164.2	440.5	130.6	331.4
SSWP	526.5	824.0	2,193	3,923	159.9	307.7	133.9	233.5
WF	225.9	342.1	1,388	2,065	79.9	139.8	75.9	113.8
PPP	176.4	286.4	221	804	34.1	88.8	29.0	64.6
SPOP	105.8	140.8	209	403	22.7	41.1	20.2	31.7
2021								
PSWP	1,004.0	1,507.6	2,494	5,919	349.3	619.0	136.9	323.2
SSWP	617.9	928.7	2,331	3,989	242.1	392.4	137.4	228.6
WF	221.4	344.5	1,456	2,127	75.2	137.7	76.9	113.4
PPP	151.8	245.9	235	710	34.4	80.4	22.8	50.3
SPOP	100.5	135.5	215	401	23.4	41.4	17.9	28.6
2022								
PSWP	1,393.6	2,076.0	2,568	6,625	363.0	717.5	136.3	361.1
SSWP	849.2	1,298.4	2,372	4,460	292.9	494.0	143.9	260.5
WF	254.7	402.5	1,412	2,153	82.2	154.6	85.6	126.1
PPP	202.9	325.3	256	804	48.1	105.1	24.9	56.6
SPOP	103.6	142.3	200	395	24.2	44.1	16.3	27.5
2023								
PSWP	1,484.7	2,105.6	2,453	5,846	395.0	763.8	142.6	361.9
SSWP	783.6	1,224.7	2,307	4,235	256.7	467.0	133.5	252.5
WF	275.5	440.3	1,346	2,145	77.6	164.5	101.3	149.0
PPP	146.3	218.5	165	475	37.0	74.5	15.0	35.3
SPOP	107.9	146.8	191	381	26.3	47.7	14.2	26.3
2024								
PSWP	1,271.7	1,877.2	2,118	5,307	318.2	665.5	135.8	353.0
SSWP	818.6	1,293.5	2,248	4,341	249.3	480.9	145.5	280.7
WF	279.6	450.3	1,292	2,093	84.2	174.2	99.1	148.7
PPP	109.0	168.9	113	362	21.4	52.4	9.3	26.5
SPOP	102.1	137.5	146	308	22.7	42.0	11.7	22.4

The secondary solid wood products (SSWP) sector also demonstrated strong performance. Direct output increased from $533.1 million in 2019 to $818.6 million in 2024, with a peak of $849.2 million in 2022. Direct value added rose from $165.0 million in 2019 to $292.9 million in 2022 before stabilizing at $249.3 million in 2024. Employment declined modestly from 2,393 jobs to 2,248 jobs (–6.1%), indicating relatively stable labor demand compared to other sectors. Employee compensation increased from $123.5 million in 2019 to $145.5 million in 2024, suggesting some improvement in labor earnings, though these gains remained smaller relative to increases in value added.

The wood furniture (WF) sector exhibited moderate but consistent growth. Direct output increased from $208.6 million in 2019 to $279.6 million in 2024, while direct value added increased from $54.1 million to $84.2 million. Direct employment declined from 1,418 jobs to 1,292 jobs (–8.9%), indicating gradual efficiency gains. Employee compensation increased more noticeably in this sector, rising from $75.2 million in 2019 to $99.1 million in 2024, reflecting a stronger alignment between economic growth and labor earnings compared to other downstream sectors.

In contrast, the pulp, paper, and paperboard (PPP) sector experienced substantial contraction across all indicators. Direct output declined from $180.8 million in 2019 to $109.0 million in 2024, despite a temporary increase in 2022. Direct employment declined sharply from 231 jobs to 113 jobs (–51.1%), representing the largest proportional decline among all sectors. Direct value added peaked at $48.1 million in 2022 before declining to $21.4 million in 2024. Employee compensation also declined significantly, from $21.9 million in 2019 to $9.3 million in 2024, indicating a simultaneous reduction in both labor demand and earnings.

The secondary paperboard and other paper products (SPOP) sector exhibited a more gradual contraction. Direct output remained relatively stable, decreasing slightly from $110.7 million in 2019 to $102.1 million in 2024. Direct value added fluctuated modestly, increasing to $26.3 million in 2023 before declining to $22.7 million in 2024. Direct employment declined from 234 jobs in 2019 to 146 jobs in 2024 (–37.6%), while employee compensation decreased from $18.2 million to $11.7 million over the same period. These patterns suggest that production levels were maintained despite reductions in labor input and compensation.

Figure 4 illustrates labor productivity trends across the downstream sectors of West Virginia's forest products industry, measured as direct value added per worker from 2019 to 2024. Overall, productivity increased across most sectors, although the magnitude and consistency of these gains varied.

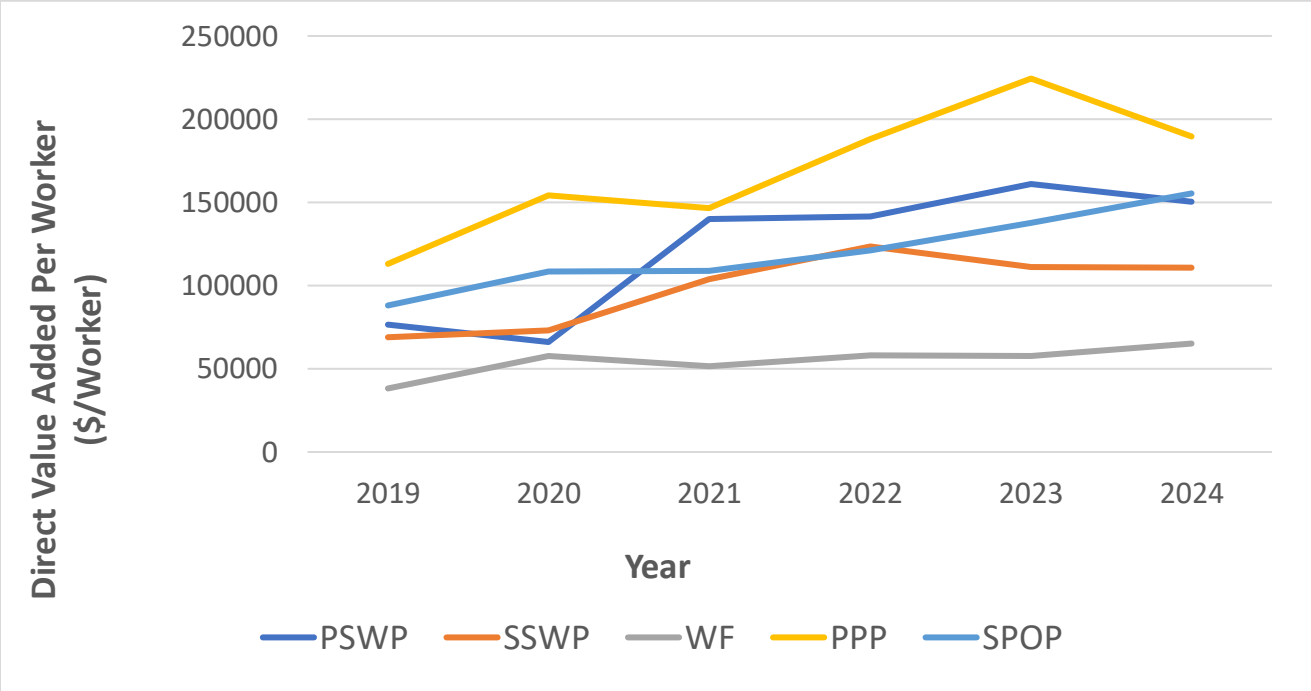

Figure 4. Labor productivity in WV's FPI downstream sectors as measured by direct value added per worker, 2019-2024.

Among the sectors, pulp, paper, and paperboard (PPP) exhibited the highest labor productivity throughout the study period. Productivity increased from approximately $113,000 per worker in 2019 to a peak of about $224,000 in 2023, then declined to approximately $189,000 in 2024. Despite recent declines in output and employment, PPP maintained the highest productivity advantage across all sectors.

The primary solid wood products (PSWP) sector demonstrated notable productivity growth, particularly after 2020. Productivity increased from approximately $77,000 per worker in 2019 to $161,000 in 2023, before slightly declining to about $150,000 in 2024. This sharp increase aligns with observed declines in employment alongside rising value added, indicating significant efficiency gains within the sector.

The secondary paperboard and other paper products (SPOP) sector showed steady and consistent growth in productivity over the study period. Productivity increased from approximately $88,000

per worker in 2019 to $155,000 in 2024, representing one of the most stable upward trends among downstream sectors. This pattern suggests gradual improvements in efficiency despite modest changes in output.

In contrast, the secondary solid wood products (SSWP) sector experienced moderate productivity growth followed by stabilization. Productivity increased from about $69,000 per worker in 2019 to approximately $123,000 in 2022, before declining slightly and stabilizing around $111,000 by 2024. This indicates some efficiency gains, though less pronounced compared to PSWP.

The wood furniture (WF) sector consistently exhibited the lowest productivity among downstream sectors. Productivity increased from approximately $38,000 per worker in 2019 to about $65,000 in 2024, with relatively gradual growth throughout the period. While gains were observed, the sector remains more labor-intensive relative to other downstream industries.

DISCUSSION

The results indicate that the post-pandemic evolution of West Virginia's forest products industry is best characterized not as a simple recovery to pre-pandemic conditions, but as a process of structural adjustment and reorganization across the value chain. At the aggregate level, the industry surpassed pre-pandemic output and value-added levels by 2022–2023, yet employment continued to decline through 2024. This divergence between economic output and labor use is one of the clearest findings of the study and is consistent with broader structural change processes in which industries respond to shocks by increasing efficiency, reorganizing production, and shifting toward more capital-intensive operations (Banaś et al. 2021, He et al. 2021, Poudel and Dahal 2025, Ye and Dai, 2020)

At the industry level, direct employment fell from 9,545 jobs in 2019 to 7,798 jobs in 2024, while direct output rose from $2.11 billion to $2.74 billion, and direct value added increased from $610.9 million to $830.3 million. Direct value added per worker rose from approximately $64,000 in 2019 to more than $110,000 in 2023 before settling at about $106,000 in 2024. This may imply that the industry's post-pandemic trajectory was driven less by workforce recovery and more by gains in per-worker value added. Such patterns are consistent with literature showing that periods of

disruption can accelerate adoption of labor-saving technologies and drive improvements in production processes (Brandeis and Hodges 2015, Dao and Platzer 2024, de Vries et al. 2021, Li et al. 2019, Poudel and Dahal 2025). Yet these aggregate patterns mask substantial differences across sectors. The most notable structural distinction in the results is the divergence between the upstream and downstream segments of the forest products value chain.

The forestry and logging sectors showed persistent weakness over the study period. Forestry remained relatively small in economic scale and exhibited patterns of decline and temporary recoveries. Logging, while larger and economically more significant than forestry, also experienced sustained contraction in both direct employment and output. Results from the current study suggest that upstream segments did not participate in the broader post-pandemic growth observed elsewhere in the industry. The logging results are especially important given the sector's critical role as a supply-chain link between standing timber and downstream manufacturing. Logging direct employment fell from 1,551 jobs in 2019 to 1,145 jobs in 2024, while output declined from $163.1 million to $127.5 million. Even though value added per worker increased over the period, those gains were achieved in the context of declining scale. Productivity gains on a per-worker basis appear to reflect labor contraction, consolidation, and possibly mechanization rather than sectoral expansion. This distinction matters because productivity gains in shrinking sectors do not necessarily indicate sectoral strength; instead, they may reflect the survival of more efficient firms after weaker operators exit. This aligns with long-standing concerns in the forest sector regarding logging capacity (G C et al., 2020), labor shortages (Bowman et al. 2023, He et al. 2021), high capital requirements (Conrad et al. 2018; 2024, He et al. 2021), aging operator demographics (Bowe et al. 2025, Bowman et al. 2023, Conrad et al. 2024, G C et al., 2020), and transportation bottlenecks (Knight et al. 2024, Kogler et al. 2025). These structural challenges predated the pandemic and may have been further exacerbated by it and its aftermath. (Jayasundara et al. 2024, Stanturf and Mansuy 2021). A sustained decline in logging capacity may ultimately constrain downstream sectors if the supply of logs cannot keep pace with manufacturing demand and the resulting structural imbalance. Downstream processors may be recovering or expanding more quickly than the upstream sectors that supply raw materials.

The forestry sector results raise a somewhat different but related concern. Although forestry is smaller than logging in absolute economic terms, it remains important because it encompasses

timber tract production and a range of forestry support activities that support the entire forest products supply chain (Espinoza 2020, FAO 2022, United Nations Economic Commission for Europe 2025). Forest management and related upstream activities provide the foundation of raw material supply, and their vitality is essential to the long-run sustainability and competitiveness of downstream logging and manufacturing operations. Its contraction may signal reduced investment in forest management-related functions, with longer-term implications for resource stewardship, stand quality, and timber availability (Barrette et al. 2023). However, the relatively short study period and the absence of direct measures of forest conditions warrant caution when drawing broader conclusions about long-term forest resource conditions. Nevertheless, the results suggest that the long-run competitiveness of the industry depends not only on manufacturing performance but also on the vitality of upstream land- and resource-based activities.

In contrast to upstream sectors, the downstream manufacturing sectors, particularly primary and secondary solid wood products, were the strongest performers over the study period. These sectors accounted for the majority of output and value-added growth within the industry and exhibited clear gains in labor productivity. The PSWP sector was the most dynamic component of the industry. Direct output rose from $879.1 million in 2019 to $1.27 billion in 2024, while direct value added increased from $208.4 million to $318.2 million, despite a decline in employment from 2,720 to 2,118 jobs. Its productivity gains were especially notable. Value added per worker nearly doubled over the period, rising from roughly $76,600 in 2019 to more than $150,000 in 2024. The SSWP sector also showed strong performance, with substantial increases in output and value added alongside relatively stable employment. These sectors appear to have translated post-pandemic market conditions into sustained gains in economic performance. Studies across Europe and North America show that downstream wood manufacturing and secondary processing have captured much of the post-pandemic growth, especially where linked to construction, furniture, packaging, and bioeconomy products This result is consistent with broader forest products literature documenting strong demand for lumber, millwork, engineered components, packaging-related products, and other wood-based materials during and after the pandemic period (Kuzman et al. 2023, Mensah et al. 2025, Poudel and Dahal 2025, Stanturf and Mansuy 2021, van Kooten and Schmitz 2022). Wood products industries benefited from elevated construction activity, home renovation demand, supply-chain disruptions that favored domestic production, and price spikes in wood commodities.

The divergence between output growth and labor compensation in PSWP is also noteworthy. Output and value added rose sharply, yet employee compensation remained relatively stable. This suggests that gains in productivity and value-added gains were not matched by proportional gains in labor compensation. This does not necessarily imply declining wages per worker, but it does indicate that a growing share of value creation may have been associated with capital, margins, or non-labor components associated with capital deepening and technological change (Abdih and Danninger 2017, Curtis et al. 2021, Poudel and Dahal 2025). Empirical evidence from wood products manufacturing indicates that increases in labor productivity have been driven in part by rising capital intensity, which tends to reduce labor's share of value added even when employment levels or average wages are relatively stable (Sorenson et al. 2016). This reinforces the interpretation of a shift toward a more capital-intensive industry (Autor et al. 2020, Guta et al. 2026). The SSWP sector also showed substantial gains in output and value added, but employee compensation increased more noticeably than in the PSWP sector. Even so, its overall performance is still consistent with an industry structure increasingly driven by productivity growth rather than employment expansion.

The wood furniture sector exhibited a more moderate trajectory than PSWP and SSWP. Output and value added increased over the study period, and productivity improved from approximately $38,000 per worker in 2019 to more than $65,000 in 2024. Employment declined only modestly relative to other sectors, a result consistent with other studies that identify furniture manufacturing as relatively resilient due to its downstream position, smaller average firm size, and reliance on flexible production systems rather than large-scale capital substitution (Kuzman et al. 2023, Sorenson et al. 2016). These trends suggest that the wood furniture sector adapted to evolving market conditions without the same degree of restructuring observed in solid wood manufacturing, achieving productivity improvements through incremental process innovation, lean manufacturing practices, and workflow optimization rather than widespread labor displacement (Abu et al. 2019; 2021). This stability may reflect continued demand for cabinetry, custom woodwork, and related products, initially spurred by pandemic-related shifts in consumption. It may also be attributed to longer-term structural drivers supporting growth in the furniture sector, including urbanization, expansion in hospitality and commercial markets, increasing consumer interest in do-it-yourself (DIY) and ready-to-assemble (RTA) furniture, and ongoing technological advancements and research and development (R&D) in wood furniture manufacturing (Research and Markets 2024).

The paper-related sectors exhibit a contrasting pattern relative to solid wood manufacturing. PPP had the highest labor productivity among downstream sectors throughout the study period, rising to more than $220,000 per worker in 2023 before declining to about $190,000 in 2024. But this productivity occurred alongside sharp contractions in employment and output. Similarly, SPOP showed steady productivity gains while employment declined. Findings from these sectors illustrate that increasing productivity is not always synonymous with sectoral strength, as productivity can increase when employment falls more rapidly than output, particularly in capital-intensive manufacturing industries (Charles et al. 2019). In solid wood manufacturing, rising productivity accompanied expanding output, suggesting growth-oriented efficiency gains. In PPP and, to a lesser degree, SPOP, rising productivity occurred alongside contraction, implying that fewer workers were supporting a smaller or stagnant economic base. This pattern is more consistent with consolidation, capital deepening, and reduced labor requirements than with sector expansion and aligns with long-term structural changes in paper markets, including digital substitution, mill closures, shifting product demand, and concentration of production in larger or more specialized facilities (Ghosal and Nair-Reichert 2007, Hussain and Bernard 2017, Sinclair and Dubois 2020, Susaeta and Rossato 2021, Toppinen et al. 2017).

The findings suggest a structural shift in West Virginia's forest products industry, whereby post-pandemic recovery occurred through internal reorganization and rising capital intensity, altering sectoral composition and labor demand instead of returning employment to pre-pandemic levels. These changes have several implications. First, the continued strength of downstream manufacturing suggests that value-added processing remains a major source of economic resilience and competitiveness in West Virginia's forest sector. Policies and business strategies that support modernization, equipment investment, process innovation, and higher-value production may therefore reinforce areas of existing strength. Second, upstream contractions raise concerns about longer-term supply-chain stability. If logging and forestry continue to weaken while manufacturing remains strong, the result could be a tighter log supply, higher procurement costs, or greater dependence on wood sourced from longer distances. That, in turn, could erode some of the gains achieved in downstream sectors.

For this reason, policies aimed at sustaining the forest products industry should not focus solely on mills and manufacturing. They should also consider the viability of harvesting, hauling, and

forestry support infrastructure. Third, the divergence between rising value added and comparatively modest changes in employee compensation suggests that the benefits of post-pandemic restructuring may not be evenly distributed across labor. This reinforces the importance of workforce development strategies that prepare workers for increasingly technical and capital-intensive roles in the sector. If productivity gains are being driven by mechanization, automation, and process upgrades, future employment may depend less on labor quantity and more on skills, adaptability, and technical training. Future industry performance may also be influenced by evolving trade policies, particularly those affecting hardwood export markets and tariffs on imported wood products, which may influence both upstream sectors reliant on export demand and downstream manufacturers competing with foreign imports. Recent U.S. actions, including a 10% tariff on all timber and lumber imports and a 25% tariff on imported kitchen cabinets and furniture (Anderson et al. 2025, Lawder and Shepardson 2025) raise input costs for downstream manufacturers and reshape competitive dynamics with foreign suppliers. Finally, looking beyond the current industry structure, the weakness of paper-related sectors suggests new opportunities in the forest bioeconomy. Engineered wood products, pellets, biochar, and other innovative uses of forest-based materials, including textiles, chemicals, and packaging, may offer promising pathways to sustain and enhance industry value. Evidence suggests that even a modest participation in these alternative markets could generate substantial new revenues, partially offsetting losses from declining graphic paper demand (Hurmekoski et al. 2018).

CONCLUSIONS

This study examined the economic contributions of West Virginia's forest products industry from 2019 through 2024 using IMPLAN data, focusing on direct and total effects, as well as labor productivity measured by direct value added per worker. The results show that the industry's post-pandemic trajectory was marked by a strong recovery in output and value added but a continued decline in employment. At the aggregate level, the industry generated more output and value added in 2024 than in 2019, even though direct employment declined substantially. This divergence suggests that the post-pandemic recovery was driven more by efficiency gains and structural adjustment than by the restoration of labor demand.

The strongest performance was concentrated in primary and secondary solid wood products, which combined higher output and value added with major gains in labor productivity. These sectors were the principal drivers of industry recovery and appear to have captured the benefits of favorable market conditions during and after the pandemic. Forestry, logging, and paper-related sectors lagged behind, with the former showing contraction and instability and the latter exhibiting high productivity but shrinking economic scale. These patterns reveal an increasingly uneven value chain in which downstream manufacturing is strengthening even as upstream capacity and some traditional processing sectors weaken.

Overall, the results indicate that West Virginia's forest products industry has not simply returned to its pre-pandemic structure. Rather, it has shifted toward a more capital-intensive, higher-productivity, and more manufacturing-centered configuration. For industry stakeholders and policymakers, this implies that future competitiveness will depend not only on supporting high-performing downstream sectors but also on maintaining upstream capacity, strengthening workforce skills, and identifying new market opportunities for sectors facing long-term structural decline.

CONFLICTS OF INTEREST

The authors confirm there are no conflicts of interest.

REFERENCES CITED

Abdih Y, Danninger S. 2017. What explains the decline of the U.S. labor share of income? An analysis of state and industry level data. https://doi.org/10.5089/9781484311004.001

Abu F, Gholami H, Mat Saman MZ, Zakuan N, Streimikiene D. 2019. The implementation of lean manufacturing in the furniture industry: a review and analysis on the motives, barriers, challenges, and the applications. J Clean Prod. 234:660-680. https://doi.org/10.1016/j.jclepro.2019.06.279

Abu F, Gholami H, Saman MZM, Zakuan N, Sharif S, Streimikiene D. 2021. Pathways of lean manufacturing in wood and furniture industries: a bibliometric and systematic review. Eur J Wood Wood Prod. 79(4):753-772. https://doi.org/10.1007/s00107-021-01713-2

Anderson-Mae A, Anderson APM, Press A. 2025 Oct 14. What to know about new U.S. tariffs on cabinets, vanities and some wooden furniture. PBS News. Available from: https://www.pbs.org/newshour/nation/cabinet-companies-hope-new-u-s-tariffs-boost-domestic-production.

Autor D, Dorn D, Katz LF, Patterson C, Van Reenen J. 2020. The fall of the labor share and the rise of superstar firms. Q J Econ. 135(2):645-709. https://doi.org/10.1093/qje/qjaa004

Azenui B, Hlatshwayo S, Spence M. 2025. Economic tectonics: a closer look at structural change and productivity trends in the U.S. economy. https://doi.org/10.5089/9798229018104.001

Banaś J, Utnik-Banaś K, Zięba S, Janeczko K. 2021. Assessing the technical efficiency of timber production during the transition from a production-oriented management model to a multifunctional one: a case from Poland 1990-2019. Forests. 12(9):1287. https://doi.org/10.3390/f12091287

Barrette J, Achim A, Auty D. 2023. Impact of intensive forest management practices on wood quality from conifers: literature review and reflection on future challenges. Curr For Rep. 9(2):101-130. https://doi.org/10.1007/s40725-023-00181-6

BenDor T, Lester TW, Livengood A, Davis A, Yonavjak L. 2015. Estimating the size and impact of the ecological restoration economy. PLoS One. 10(6):e0128339. https://doi.org/10.1371/journal.pone.0128339

Berman A, Plemmons R. 1979. Nonnegative matrices in the mathematical sciences. London (UK): Academic Press. https://doi.org/10.1016/C2013-0-10361-3

Bowe SA, Ballweg JM, Blinn CR, Nolle DA, Smail RA. 2025. The logging sector in Minnesota and Wisconsin: status, issues, and challenges in 2021. J For. 123(1):41-62. https://doi.org/10.1093/jofore/fvx014

Bowman T, Jeffers S, Naka K. 2023. Characteristics and concerns of logging businesses in the Southeastern United States: results from a state-wide survey from Alabama. Forests. 14(9):1695. https://doi.org/10.3390/f14091695

Brandeis C, Hodges DG. 2015. Forest sector and primary forest products industry contributions to the economies of the Southern states: 2011 update. J For. 113(2):205-209. https://doi.org/10.5849/jof.14-054

Charles KK, Hurst E, Schwartz M. 2019. The transformation of manufacturing and the decline in US employment. NBER Macroecon Annu. 33:307-372. https://doi.org/10.1086/700896

Chizmar S, Parajuli R, Bruck S, Frey G, Sills E. 2024. Forest-based employment in the Southern United States amidst the COVID-19 pandemic: a causal inference analysis. Forest Sci. 70(1):23-36. https://doi.org/10.1093/forsci/fxad042

Conrad JL IV, Greene WD, Hiesl P. 2018. A review of changes in US logging businesses 1980s-present. J For. 116(3):291-303. https://doi.org/10.1093/jofore/fvx014

Conrad JL IV, Greene WD, Hiesl P. 2024. Georgia and Florida logging businesses persevere through pandemic, rising costs, and uncertainty. Forest Sci. 70(1):47-56. https://doi.org/10.1093/forsci/fxad050

Curtis EM, Garrett DG, Ohrn EC, Roberts KA, Suárez Serrato JC. 2021. Capital investment and labor demand. NBER Working Paper 29485. https://doi.org/10.3386/w29485

Dao M, Platzer J. 2024. Post-pandemic productivity dynamics in the United States. IMF Working Pap. 2024(124). https://doi.org/10.5089/9798400279713.001

de Vries K, Erumban A, van Ark B. 2021. Productivity and the pandemic: short-term disruptions and long-term implications. Int Econ Econ Policy. 18(3):541-570. https://doi.org/10.1007/s10368-021-00515-4

Deb P, Assogba NP, Li W. 2023. Price volatility modeling for the lumber futures market: a GARCH-MIDAS approach. Forest Sci. 69(5):510-519. https://doi.org/10.1093/forsci/fxad021

Espinoza O. 2020. Trends in the U.S. forest products sector, markets, and technologies. In: Dockry MJ, Bengston DN, Westphal LM, comps. Drivers of change in U.S. forests and forestry over the next 20 years. Gen Tech Rep NRS-P-197:26-49. https://doi.org/10.2737/NRS-GTR-P-197-paper4

FAO. 2020. Impacts of COVID-19 on wood value chains and forest sector response. Rome (IT): FAO. https://doi.org/10.4060/cb1987en

FAO. 2022. Global forest sector outlook 2050: assessing future demand and sources of timber for a sustainable economy. Rome (IT): FAO. Available from: https://www.fao.org/family-farming/detail/en/c/1633694/

G C S, Potter-Witter K, Blinn CR, Rickenbach M. 2020. The logging sector in the Lake States of Michigan, Minnesota, and Wisconsin: status, issues, and opportunities. J For. 118(5):501-514. https://doi.org/10.1093/jofore/fvaa021

Gagnon B, MacDonald H, Hope E, Blair MJ, McKenney DW. 2022. Impact of the COVID-19 pandemic on biomass supply chains: the case of the Canadian wood pellet industry. Energies. 15(9):3179. https://doi.org/10.3390/en15093179

Gazal K, Deskins J, Spong B, McNeel J. 2024. Tracking the economic contributions of West Virginia's forest products industry during the COVID-19 pandemic era. Forest Prod J. 74(4):317-328. https://doi.org/10.13073/FPJ-D-24-00028

Ghosal V, Nair-Reichert U. 2007. Investments in modernization, innovation and gains in productivity: evidence from firms in the global paper industry. SSRN. https://doi.org/10.2139/ssrn.967511

Guta D, Nelson H, Scorah H. 2026. Productivity of Canadian forest product industries: panel data evidence from five major provinces. J For Econ. 1-37. https://doi.org/10.1108/JFE-05-2025-0605

He M, Smidt M, Li W, Zhang Y. 2021. Logging industry in the United States: employment and profitability. Forests. 12(12):1720. https://doi.org/10.3390/f12121720

Herrendorf B, Rogerson R, Valentinyi A. 2022. New evidence on sectoral labor productivity: implications for industrialization and development. SSRN. https://doi.org/10.2139/ssrn.4056788

Hurmekoski E, Jonsson R, Korhonen J, Jänis J, Mäkinen M, Leskinen P, Hetemäki L. 2018. Diversification of the forest industries: role of new wood-based products. Can J For Res. 48(12):1417-1432. https://doi.org/10.1139/cjfr-2018-0116

Hussain J, Bernard JT. 2017. Regional productivity convergence: pulp and paper industries in US, Canada, Finland, and Sweden. J For Econ. 28:49-62. https://doi.org/10.1016/j.jfe.2017.04.005

IMPLAN. 2021. 2020 data season is here. Available from: https://blog.implan.com/2020-implan-data. Accessed 2026 May 6.

IMPLAN. 2023. ICA: introduction to industry contribution analysis. Available from: https://support.implan.com/hc/en-us/articles/360025854654-ICA-Introduction-to-Industry-Contribution-Analysis. Accessed 2026 May 6.

Jayasundara M, Kadam P, Dwivedi P. 2024. The impact of COVID-19 on the global forestry sector: a bibliometric review. For Policy Econ. 158:103103. https://doi.org/10.1016/j.forpol.2023.103103

Knight CRD, Bolding MC, Conrad JL, Barrett SM. 2024. Log truck transportation challenges and innovative solutions. Int J For Eng. 35(1):113-121. https://doi.org/10.1080/14942119.2023.2273123

Kogler C, Beiglböck A, Rauch P. 2025. An empirical study of resilience in Austrian wood transport. Transp Res Part A. 191:104303. https://doi.org/10.1016/j.tra.2024.104303

Kuzman MK, Oblak L, Glavonjić B, Barčić AP, Obućina M, Haviarova E, Grošelj P. 2023. Impact of COVID-19 on wood-based products industry in Southeastern Europe. Wood Mater Sci Eng. 18(3):1115-1126. https://doi.org/10.1080/17480272.2022.2109210

Lawder D, Shepardson D. 2025 Sep 30. Trump sets 10% tariff on lumber imports, 25% on cabinets and furniture. Reuters. Available from: https://www.reuters.com/world/trump-sets-10-tariff-lumber-imports-higher-rates-wooden-products-2025-09-30/

Li Y, Mei B, Linhares-Juvenal T. 2019. The economic contribution of the world's forest sector. For Policy Econ. 100:236-253. https://doi.org/10.1016/j.forpol.2019.01.004

Markets R and. 2024 Jun 6. Global wood furniture market on the rise: projected to reach US$ 413.5 billion by 2032. GlobeNewswire. Available from: https://www.globenewswire.com/news-release/2024/06/06/2894523/28124/en/Global-Wood-Furniture-Market-On-the-Rise-Projected-to-Reach-US-413-5-Billion-by-2032.html

Mensah P, Pimenta AS, Melo RR de, Amponsah J, Tuo G, Chakurah I, Ampadu SD, Buckman I, Nikoi M, Minkah E, Miranda N de O, Medeiros PL de. 2025. The global supply chain of wood products: a literature review. Forests. 16(7):1036. https://doi.org/10.3390/f16071036

Miller RE, Blair PD. 2009. Input-output analysis: foundations and extensions. 2nd ed. Cambridge (UK): Cambridge University Press. https://doi.org/10.1017/CBO9780511626982

Nealy M. 2023 Sep 20. Economic effects & multipliers. IMPLAN Support. Available from: https://support.implan.com/hc/en-us/articles/18944332362523-Economic-Effects-Multipliers

Parajuli RJ, Henderson JE, Tanger SM, Joshi O, Dahal RP. 2018. Economic contribution analysis of the forest products industry. J For. 116(6):1-7. https://doi.org/10.1093/jofore/fvy047

Pelkki M, Guitierrez A. n.d. Arkansas Forest Industry Productivity: a 20-year assessment. Arkansas Center for Forest Business fact sheets. Available from: https://www.uamont.edu/academics/CFANR/acfb_factsheets.html. Accessed 2026 Mar 13.

Poudel J, Dahal R. 2025. A comprehensive look at the forest products industry's economic contribution to the United States: pre- and post-COVID analysis. For Policy Econ. 172:103440. https://doi.org/10.1016/j.forpol.2025.103440

Prestemon J. 2022. COVID-19 and forest products. ORMS Today. Available from: https://pubsonline.informs.org/do/10.1287/orms.2026.01.04

Sinclair P, Dubois M. 2020. One engineer and a dog: technological change and social restructuring in Alabama's pulp and paper industry. Available from: https://www.semanticscholar.org/paper/One-Engineer-and-a-Dog%3A-Technological-Change-and-in-Sinclair-Dubois/9cc15f1550f50f3beb67ff9d49692755fdbb0967

Sorenson CB, Keegan CE, Morgan TA, McIver CP, Niccolucci MJ. 2016. Employment and wage impacts of timber harvesting and processing in the United States. J For. 114(4):474-482. https://doi.org/10.5849/jof.14-082

Stanturf JA, Mansuy N. 2021. COVID-19 and forests in Canada and the United States: initial assessment and beyond. Front For Glob Change. 4:666960. https://doi.org/10.3389/ffgc.2021.666960

Susaeta A, Rossato FG. 2021. Efficiency of pulp and paper industry in Brazil. For Policy Econ. 128:102484. https://doi.org/10.1016/j.forpol.2021.102484

Toppinen A, Pätäri S, Tuppura A, Jantunen A. 2017. The European pulp and paper industry in transition to a bioeconomy: a Delphi study. Futures. 88:1-14. https://doi.org/10.1016/j.futures.2017.02.002

United Nations Economic Commission for Europe. 2025. Sustainable and circular bioeconomy in forest-based industries: how to get there. Geneva (CH): United Nations. https://doi.org/10.18356/9789213587096

U.S. Bureau of Economic Analysis. 2026. SAGDP1 state annual gross domestic product (GDP) summary. Accessed 2026 May 6. https://doi.org/10.69645/FJBP9682

USDA Forest Service. 2021. Forests of West Virginia, 2020. Resource Update FS-339. Madison (WI): USDA Forest Service. https://doi.org/10.2737/FS-RU-339

USDA Forest Service. 2024. Timber product output and use for West Virginia, 2018. Resource Update FS-417. https://doi.org/10.2737/FS-RU-417

van Kooten GC, Schmitz A. 2022. COVID-19 impacts on U.S. lumber markets. For Policy Econ. 135:102665. https://doi.org/10.1016/j.forpol.2021.102665

West Virginia Economic Development. 2021. Forest products. Available from: https://westvirginia.gov/industries/forestproducts/

Woodall C, Piva RJ, Skog KE, Ince PJ, Luppold WG. 2011. An assessment of the downturn in the forest products sector in the northern region of the United States. For Prod J. 61(8):604-613. https://doi.org/10.13073/0015-7473-61.8.604

Ye K, Dai Y. 2020. The evolution pattern of input and output of Chinese forest products industry. J Phys Conf Ser. 1629(1):012084. https://doi.org/10.1088/1742-6596/1629/1/012084

Disclaimer/Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors, and the reviewers. Forest Business Analytics and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.