

# **A Review and Validation of the Implan Model for Pennsylvania's Solid Hardwood Product Industries**

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**Abstract:** The IMPLAN model for Pennsylvania was reviewed with respect to the industries processing the state's solid hardwood resources. Several sectors were found to be under represented in the standard sources of industrial activity. Further problems were attributed to the lack of distinction between hardwoods and softwoods in the national model. A further set of changes was made to update this set of industries.

## **INTRODUCTION**

Pennsylvania's hardwood resources are processed by a variety of industries in converting raw timber to finished goods. A detailed input-output model of Pennsylvania economy was used to study the structure of these industries. The model described each processing sector in terms of its inputs and products, and the origin or direction of their flow. In-state sales and purchases were further evaluated on the basis of the export and import of products. In addition, the economic contribution of each industry was identified in terms of its value added and associated employment.

## **THE SOLID HARDWOOD PRODUCT SECTORS**

Eleven industrial sectors have been identified as the principal solid hardwood processing groups for this study. The first element or stage of operations involves the logging camps and logging contractors sector (SIC code 2411). Within this stage, the timber resources are harvested and marketed to the primary processing sectors. At the primary processing stage, raw logs are converted to primary products, usually lumber, which in turn serves as an input to the secondary hardwood processing sectors. Examples of primary processors are sawmills and planing mills (SIC code 2421) and hardwood dimension and flooring mills (SIC code 2426). The wood pallets and skids industry (SIC 2448) also functions as a primary processor, though its contributions to secondary processing is in the form of packaging and shipping units. Among the secondary processing sectors considered in this study are millwork (SIC 2431) and wood kitchen cabinets (SIC 2434). Typically, these sectors provide semi-finished and finished products for the home construction industries. Other major secondary industries included in this study are the wood household furniture (SIC 2511), wood TV and radio cabinets (SIC 2517), upholstered household furniture (SIC 2512), wood office furniture (SIC 2521), and public building furniture (SIC 2531). A major portion of these industries' sales are to the final demand sectors of the economy.

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## DESCRIPTION OF THE IMPLAN MODEL

IMPLAN, "Impact analysis for PLANning," has been chosen as the input-output model for this study. The IMPLAN model was designed by the Forest Service to estimate the regional economic impacts of the forest management plans for the USDA Forest Service Nation's Forests (Alward et al. 1985).

IMPLAN follows the typical non-survey approach to input-output modeling. The model relies on two sets of data. The first of these is a 528 sector input-output transactions table based upon the Bureau of Economic Analysis National I-O table (USDC 1984b). This describes the intermediate utilization and production of commodities by United States manufacturers and represents a highly disaggregated description of the average sectored input and output technologies. In addition, the model identifies the employment and industrial output levels for a potential set of 528 sectors within each county of the United States. Also included at the county level are the components of final demand and value-added for each of the sectors. Sources for the county level data include: Agricultural Statistics (USDA 1987), Census of Agriculture (USDC 1985), Census of Housing (USDC 1982), Census of Governments (USDC 1984a), County Business Patterns (USDC 1983) and Dun and Bradstreet (1982) (USDA Forest Service 1985).

Version II of IMPLAN, released in 1986, contained several improvements, some of which are significant to this study. A major modification was the adoption of an industry-by-commodity accounting framework consistent with the United Nation's System of National Accounts (Alward et al. 1985). This identifies the total production for any given commodity, above and beyond the production level of the industry for which the product is typical. For example, companies within the sawmill sector may also produce dimension stock and/or pallets. Accordingly, the industry-by-commodity format includes the sawmill sector's output of dimension and pallet products, in addition to sawn lumber. This format can also be used to accommodate different assumptions about the production technologies of the industries and commodities in question (Miller and Blair 1985, Bulmer-Thomas 1982, Gigantes 1970).

The Pennsylvania economy, as estimated by IMPLAN, was initially based upon a national technology matrix of inter-industrial relationships for the year 1982. No modifications were made to the production functions of individual industries. IMPLAN then regionalized the national input-output matrix based upon the primary inputs and final demands for as many as 528 sectors within the Pennsylvania economy. In addition, regional information about employment and the total output of the industries was used in the regionalization process. A final input to the regionalization process was the estimate of commodity demands that could be satisfied locally. These regional purchase coefficients (RPC's) are a primary determinate in the calculations of domestic imports and exports. Overall, the accuracy of the model is directly dependent upon the reliability of such regional data.

One significant limitation of the IMPLAN system is its aggregation of hardwood and softwood timber. Since these are not close substitutes for most applications, a mistreatment of intra-regional trade can result. For example, the millwork sector uses large volumes of softwoods in the manufacture of doors, windows, and moldings. However, IMPLAN, using national averages, assumes that the millwork sector obtains its inputs in regional markets. Since little softwood is grown in Pennsylvania, this leads to erroneous conclusions.

The IMPLAN user can modify many aspects of the model. Alternate data sources can be used to better estimate the value of primary inputs and final demands within the region. These values may be further modified with improved estimates of the total output and employment for regional industries. The RPC's for regional commodities may also be re-specified by the investigator. The production functions in the technology matrix may also be changed. In addition, sectors can be further aggregated or disaggregated, if desired.

## REVISIONS TO THE PENNSYLVANIA IMPLAN MODEL

An allied objective within this study was to evaluate and improve the accuracy of the IMPLAN model in depicting the hardwood product industries. The upgraded model was based on the Pennsylvania economy in 1987, the latest year for which data was commonly available. Several sets of modifications were made, including:

- (1) Update of employment, value added, and total output levels for all industrial sectors to a 1987 basis.
- (2) Review and revision of the forest product sectors for reporting errors.
- (3) Review and revision of regional purchase coefficients for all industrial sectors and, in particular, the forest product sectors.
- (4) Revision of final demands for all products and services by the household and government sectors.
- (5) Adjustment of all monetary values associated with the 1982 IMPLAN model to a 1987 basis.

### Updating of Employment and Output Levels

Non-agricultural employment was revised to a 1987 basis (Penna. Bureau of Labor Statistics 1989) and subsequently used as an indicator for updating the output and value added for each respective industrial sector. In the case of the agricultural sectors, the commodity outputs were revised to a 1987 basis (USDC 1989), with these values used as indicators of the relative changes in employment and value added within the agricultural sectors.

As a further step in the review process, the productivity changes for U.S. industries over the 1981-1987 period were identified. These changes in output per employee were used to further adjust output and value added estimators within the non-agricultural sectors. In the case of the agricultural sectors, the productivity changes were used to further revise employment estimates.

### Revisions to the Forest Product Sectors

Certain forest product industries, notably logging and sawmilling, have the potential of being under reported due to their workers not receiving coverage in various government unemployment and insurance programs. A 1981 I-O survey of all forest product industries in an eight county region of north central Pennsylvania (Westman et al. 1985) was compared to an IMPLAN model of the same region to estimate the extent of under reporting in the state-wide model. Ratios for employment, employee compensation, value added and total industrial output were established between the two models and subsequently applied to the Pennsylvania IMPLAN model for purposes of revising the state's forest product industries. Additional revisions were extended to Pennsylvania's wood pallet industry based upon a recent state-wide survey of this industry (Fraser 1985).

### Regional Purchase Coefficients and Further Output Adjustments

The regional purchase coefficients for in-state timber and lumber products among the forest product sectors were reviewed and adjusted based upon related studies of these sectors and the inherent characteristics of the state's timber resources and allied industrial demands. The RPC's for log inputs to the sawmill, dimension mill, millwork, and kitchen cabinet sectors were increased to 0.85. These changes were in accordance with the study by Westman et al. (1985), and a general understanding of the hardwood industries in Pennsylvania. The wood pallet sector was constrained to purchase only in-state inputs with an RPC for lumber of 1.0. This reflected the sector's

traditional use of low grade hardwoods from local markets (Fraser 1985). Although paper and paperboard mills were outside this study, their demand for log inputs had a direct impact on the logging sector. Accordingly, the paper mill RPC's for log input was set at 0.50 to reflect their purchase of hardwood fiber from in-state sources. The remainder of their log input, representing softwood fiber, was met by out-of-state sources.

The net effect of the RPC changes for log input was an unreasonably high import of hardwood logs from adjoining states. In order to more accurately reflect the timber production level within Pennsylvania, in-state production was increased by about 20%, thereby reducing timber imports to a more reasonable level and generating an expected volume of domestic log exports.

In a similar manner, the forestry sector, representing the owners of timber, had an insufficient output level for supporting the now enlarged logging sector. Since the RPC for in-state timber was already set at 0.9, the output level of this sector was increased until a reasonable import-export profile was observed.

Other anomalies within the Pennsylvania IMPLAN model were the specification of zero RPC's for the output from several major industrial sectors outside the forest products group. This included the electric service sector, wholesale and retail sectors, and the eating and drinking place sector. In effect, all of their output would be sold to export markets. These RPC's were subsequently reset to 0.6, in correspondence with the RPC's of similar products from allied sectors within Pennsylvania's economy.

### **Final Demand Updates**

Changes in the level of Personal Consumption Expenditures (U.S. Department of Commerce 1988), Federal Budgets (US Treasury Department 1988), and State Budgets (Pennsylvania Office of the Budget 1987) were used to update household and government demands to 1987 levels. Since these purchases were not specified by industry, averages were used, leaving the distribution of expenditures among industrial sectors unchanged from their original 1982 levels.

Foreign export levels for the manufacturing sectors were obtained at a two digit SIC level for 1982 (Pennsylvania Department of Commerce 1987). These values were used to update this component of final demand, with the changes distributed proportionally within the two digit aggregates.

### **Inflation Adjustments**

A final adjustment to the Pennsylvania model involved the updating of all values to 1987 dollars. Commodity prices were obtained from the Bureau of Labor Statistics (U.S. Department of Labor 1988) for the period 1981-1986. An additional adjustment was made using OECD inflation indices to get the figure into 1987 dollars (OECD 1988). These inflation values were applied throughout the model on a commodity-by-commodity basis to develop figures comparable with the 1987 fiscal year.

## **RESULTS**

The size and stature of the solid hardwood product industries can be measured in several ways. A gross indication of size comes from the total output, or sales of each industry (Table 1). The SHP industries had estimated sales in 1987 of almost \$3 billion. This represented 2.1 percent of the total sales among all manufacturing industries in Pennsylvania, and 0.9 percent of all industrial sales in the state. Within the SHP industries, the sawmill sector had the most sales (\$845 million), followed by the logging sector (\$580 million) and the kitchen cabinet sector (\$490 million).

Table 1.—Pennsylvania's economy in 1987

Industrial sector	Total sales		Value added		Wages & salaries		Employment (# of Jobs)
	Millions of dollars		Millions of dollars		Millions of dollars		
Agriculture, forestry and fisheries	\$3,882		\$1,291		\$546		95020
Mining	\$6,382		\$3,487		\$1,516		26903
Construction	\$14,956		\$6,129		\$5,445		181652
Manufacturing (less hardwood Industries)	\$137,182		\$48,175		\$36,723		1023409
Solid hardwood product Industries	\$2,987		\$1,174		\$716		38121
160 - Logging camps and logging contractors	\$580		\$206	17.58%	\$92	12.86%	4794
161 - Sawmills and planing mills, general	\$845		\$365	31.13%	\$173	24.14%	9796
162 - Hardwood dimension and flooring mills	\$159		\$80	6.82%	\$41	5.78%	2799
164 - Millwork	\$256		\$67	5.74%	\$52	7.32%	2942
165 - Wood kitchen cabinets	\$490		\$190	16.14%	\$162	22.62%	6358
170 - Wood pallets and skids	\$151		\$63	5.37%	\$37	5.22%	2406
174 - Wood household furniture	\$222		\$92	7.81%	\$71	9.94%	4432
176 - Wood TV and radio Cabinets	\$14		\$5	0.42%	\$5	0.66%	319
177 - Upholstered household furniture	\$104		\$41	3.49%	\$34	4.71%	1659
180 - Wood office furniture	\$137		\$54	4.62%	\$40	5.54%	2192
182 - Public building furniture	\$28		\$10	0.88%	\$9	1.21%	424
Transportation, Communications and Utilities	\$32,234		\$16,823		\$8,381		231832
Wholesale and Retail Trade	\$19,173		\$13,766		\$8,793		872296
Finance, Insurance and Real Estate	\$32,426		\$18,601		\$8,993		288766
Services	\$75,781		\$44,274		\$31,424		1476055
Government Enterprises	\$4,482		\$2,399		\$2,504		87353
Special Industries	\$15,754		\$15,754		\$13,795		706154
Total	\$345,239		\$171,875		\$118,835		5027561

Table 2.—Imports and exports of Pennsylvania's hardwood products

Solid hardwood sectors	Regional consumption		Foreign		Domestic		Total regional		Regional		Net domestic export/import
	of regional production		export	import	export	import	output	consumption	Imports	export/import	
160 - Logging camps and logging contractors	\$485.1		\$10.1		\$110.1		\$604.1	\$636.1	\$141.1		-\$31.1
161 - Sawmills and planing mills, general	\$378.1		\$17.1		\$437.1		\$832.1	\$651.1	\$255.1		\$181.1
162 - Hardwood dimension and flooring mills	\$61.1		\$1.1		\$87.1		\$149.1	\$85.1	\$24.1		\$64.1
164 - Millwork	\$124.1		\$2.1		\$148.1		\$274.1	\$149.1	\$23.1		\$126.1
165 - Wood kitchen cabinets	\$51.1		\$1.1		\$429.1		\$481.1	\$54.1	\$3.1		\$427.1
170 - Wood pallets and skids	\$33.1		\$1.1		\$107.1		\$140.1	\$36.1	\$3.1		\$104.1
174 - Wood household furniture	\$195.1		\$28.1		\$0.1		\$222.1	\$357.1	\$134.1		-\$134.1
176 - Wood TV and radio Cabinets	\$6.1		\$3.1		\$7.1		\$15.1	\$11.1	\$3.1		\$5.1
177 - Upholstered household furniture	\$100.1		\$5.1		\$0.1		\$105.1	\$242.1	\$137.1		-\$137.1
180 - Wood office furniture	\$37.1		\$5.1		\$81.1		\$123.1	\$52.1	\$10.1		\$71.1
182 - Public building furniture	\$18.1		\$0.1		\$18.1		\$37.1	\$46.1	\$28.1		-\$10.1

The contribution of an industry to the state's economy can also be measured by its value added. This measures the benefits accruing to employees as wages and salaries, to industrial ownership as profits, and to the government sector as taxes and transfers. The SHP industries contributed over \$1.1 billion to Pennsylvania's gross product of \$176 billion, including 0.6 percent of the total value added to the state economy and 2.4 percent of the value added contributed by manufacturing. The largest individual contributors of value added were again the sawmill sector (\$365 million), the logging sector (\$206 million) and the kitchen cabinet sector (\$190 million).

Other measures of an industry's importance to society are the people hired and the wages they received. The SHP industries paid out \$716 million in wages and salaries to over 38,000 employees in 1987. This represented 1.9 percent of manufacturing wages and 3.6 percent of manufacturing jobs in the state. Overall, these industries represented 0.6 percent of all wages and 0.8 percent of all jobs in the state. The leading SHP sectors in wage payments were the sawmill sector (\$173 million), the kitchen cabinet sector (\$162 million) and the logging sector (\$92 million). In terms of employment, these sectors supplied 9796, 6358, and 4794 jobs, respectively.

### **SUMMARY OF THE INPUT-OUTPUT CHARACTERISTICS OF THE SHP GROUP**

A review of the commodity balances for the solid hardwood products is provided in Table 2. The net trade deficit registered in logging products was largely due to the import of softwood fiber for paper manufacturing. In terms of hardwood logs, Pennsylvania was a net exporter to adjacent states and to foreign markets. A substantial domestic and foreign export of sawmill products was also evident. The general viability of Pennsylvania's hardwood forest as a raw material base was evident in the export of \$119 million in logs and \$454 million in sawmill products. In part, the prominence of hardwood lumber was partially masked by the import of softwood lumber for residential home building.

Dimension and flooring, and pallet products, largely represented a subsidiary component of sawmill products. As a means of increasing the sale of middle and lower grades of lumber, additional manufacturing was involved in this set of products. Substantial export was evident among these products, with dimension having a gross export of \$88 million and pallets of \$107 million.

Although millwork proved to be another major source of net exports, there was some question whether this group of products was dependent on hardwood resources. The focus on windows, doors, and allied residential building products suggested that these were largely softwood products, having limited ties to Pennsylvania's forests.

At the secondary processing level, two products showed a certain competitive advantage for Pennsylvania; kitchen cabinets and wood office furniture. Kitchen cabinets had a net domestic export of \$427 million and office furniture of \$71 million. Both product groups utilized substantial volumes of hardwood input from Pennsylvania. However, they also used a wide array of other inputs, including plastics, hardware, paints, and softwood-based products. In all probability, the regional advantage enjoyed by the kitchen cabinet industry was closely linked with the residential housing market along the East Coast.

Only limited economic advantages were evident among the remaining secondary products, namely wood household, upholstered, and public building furniture. As a group, their manufacture amounted to \$363 million. However, the regional market for these products was \$645 million, with \$281 million in products imported to Pennsylvania.

## CONCLUSIONS

The IMPLAN model for Pennsylvania's economy was compared with other independent data sources. Several sets of modifications were required to provide a realistic description of the state's solid hardwood product industries. The small firm size of some processing sectors removes them from having to report their employment to state unemployment insurance programs, a key source of activity levels for the regional IMPLAN data sets. The lack of distinction between hardwoods and softwoods in the model's data sets, meant that the regional purchase of these products was misstated.

The sawmill and planing mill industry was the largest component of the solid hardwood sectors. Additional sectors of significance included the logging sector, the kitchen cabinet sector and the household furniture sector. In terms of bringing outside income into the state, the kitchen cabinet sector provided the greatest impacts. The wood household furniture and the upholstered furniture sectors were large net import sectors, and consequently represent opportunities for expansion in the state economy.

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