Forestry's Economic Contribution in the United States, 2016

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Abstract

Economic contributions of an industry sector are often vital information in the policy-making process. IMPLAN data and software were used to determine the economic contribution of forest industries to all 50 states plus Washington, D.C. Rankings of the states' contributions to employment, employee compensation, and value added were determined. National forest inventory data, rural population, and industrial energy costs were examined for correlation with total forestry contributions to each state's economies. Rankings were based on absolute contributions as well as contributions as a percentage of a state's total economy. Percentage rankings present the relative importance of forestry to a state's economy, and can differ considerably from absolute value rankings. Regional and national contributions were also calculated to model interstate and regional contribution ''leakages,'' or trade effects. Differences in both interstate and interregional trade flows are substantial. Industrial energy costs, rural population, and timber removals were significantly correlated with total economic contributions.

The economic contributions of natural resources are cited for their importance in sustaining rural communities, justifying public expenditures in economic developments, and defending sustainable development (Back 1969, Flick and Teeter 1988, Aruna et al. 1997, Hellstrand et al. 2009, Hjerpe et al. 2017). The importance of forestry's contribution to states' economies is often well understood in states that have sizable wood-processing industries and substantial forested rural areas. However, forestry's economic contributions in each of the 50 states plus Washington, D.C. are substantial and provide valuable information to policy makers at state, regional, and national levels.

Consistency in multisector analyses is desired when comparing states and regions (Joshi et al. 2017). Economic analysts often use different combinations of forestry sectors to define the ''forest industry'' and often report their findings using different criteria. For example, one state may report value added, whereas another state reports output (Parajuli et al. 2018). Clarity in understanding the difference between impact and contribution analyses is also critical as these terms are often used interchangeably by economists themselves when communicating to the public (Munn and Henderson 2003, McConnell 2013). Impact analysis refers to the addition or subtraction of an industry within a sector, while contribution analysis is the change in a regional economy related to entire economic sectors. Both include direct effects of economic change as well as the multipliers of effects on related industries (indirect effects) and household spending from both direct and indirect industries (induced effects). When removing entire sectors or multiple sectors in contribution analyses, it is vital to remove or accommodate for internal purchases from other sectors that are part of the analysis. In forestry, where there is a high degree of cross-sector purchasing, failure to account for these can lead to substantially overestimating the economic contribution of a multisector industry (Parajuli et al. 2018).

The economic measures by which contributions are measured also have substantial differences. Employment and employee compensation are direct and easily understood by policy makers, and are useful in comparisons to other industries. Output, which is analogous to value of shipments, is easily understood by policy makers, but in multisector industries that are vertically integrated, output overestimates the value of economic activities. For example, the lumber output from sawmills includes the value of the logs purchased to produce that lumber. Value-added measurement avoids this ''double counting'' by removing the cost of inputs from sales. Though calculated differently, value added is analogous to gross regional product (Hodges

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et al. 2011b, English et al. 2016) and represents the total of employee compensation, taxes less subsidies, and gross operating surplus (IMPLAN 2018).

Leakage in contribution or impact studies refers to the indirect spending by related industries and household spending by direct and indirect industry sectors (induced effects) that occur outside the region defined by a model (Cheney 2018a). The smaller the region, the greater the leakage. While contribution analyses can reliably predict economic effects within a region, they do not measure leakage, which can be estimated by examining larger regions. National input–output models such as IMPLAN do not incorporate international trade flows and cannot estimate economic contributions outside of the United States.

The objective of this study is to apply a consistent contribution-analysis methodology to all 50 states plus Washington, D.C., and determine direct and total contributions from forestry using criteria of employment, employee compensation, and value added. Individual state, regional, and national contributions are presented. Previous studies have completed similar comparisons in the horticulture industry (Hodges et al. 2011a), but forestry-specific contribution studies have been only regional in nature (Aruna et al. 1997, Brandeis and Hodges 2015, Joshi et al. 2017). State and regional rankings are useful for understanding how states benefit and use their forest resources to generate economic activity. Also, the three major inputs into forest economic activity (timber, labor, and energy) will be examined for correlation with total value-added economic contribution. This study will provide a geographic basis for comparison of industries, serve as a basis for temporal comparisons in the future, and provide insight into factors that affect forestry economic contributions.

Methods

This study used the 2016 IMPLAN 51-state dataset and the IMPLAN version 3 software. The method of contribution analysis follows that described by Parajuli et al. (2018), and the methodology recommended by IMPLAN (Cheney 2018b, 2018c). This involves model customization whereby commodity production is modified so that industry sectors only produce their primary commodity, and no by-products are allowed. Trade flows are modified so that industry sector purchases are limited to the amount of direct purchases by that sector. After each modification, the IMPLAN model is reconstructed to develop the appropriate multipliers for the contribution analysis.

All values reported are in 2016 US dollars. The IMPLAN National Trade Flows model was used to model trade flows for each state and the multistate regions. The national model requires the use of supply/demand pooling. All households, state institutions, and local government institutions were included in the determination of economic contributions. It was assumed that federal government defense and nondefense spending would not be affected by changes in the forestry sector.

The sectors used to define ''forestry'' are listed in Table 1. The basis for this list was a survey done of forest economists and economic analysts in the US South in 2016 (Joshi et al. 2017). Only those sectors that were used by the majority of researchers and analysts were included. The one exception was IMPLAN sector 19, ''Support Activities for Agriculture and Forestry.'' In agricultural states, the number of workers in the forestry sector are only a small fraction of this sector. For example, IMPLAN data for California shows 245,109.52 workers in this sector. All other forestry sectors as defined by Table 1 combined in California total 84,233 workers. In the contribution analysis for California, only 979 workers in Sector 19 are shown as indirect and induced contribution of forestry. All states showed that forestry support workers were less than 50 percent of the total workers reported in sector 19, and typically that percentage was 30 percent or lower. Therefore, the contributions from sector 19 will be reported under the total, but not as direct contributions in this study.

Table 1.—IMPLAN forestry sectors.

IMPLAN industry code	Description
15	Forestry, forest products, and timber tract production
16	Commercial logging
47	Electric power generation—biomass
134	Sawmills
135	Wood preservation
136	Veneer and plywood manufacturing
137	Engineered wood member and truss manufacturing
138	Reconstituted wood product manufacturing
139	Wood window and door manufacturing
140	Cut stock, resawing lumber, and planing
141	Other millwork, including flooring
142	Wood container and pallet manufacturing
143	Manufactured home (mobile home) manufacturing
144	Prefabricated wood building manufacturing
145	All other miscellaneous wood product manufacturing
146	Pulp mills
147	Paper mills
148	Paperboard mills
149	Paperboard container manufacturing
150	Paper bag and coated and treated paper manufacturing
151	Stationery product manufacturing
152	Sanitary paper product manufacturing
153	All other converted paper product manufacturing
368	Wood kitchen cabinet and countertop manufacturing
369	Upholstered household furniture manufacturing
370	Nonupholstered wood household furniture manufacturing
372	Institutional furniture manufacturing
373	Wood office furniture manufacturing
374	Custom architectural woodwork and millwork

Contributions from individual subsectors within forestry such as logging, solid wood products, pulp and paper, or furniture were calculated, but are not reported in this article due to size and space considerations. Direct contributions by all forestry sectors reflect the employment, output, and value added that come directly from those sectors. Total contributions include indirect effects and induced effects. Indirect effects reflect the contributions of industries that trade with forestry sectors. Examples of this include wholesale trade, truck transportation, building services, and machine shops. Induced contributions are based on the household spending from all direct and indirect sectors. States were allocated to the North Central, Northeast, Southeast, Plains States, Mountain West, or Pacific regions.

Employment, employee compensation, and value added were the economic criteria reported. State results are reported by region, with regional ranking and national ranking reported for all criteria. Direct forestry contributions

and total forestry contributions are presented both as totals and as a percentage of the total state/regional/national economy. While total values indicate the size of forestry's contribution, percentage values reflect the importance of an industry within a region's economy, normalizing the results for the size of that region's total economy (Brandeis and Hodges 2015).

For correlation analysis, Forest Inventory and Analysis program data for forest removals in each state were obtained using the Evalidator tool (US Department of Agriculture 2019). Rural population data for each state were obtained from the American Factfinder 2010 census database (US Census Bureau 2019). Industrial energy cost for each state was obtained from the US Energy Information Agency (EIA) 2016 price reports (US EIA 2019). Pearson's correlation coefficient was calculated between total value-added contribution and timber removals, rural population, and industrial energy cost.

Results and Discussion

The 10 states with the greatest direct forestry contribution are shown in Figure 1. Six of the top 10 states are in the Southeast region (Georgia, North Carolina, Texas, Alabama, South Carolina, and Tennessee), two are in the North Central (Wisconsin, Ohio), and one each is in the Pacific (California) and Northeast (Pennsylvania) regions. Direct contributions are those made by the forestry sectors identified in Table 1, and are provided by region for all states in Tables 2 through 7.

Total contributions include those directly made by forestry sectors as well as related industries (indirect effects), and household spending by direct and related industries (induced effects). The top 10 states' total contributions to their respective state gross domestic product (GDP) are shown in Figure 2. For the top six states, the order is the same as for direct effects. The order for the 6th through 10th states differs, and New York moves ahead of South Carolina in terms of total contributions. The overall value-added multiplier for New York is 2.54, and 1.84 for South Carolina. Trade flows and household spending within the state of New York are higher than in South Carolina, which also has greater regional trade with neighboring states and potentially more leakage, which will be discussed later.

The absolute values of the direct and total contributions of forestry can obscure the importance of forestry within a state. States with relatively small economies, such as Maine and Arkansas, have relatively large proportions of their economies that are dependent upon forest economic activities. The dependency of a state's economy on forestry can be estimated by examining the total value-added contributions of forestry as a percentage of the entire state's economy. Figure 3 shows the 10 states with the greatest dependency on their forest economies as expressed by the percentage of forestry value-added contributions to state total value added (GDP). While many of the states in Figure 3 are the same as those in Figures 1 and 2, it is noteworthy that Maine, Arkansas, Mississippi, South Carolina, Oregon, and Idaho are among the top 10 states most dependent on forestry's contributions to their total economic activity. These states have smaller total GDPs than most of the states listed in Figures 1 and 2. Forestry is a large component of these states' total economy and is an important component in economic growth and sustainability. The direct and total economic contributions for employment, employee compensation, and value added, expressed as percentages of state totals, are presented in Tables 8 through 13, with regional and national rankings.

Leakage from states and regions due to interstate and interregion trading can be substantial. Table 14 shows the six regions' direct and total forestry contributions, the total of each region's contributions, and the national direct and total contributions of forestry. Note that the sum of all direct

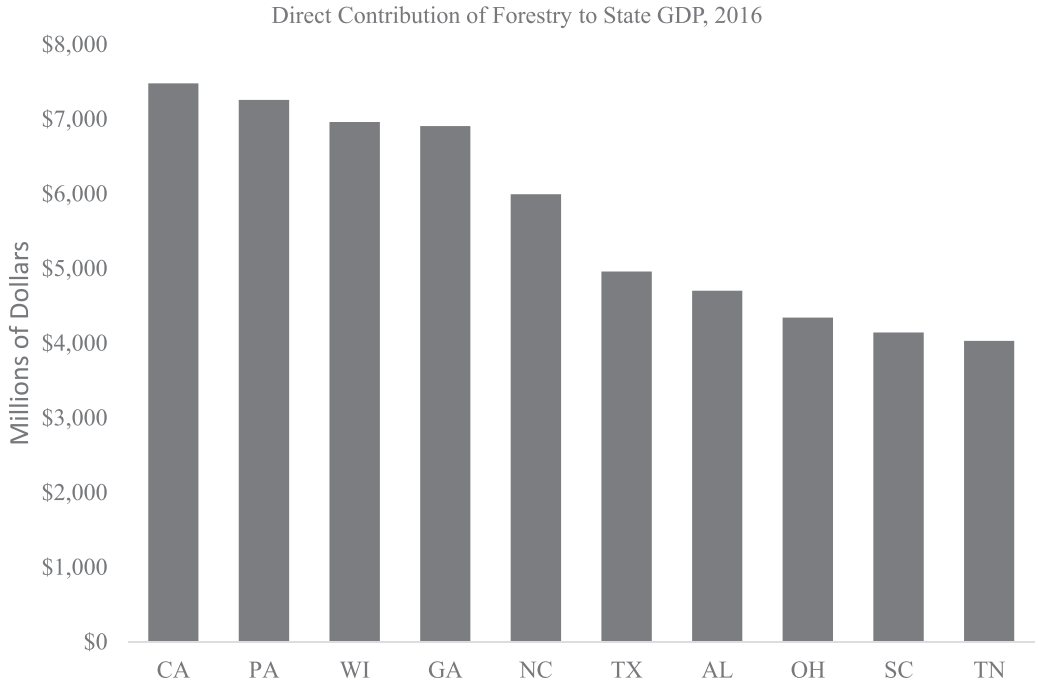

Figure 1.—States with largest direct contribution by forestry to gross domestic product (GDP), 2016.

Table 2.—Northeast region forestry direct and total contribution to employment, employee compensation, and value added in 2016.[a]

State	Forestry direct contribution									Forestry total contribution								
	Employment (*n*)	Rank		Employee compensation ($)	Rank		Value added ($)	Rank		Employment (*n*)	Rank		Employee compensation ($)	Rank		Value added ($)	Rank	
		R	N		R	N		R	N		R	N		R	N		R	N
Connecticut	7,357	8	37	460	6	32	681	6	33	16,965	8	36	1,031	6	32	1,735	6	33
Washington, D.C.	90	13	51	5	13	51	15	13	51	135	13	51	9	13	51	21	13	51
Delaware	1,723	12	47	110	12	46	255	11	44	3,658	12	47	210	12	46	446	12	45
Massachusetts	14,936	5	28	1,018	4	26	1,459	4	27	39,815	5	27	2,561	4	25	4,092	4	26
Maryland	8,233	7	35	413	7	35	648	7	34	18,158	6	34	937	7	35	1,605	7	35
Maine	16,539	4	27	873	5	28	1,217	5	28	41,265	4	26	1,904	5	27	3,132	5	28
New Hampshire	5,779	9	39	269	9	39	415	9	38	12,271	9	38	590	9	38	989	9	38
New Jersey	17,472	3	25	1,397	3	22	1,702	3	26	44,821	3	25	3,014	3	21	4,587	3	25
New York	40,337	2	11	2,262	2	13	3,661	2	11	88,944	2	15	5,432	2	8	9,309	2	8
Pennsylvania	66,536	1	4	3,694	1	4	7,257	1	2	161,067	1	5	8,644	1	3	16,352	1	2
Rhode Island	2,473	11	46	142	11	45	194	12	46	5,814	11	46	310	11	44	506	11	44
Vermont	5,751	10	40	204	10	42	337	10	42	11,371	10	39	438	10	41	767	10	41
West Virginia	9,534	6	33	398	8	36	573	8	37	17,672	7	35	716	8	36	1,186	8	37

[a] Dollar values in millions. R = regional; N = national.

Table 3.—Southeast region forestry direct and total contribution to employment, employee compensation, and value added in 2016.[a]

State	Forestry direct contribution									Forestry total contribution								
	Employment (*n*)	Rank		Employee compensation ($)	Rank		Value added ($)	Rank		Employment (*n*)	Rank		Employee compensation ($)	Rank		Value added ($)	Rank	
		R	N		R	N		R	N		R	N		R	N		R	N
Alabama	42,921	4	10	2,491	4	8	4,702	4	7	99,836	5	9	4,821	5	13	9,041	5	10
Arkansas	27,562	10	21	1,506	10	21	3,056	10	10	65,780	10	21	3,103	9	20	6,138	9	20
Florida	38,568	6	13	1,979	6	16	3,483	6	14	100,455	4	8	4,777	6	14	8,691	6	12
Georgia	53,975	3	6	3,234	3	6	6,907	3	4	151,477	3	6	7,804	3	6	15,397	1	4
Kentucky	21,137	11	22	1,278	11	23	2,408	11	23	55,019	11	22	2,566	12	24	4,750	12	24
Louisiana	20,443	12	24	1,265	12	24	2,681	12	22	52,712	12	24	2,607	11	23	5,285	10	21
Mississippi	36,738	7	15	1,652	9	20	2,787	9	21	71,621	9	20	2,885	10	22	5,274	11	22
North Carolina	72,976	1	2	3,797	1	3	5,993	1	5	169,814	1	3	8,149	2	5	14,118	2	5
Oklahoma	8,713	13	34	443	13	33	1,082	13	29	21,168	13	33	966	13	34	2,154	13	30
South Carolina	27,943	9	20	1,895	7	18	4,142	7	9	72,807	8	19	3,757	8	19	7,618	7	17
Tennessee	39,299	5	12	2,377	5	10	4,030	5	10	98,006	6	10	5,034	4	10	9,058	4	9
Texas	66,885	2	3	3,487	2	5	4,959	2	6	162,152	2	4	8,157	1	4	14,106	3	6
Virginia	35,268	8	17	1,810	8	19	3,172	8	19	80,774	7	17	4,174	7	18	7,487	8	18

[a] Dollar values in millions. R = regional; N = national.

Table 4.—North Central region forestry direct and total contribution to employment, employee compensation, and value added in 2016.[a]

State	Forestry direct contribution									Forestry total contribution								
	Employment (*n*)	Rank		Employee compensation ($)	Rank		Value added ($)	Rank		Employment (*n*)	Rank		Employee compensation ($)	Rank		Value added ($)	Rank	
		R	N		R	N		R	N		R	N		R	N		R	N
Iowa	17,434	8	26	1,007	8	27	1,848	8	25	35,240	8	28	3,229	7	28	1,748	8	27
Illinois	35,534	5	16	2,246	5	14	3,215	6	18	91,474	5	14	5,268	3	9	8,789	3	11
Indiana	46,906	3	8	2,356	3	11	3,340	3	15	96,440	3	12	4,420	6	17	7,275	6	19
Michigan	38,417	4	14	2,298	4	12	3,288	4	16	95,400	4	13	4,997	4	11	8,130	4	15
Minnesota	32,426	6	19	1,962	6	17	3,230	5	17	83,525	6	16	4,636	5	15	7,807	5	16
Missouri	24,004	7	23	1,093	7	25	2,313	7	24	53,983	7	23	2,469	8	26	4,859	7	23
Ohio	51,612	2	7	2,768	2	7	4,341	2	8	129,209	2	7	6,360	2	7	11,192	2	7
Wisconsin	66,208	1	5	3,984	1	2	6,963	1	3	171,364	1	2	8,916	1	2	15,899	1	3

[a] Dollar values in millions. R = regional; N = national.

Table 5.—Central Plains region forestry direct and total contribution to employment, employee compensation, and value added in 2016.[a]

State	Forestry direct contribution									Forestry total contribution								
	Employment (*n*)	Rank		Employee compensation ($)	Rank		Value added ($)	Rank		Employment (*n*)	Rank		Employee compensation ($)	Rank		Value added ($)	Rank	
		R	N		R	N		R	N		R	N		R	N		R	N
Kansas	7,435	1	36	368	1	37	624	1	35	15,074	1	37	691	1	37	1,254	1	36
Nebraska	4,916	3	42	236	3	40	374	3	41	10,410	3	42	477	2	39	833	2	39
South Dakota	5,854	2	38	274	2	38	382	2	40	10,846	2	40	471	3	40	784	3	40
North Dakota	3,173	4	45	158	4	44	204	4	45	5,847	4	45	280	4	45	432	4	46

[a] Dollar values in millions. R = regional; N = national.

Table 6.—Mountain West region forestry direct and total contribution to employment, employee compensation, and value added in 2016.[a]

State	Forestry direct contribution									Forestry total contribution								
	Employment (*n*)	Rank		Employee compensation ($)	Rank		Value added ($)	Rank		Employment (*n*)	Rank		Employee compensation ($)	Rank		Value added ($)	Rank	
		R	N		R	N		R	N		R	N		R	N		R	N
Arizona	12,228	2	30	549	2	30	739	3	32	28,144	2	30	1,263	1	29	2,061	2	31
Colorado	10,125	4	32	440	4	34	579	4	36	21,877	4	32	1,022	4	33	1,618	4	34
Idaho	12,890	1	29	648	1	29	1,052	1	30	28,860	1	29	1,227	2	30	2,176	1	29
Montana	5,583	5	41	226	5	41	391	5	39	10,812	5	41	419	5	42	762	5	42
New Mexico	3,338	7	44	98	7	47	164	7	47	5,859	7	44	195	7	47	353	7	47
Nevada	3,541	6	43	194	6	43	261	6	43	7,385	6	43	379	6	43	615	6	43
Utah	10,579	3	31	496	3	31	954	2	31	23,685	3	31	1,049	3	31	2,000	3	32
Wyoming	1,318	8	50	35	8	50	60	8	50	2,084	8	50	63	8	50	120	8	50

[a] Dollar values in millions. R = regional; N = national.

Table 7.—Pacific region forestry direct and total contribution to employment, employee compensation, and value added in 2016.[a]

State	Forestry direct contribution									Forestry total contribution								
	Employment (*n*)	Rank		Employee compensation ($)	Rank		Value added ($)	Rank		Employment (*n*)	Rank		Employee compensation ($)	Rank		Value added ($)	Rank	
		R	N		R	N		R	N		R	N		R	N		R	N
Alaska	1,343	5	49	59	4	48	93	4	48	2,403	5	49	106	5	49	188	5	49
California	84,233	1	1	4,639	1	1	7,479	1	1	200,047	1	1	11,279	1	1	19,710	1	1
Hawaii	1,345	4	48	39	5	49	68	5	49	2,965	4	48	111	4	48	205	4	48
Oregon	43,206	2	9	2,398	2	9	3,640	2	12	96,554	2	11	4,916	2	12	8,150	3	14
Washington	34,355	3	18	2,110	3	15	3,628	3	13	79,475	3	18	4,525	3	16	8,271	2	13

[a] Dollar values in millions. R = regional; N = national.

contributions by region do add up to the national totals, but for total contributions, the national effects are much greater. This is because the national model captures interregional trading and household spending. The interregional leakage is substantial; based on Table 14, interregional trade flows account for 1,031,355 jobs, $57,839 million in employee compensation, and $112,670 million in value added.

While not shown directly in Tables 1 through 7, similar direct totals can be calculated for each of the six regions. In the Northeast region (Table 2), for example, adding the direct forestry contributions from each state yields totals of 196,760 jobs, $11.244 million in employee compensation, and $18,410 million in value added. These correspond to the values shown for direct contributions in Table 14 for the Northeast region. Adding up the direct total contributions in Table 2 shows 461,957 jobs, $25.795 million in employee compensation, and $44.727 million in value-added for the Northeast region. Subtracting the sum of total contributions for all the states from the single regional totals shown in Table 14 shows the interstate trade flow in the Northeast region of 65,843 jobs, $5.155 million in employee compensation, and $9.509 million in value added. Table 15 shows interstate trade flows within each region for all six regions, and the percentage that interstate trade flows compose a part of total forestry contributions in that region. Interstate trade flows are highest in the Southeast United States, but the Northeast and North Central regions have similar interstate effects. The Central Plains, Mountain West, and Pacific regions all have substantially fewer interstate trade flow effects. Interstate trading among a diverse and ubiquitous forest products industry in the Southeast, North Central, and Northeast may explain why in those regions, the sum of individual states' contributions underestimates regional contributions so substantially. In

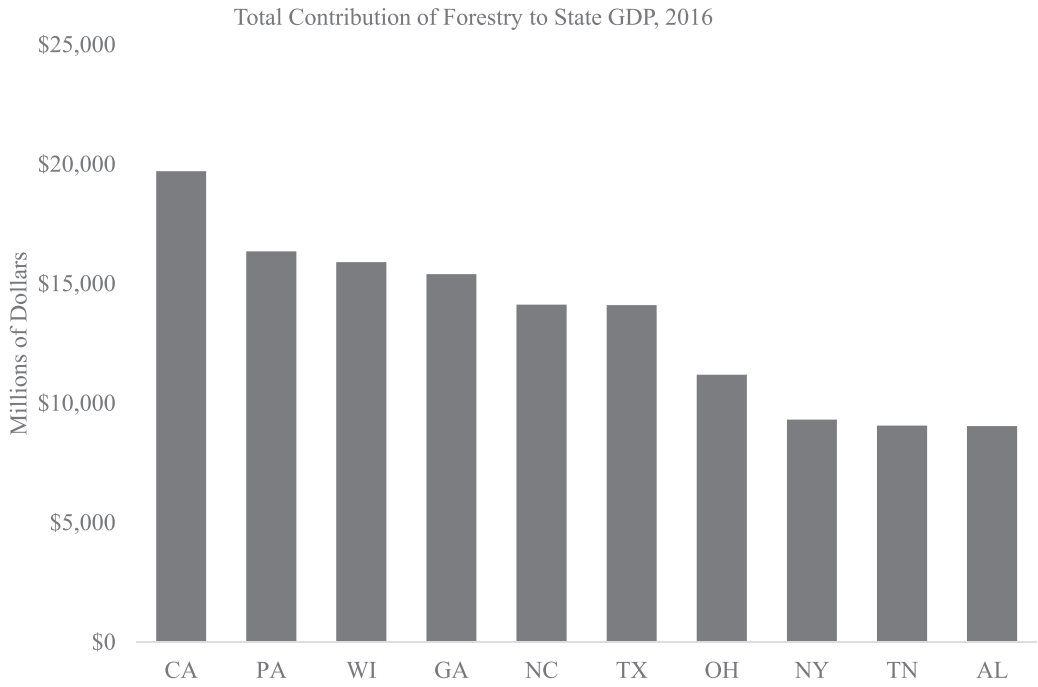

Figure 2.—States with largest total contribution by forestry to gross domestic product (GDP), 2016.

the Central Plains and Mountain West, forest industry is widely and irregularly distributed, and forestry makes up a smaller percentage of those regions' economies. The lower interstate trading in the Pacific region may be caused by the transportation distances involved in a region that includes Hawaii and Alaska and also by strong global trade in wood products with Asia; this exporting would not be captured in the national-level IMPLAN model.

Total (direct + indirect + induced) contribution from forestry was correlated with timber removals (Fig. 4), rural population (Fig. 5), and industrial energy cost (Fig. 6). A simple linear regression line is presented in each figure that indicates the expected forestry contribution based on each independent variable. Table 16 presents data for four states that overperform expected economic contributions from these three resources, and also four states that consistently

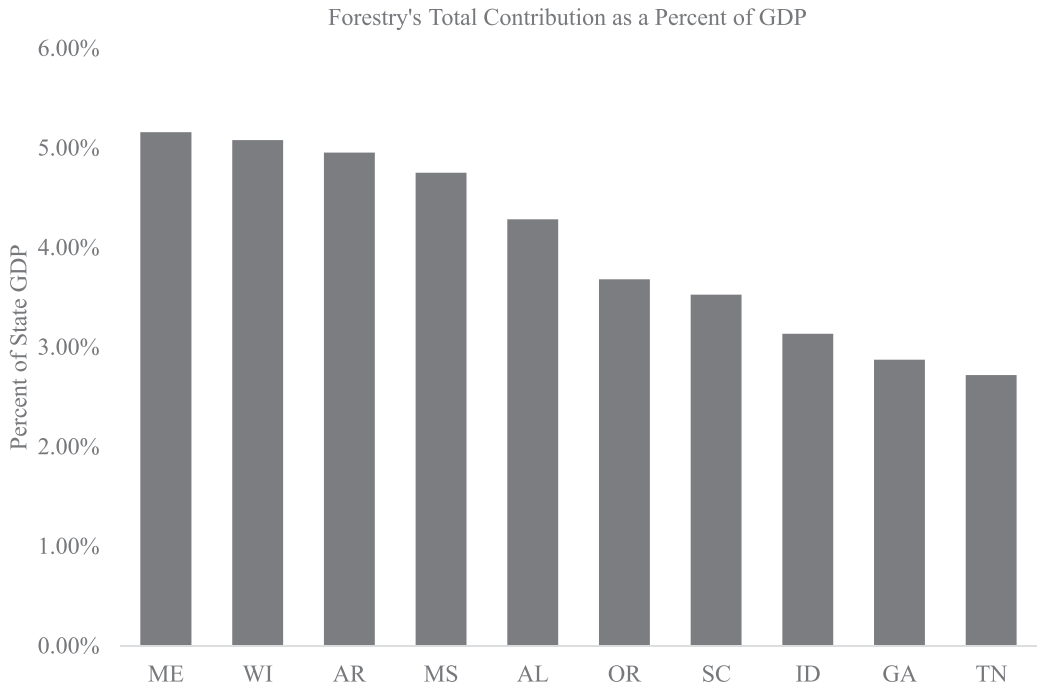

Figure 3.—States with largest percentage of state gross domestic product (GDP) attributed to forestry total contribution, 2016.

Table 8.—Northeast region forestry direct and total contribution to employment, employee compensation, and value added as a percentage of the state's economy, 2016.[a]

	Forestry direct contribution									Forestry total contribution								
State	Employment (%)	Rank R	Rank N	Employee compensation (%)	Rank R	Rank N	Value added (%)	Rank R	Rank N	Employment (%)	Rank R	Rank N	Employee compensation (%)	Rank R	Rank N	Value added (%)	Rank R	Rank N
Connecticut	0.32	10	43	0.33	10	42	0.26	10	41	0.74	9	41	0.73	9	41	0.67	9	41
Washington, D.C.	0.01	13	51	0.01	13	51	0.01	13	51	0.02	13	51	0.01	13	51	0.02	13	51
Delaware	0.30	11	43	0.35	8	51	0.37	6	42	0.64	11	51	0.68	10	51	0.64	10	42
Massachusetts	0.32	9	42	0.34	9	39	0.29	9	40	0.86	7	36	0.85	8	36	0.80	8	36
Maryland	0.23	12	48	0.20	12	49	0.17	12	48	0.50	12	48	0.45	12	45	0.42	12	45
Maine	1.99	1	2	2.56	1	2	2.00	1	5	4.96	1	1	5.58	1	1	5.16	1	1
New Hampshire	0.66	5	26	0.60	5	27	0.52	5	29	1.41	5	27	1.32	5	28	1.25	5	28
New Jersey	0.33	8	41	0.44	7	34	0.30	8	38	0.84	8	37	0.94	7	35	0.80	7	35
New York	0.33	7	40	0.28	11	43	0.25	11	42	0.73	10	42	0.67	11	43	0.63	11	43
Pennsylvania	0.88	4	17	0.92	4	20	0.99	3	16	2.12	3	16	2.15	3	16	2.23	3	16
Rhode Island	0.39	6	32	0.44	6	33	0.33	7	35	0.92	6	33	0.96	6	32	0.87	6	32
Vermont	1.32	2	7	1.11	2	15	1.07	2	14	2.62	2	10	2.40	2	12	2.44	2	12
West Virginia	1.06	3	11	1.05	3	18	0.78	4	20	1.97	4	18	1.88	4	22	1.62	4	22

[a] R = regional; N = national.

Table 9.—Southeast region forestry direct and total contribution to employment, employee compensation, and value added as a percentage of the state's economy, 2016.[a]

	Forestry direct contribution									Forestry total contribution								
State	Employment (%)	Rank R	Rank N	Employee compensation (%)	Rank R	Rank N	Value added (%)	Rank R	Rank N	Employment (%)	Rank R	Rank N	Employee compensation (%)	Rank R	Rank N	Value added (%)	Rank R	Rank N
Alabama	1.64	3	6	2.20	3	5	2.23	3	3	3.82	3	6	4.26	3	5	4.28	3	5
Arkansas	1.69	2	5	2.30	2	4	2.47	2	2	4.04	2	4	4.74	2	3	4.95	1	3
Florida	0.33	13	38	0.39	13	37	0.37	12	33	0.87	13	34	0.94	13	31	0.93	12	31
Georgia	0.91	8	16	1.13	8	14	1.29	5	9	2.55	6	11	2.74	7	9	2.87	5	9
Kentucky	1.00	6	13	1.14	7	13	1.18	7	11	2.19	8	15	2.28	8	14	2.33	8	14
Louisiana	0.77	9	22	1.10	9	17	1.14	9	13	1.97	9	17	2.26	9	15	2.25	9	15
Mississippi	2.34	1	1	2.88	1	1	2.51	1	1	4.56	1	3	5.02	1	4	4.75	2	4
North Carolina	1.25	4	9	1.40	5	9	1.15	8	12	2.92	4	8	3.01	5	11	2.70	7	11
Oklahoma	0.38	12	34	0.47	11	31	0.58	11	28	0.93	12	32	1.03	11	29	1.16	11	29
South Carolina	1.04	5	12	1.63	4	8	1.92	4	6	2.71	5	9	3.23	4	7	3.53	4	7
Tennessee	1.00	7	14	1.35	6	10	1.21	6	10	2.49	7	13	2.86	6	10	2.72	6	10
Texas	0.40	11	31	0.42	12	35	0.30	13	37	0.98	11	31	0.99	12	33	0.86	13	33
Virginia	0.69	10	24	0.63	10	26	0.62	10	26	1.57	10	25	1.46	10	26	1.47	10	26

[a] R = regional; N = national.

Table 10.—North Central region forestry direct and total contribution to employment, employee compensation, and value added as a percentage of the state's economy, 2016.[a]

	Forestry direct contribution									Forestry total contribution								
State	Employment (%)	Rank R	Rank N	Employee compensation (%)	Rank R	Rank N	Value added (%)	Rank R	Rank N	Employment (%)	Rank R	Rank N	Employee compensation (%)	Rank R	Rank N	Value added (%)	Rank R	Rank N
Iowa	0.84	4	19	1.11	3	16	1.02	2	15	1.69	6	23	3.57	2	18	0.97	8	18
Illinois	0.46	8	30	0.52	8	30	0.41	8	30	1.17	8	29	1.22	8	30	1.11	7	30
Indiana	1.21	2	10	1.34	2	11	0.95	4	18	2.49	2	12	2.52	3	17	2.07	3	17
Michigan	0.69	6	25	0.83	5	23	0.66	7	25	1.70	5	22	1.80	6	21	1.62	5	21
Minnesota	0.87	3	18	1.00	4	19	0.97	3	17	2.24	3	14	2.37	4	13	2.33	2	13
Missouri	0.65	7	27	0.64	7	25	0.75	5	23	1.45	7	26	1.46	7	25	1.57	6	25
Ohio	0.74	5	23	0.83	6	24	0.68	6	24	1.85	4	20	1.90	5	19	1.77	4	19
Wisconsin	1.80	1	3	2.31	1	3	2.23	1	4	4.66	1	2	5.16	1	2	5.08	1	2

[a] R = regional; N = national.

Table 11.—Central Plains region forestry direct and total contribution to employment, employee compensation, and value added as a percentage of the state's economy, 2016.[a]

	Forestry direct contribution								Forestry total contribution							
	Employment	Rank		Employee compensation	Rank		Value added	Rank		Employment	Rank		Employee compensation	Rank		Value added	Rank	
State	(%)	R	N	(%)	R	N	(%)	R	N	(%)	R	N	(%)	R	N	(%)	R	N
Kansas	0.39	3	33	0.44	3	32	0.38	3	32	0.78	4	39	0.83	4	37	0.77	3	37
Nebraska	0.37	4	35	0.41	4	36	0.32	4	36	0.79	3	38	0.83	3	39	0.72	4	39
South Dakota	0.97	1	15	1.17	1	12	0.77	1	21	1.81	1	21	2.01	1	24	1.59	1	24
North Dakota	0.55	2	29	0.59	2	29	0.40	2	31	1.00	2	30	1.04	2	34	0.84	2	34

[a] R = regional; N = national.

Table 12.—Mountain West region forestry direct and total contribution to employment, employee compensation, and value added as a percentage of the state's economy, 2016.[a]

	Forestry direct contribution								Forestry total contribution							
	Employment	Rank		Employee compensation	Rank		Value added	Rank		Employment	Rank		Employee compensation	Rank		Value added	Rank	
State	(%)	R	N	(%)	R	N	(%)	R	N	(%)	R	N	(%)	R	N	(%)	R	N
Arizona	0.34	4	37	0.33	4	41	0.24	4	43	0.78	4	40	0.75	4	40	0.68	4	40
Colorado	0.28	7	47	0.25	5	44	0.18	5	44	0.60	5	44	0.57	5	44	0.50	5	44
Idaho	1.32	1	8	1.79	1	7	1.52	1	8	2.96	1	7	3.39	1	8	3.13	1	8
Montana	0.84	2	20	0.91	2	21	0.82	2	19	1.62	2	24	1.68	2	23	1.61	2	23
New Mexico	0.30	6	44	0.21	8	48	0.17	7	47	0.53	6	45	0.41	7	47	0.37	7	47
Nevada	0.21	8	49	0.24	6	45	0.17	6	46	0.44	8	49	0.48	6	46	0.41	6	46
Utah	0.55	3	28	0.60	3	28	0.60	3	27	1.24	3	28	1.26	3	27	1.26	3	27
Wyoming	0.33	5	39	0.21	7	47	0.16	8	49	0.53	7	46	0.37	8	49	0.32	8	49

[a] R = regional; N = national.

Table 13.—Pacific region forestry direct and total contribution to employment, employee compensation, and value added as a percentage of the state's economy, 2016.[a]

	Forestry direct contribution								Forestry total contribution							
	Employment	Rank		Employee compensation	Rank		Value added	Rank		Employment	Rank		Employee compensation	Rank		Value added	Rank	
State	(%)	R	N	(%)	R	N	(%)	R	N	(%)	R	N	(%)	R	N	(%)	R	N
Alaska	0.29	4	46	0.22	4	46	0.18	4	45	0.52	4	47	0.40	4	48	0.36	4	48
California	0.37	3	36	0.34	3	40	0.29	3	39	0.87	3	35	0.82	3	38	0.76	3	38
Hawaii	0.15	5	50	0.08	5	50	0.08	5	50	0.32	5	50	0.24	5	50	0.24	5	50
Oregon	1.77	1	4	2.04	1	6	1.64	1	7	3.96	1	5	4.19	1	6	3.68	1	6
Washington	0.80	2	21	0.84	2	22	0.76	2	22	1.86	2	19	1.81	2	20	1.72	2	20

[a] R = regional; N = national.

Table 14.—Forestry direct and total contributions by region and for the total United States, 2016.[a]

	Forestry direct contribution			Forestry total contribution[b]		
Region	Employees (*n*)	Employee compensation ($)	Value added ($)	Employees (*n*)	Employee compensation ($)	Value added ($)
Northeast	196,760	11,244	18,410	527,800	30,950	54,236
Southeast	496,428	27,214	49,404	1,447,077	72,171	136,390
North Central	312,541	17,714	28,538	874,107	45,506	79,753
Central Plains	21,378	1,036	1,585	43,286	1,981	3,442
Mountain West	59,602	2,686	4,199	137,198	6,194	10,783
Pacific	164,483	9,245	14,909	405,235	22,803	40,118
Totals of regions	1,251,191	69,139	117,045	3,434,702	179,606	324,722
United States	1,251,191	69,139	117,045	4,466,056	237,445	437,392

[a] Dollar values in millions.
[b] US total contributions do not match totals of regions due to leakage effects.

Table 15.—Interstate trade flow effects by region in the United States, 2016.[a]

Region	Interstate trade flow effects of forestry total contributions by region			Interstate trade flow effects as a percentage of total trade flow effects by region		
	Employment (*n*)	Employee compensation ($)	Value added ($)	Employment (%)	Employee compensation (%)	Value added (%)
Northeast	65,843	5,155	9,509	12.48	16.66	17.53
Southeast	245,455	13,371	27,273	16.96	18.53	20.00
North Central	117,471	5,212	14,053	13.44	11.45	17.62
Central Plains	1,108	62	139	2.56	3.15	4.04
Mountain West	8,492	576	1,078	6.19	9.29	10.00
Pacific	23,792	1,866	3,593	5.87	8.18	8.96
Totals of regions	462,161	26,241	55,645			

[a] Dollar values in millions.

underperform. The forest resources and forest industry in each of these eight states would be generally considered ''important'' and substantial.

Timber removal and total economic contribution had a positive correlation coefficient of 0.52 that was significant ($P < 0.001$). Those states that have greater economic contributions than timber removals (Fig. 4; Table 16) are states with substantial lumber and paper industries which have known trading synergies and high value-added multipliers (Aruna et al. 1997, Hodges et al. 2011b, Dahal et al. 2013). Interestingly, those states whose contributions are less than expected from timber harvests, such as West Virginia, are states in proximity to the overperformers, such as Pennsylvania. This relationship may also exist between Mississippi and Alabama. This may suggest trade flows in logs from underperforming states to overperforming states. In the case of Maine and Alaska, international borders may result in international trade flow leakage that the model cannot determine.

Total contributions are also positively and significantly correlated with rural population ($r = 0.83$, $P < 0.001$). In contrasting the over- and underperforming states (Fig. 5; Table 16), the quality of educational systems, workforce quality, and a diversity of rural employment opportunities appear to be the strengths of overperforming states relative to underperforming states. Good transportation networks, access to metropolitan areas, and high-quality rural public infrastructure are known to positively affect rural communities and economies (Aldrich and Kusmin 1997).

As expected, industrial energy is negatively and significantly correlated with total forestry contributions ($r = -0.31$, $P = 0.03$). Georgia, Pennsylvania, Wisconsin, and California have similar energy costs to Mississippi, Maine, and West Virginia (Fig. 6), but the latter three states do not seem to use energy as efficiently to obtain economic benefits as the former four states (Table 16). This suggests that high energy costs can be overcome by lower resource costs and high-quality labor. The forest products industry does generate 63 percent of its energy requirements from woody biomass (US Department of Energy 2019); thus the forestry sector has some independence from the overall industrial energy costs in a state.

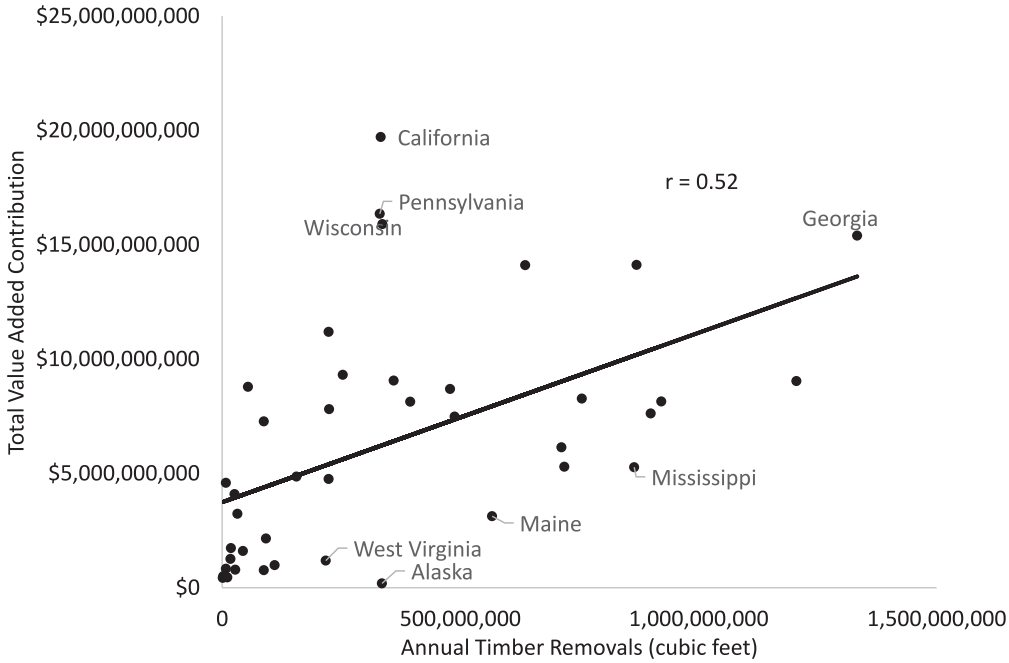

Figure 4.—Total value-added contribution from forestry and annual timber removals by state.

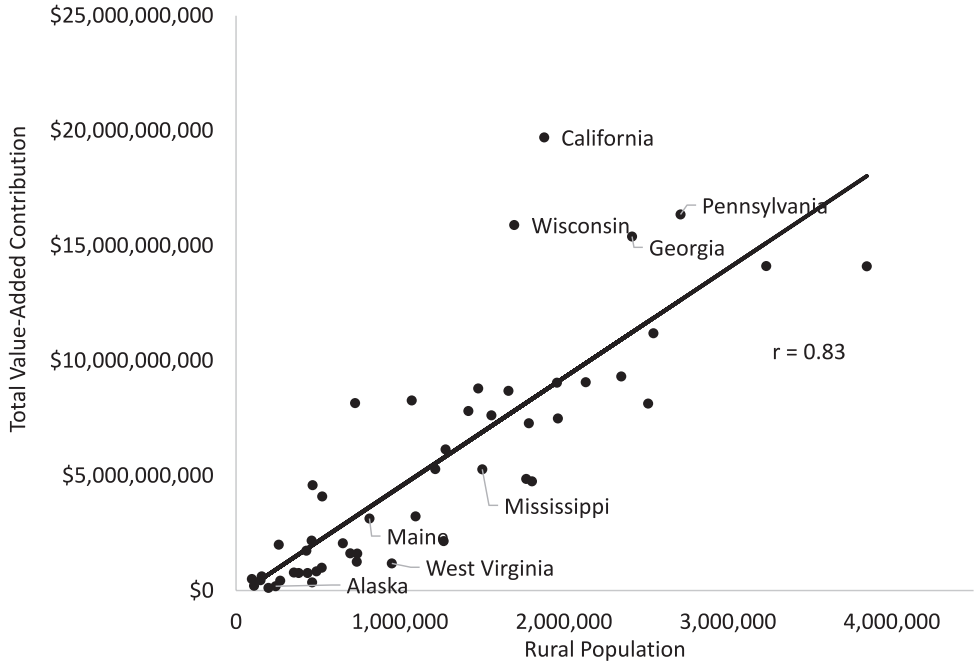

Figure 5.—Total value-added contribution from forestry and rural population by state.

Conclusions

Understanding state, regional, and national contributions of forestry to the economy is important for policy makers. These economic contributions occur jointly with a wide range of social and ecological services on a sustainable basis throughout the country—a fact that is not well recognized by state and federal policy makers. With few foresters occupying seats in state legislatures, and only one professional forester in the US Congress, having economic data to use as a gateway to broader conversations about conservation issues with policy makers is essential.

Preliminary correlation between timber resources, labor costs, and energy costs indicate that further study and modeling may elucidate important relationships in how efficiently the forest industry and state economies use these resources to obtain economic benefits. From this initial evaluation, the quantity of rural labor appears to be the strongest factor in predicting economic contributions from forestry, followed by timber harvests and energy. Econo-

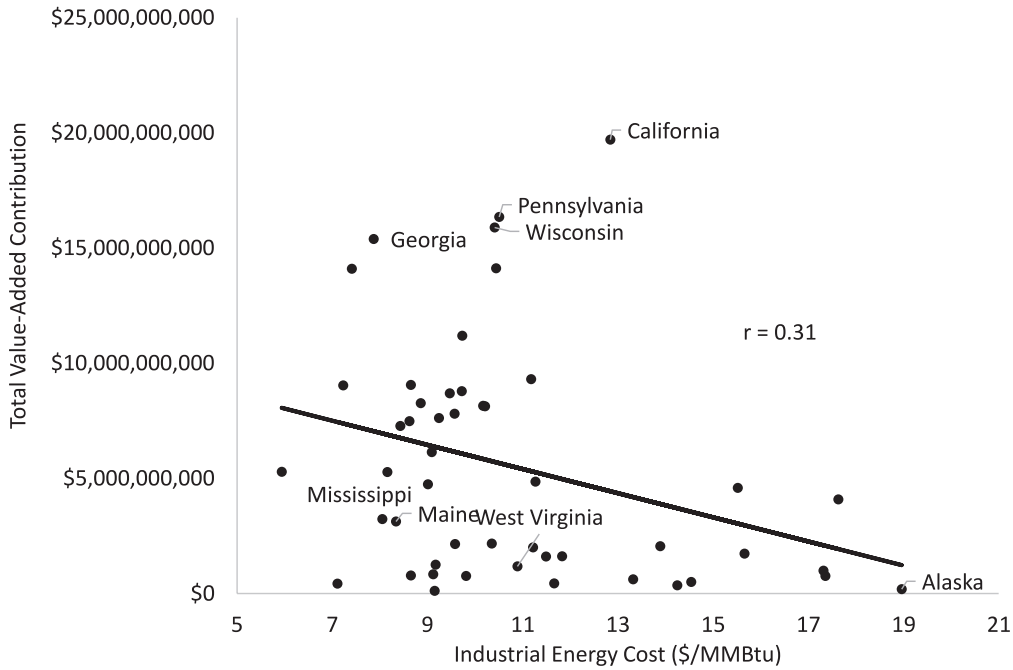

Figure 6.—Total value-added contribution from forestry and industrial energy cost by state.

Table 16.—Percentage of expected value-added contribution from timber harvests, rural population, and industrial energy cost for eight states.

State	Predictive criteria (%)		
	Timber harvest	Rural population	Industrial energy costs
Overachievers			
California	317	227	444
Georgia	113	137	218
Pennsylvania	264	129	289
Wisconsin	255	203	278
Underachievers			
Alaska	3	21	15
Maine	39	86	46
Mississippi	52	76	76
West Virginia	22	28	22

metric modeling may reveal important interactions among these variables and a more thorough understanding of the relationship between the basic inputs of wood fiber, labor, and energy, and economic contribution. Integration of data on forest products' interstate and global trade may also reveal additional insight.

States with diverse economies such as New York and California seem to benefit more from their forest economies by having greater internal trading and use of forest products. Some states with relatively small forest resources, such as Kansas, benefit by having forest industries close to neighboring states from which wood is imported. Lower contribution multipliers may be the result of less diverse economies that are not well integrated with forest products manufacturers.

Finally, these data can provide a baseline for monitoring forest industry health as reported by Brandeis and Hodges (2015). The relationship of forestry's economic contributions in a changing social and economic environment can help to identify challenges and opportunities with an aim of enhancing sustainable forestry-based economic development.

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