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A Regional Analysis of Pallet Supply and Demand

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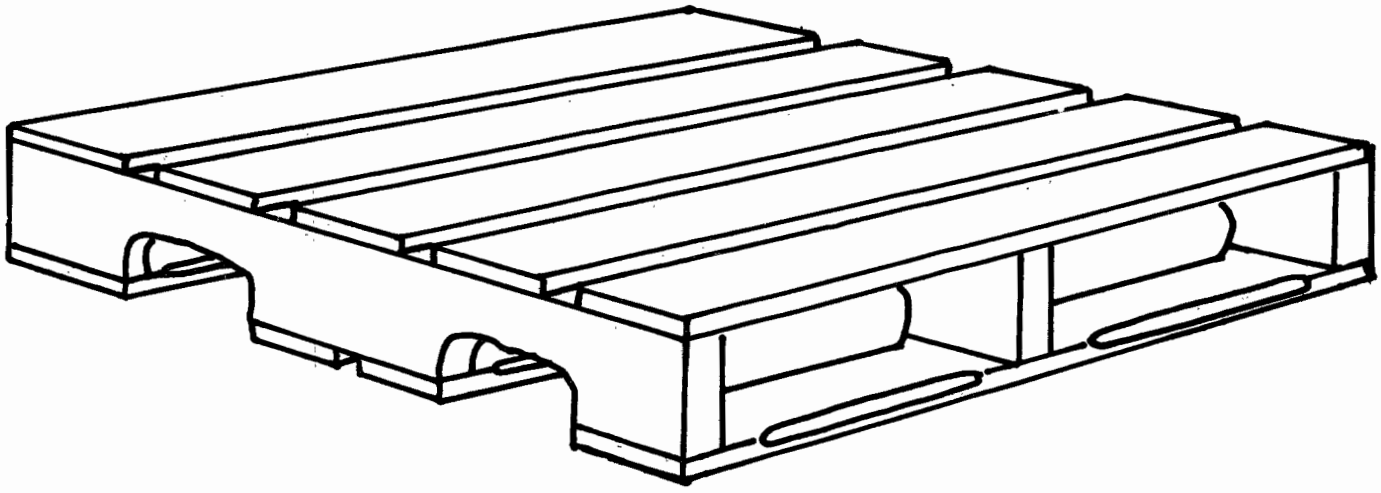

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Abstract

Eight regional demand and supply equations for pallets were developed in this study. Demand for pallets is affected by the price pallet users receive for their products, the price pallet users pay for labor, and past price of labor versus the cost of new capital equipment as approximated by interest rates. Pallet production is affected by pallet price, past lumber price, past wage rates in the pallet industry, and an index of labor productivity. Results indicate that forces outside of the pallet market tend to influence pallet demand, while forces inside of the pallet market greatly influence pallet supply. However, since the level of demand has a great deal of influence on pallet price, it is concluded that the pallet market is strongly influenced by overall general economic activity, while it is only weakly influenced by activity within the forest products markets.

Introduction

The pallet industry has grown rapidly since 1935, with major growth periods in the early and late 1970's (Fig. 1). Both of these strong growth periods were marked by increasing industrial output coupled with escalating labor costs. The only major downturn in pallet production occurred during the 1974-75 and 1981-82 economic recessions.

In 1982, the pallet industry consumed more than 3 billion board feet of hardwood lumber and more than 600 million board feet of softwood lumber. These quantities represent a minimum of 36 percent of the hardwood lumber and 9 percent of all lumber consumed in the United States during 1982. This level of consumption makes the pallet industry the largest user of hardwood lumber and the second largest user of all lumber in the United States.

If present pallet use and pallet construction methods are continued, the resulting demand for hardwood lumber for pallets has the potential to cause regional problems in the supply of hardwood raw material. In order to assess the impact that the pallet industry will have on the regional distribution of our hardwood resource in the future, information on the regional demand, supply, and price of pallets is needed.

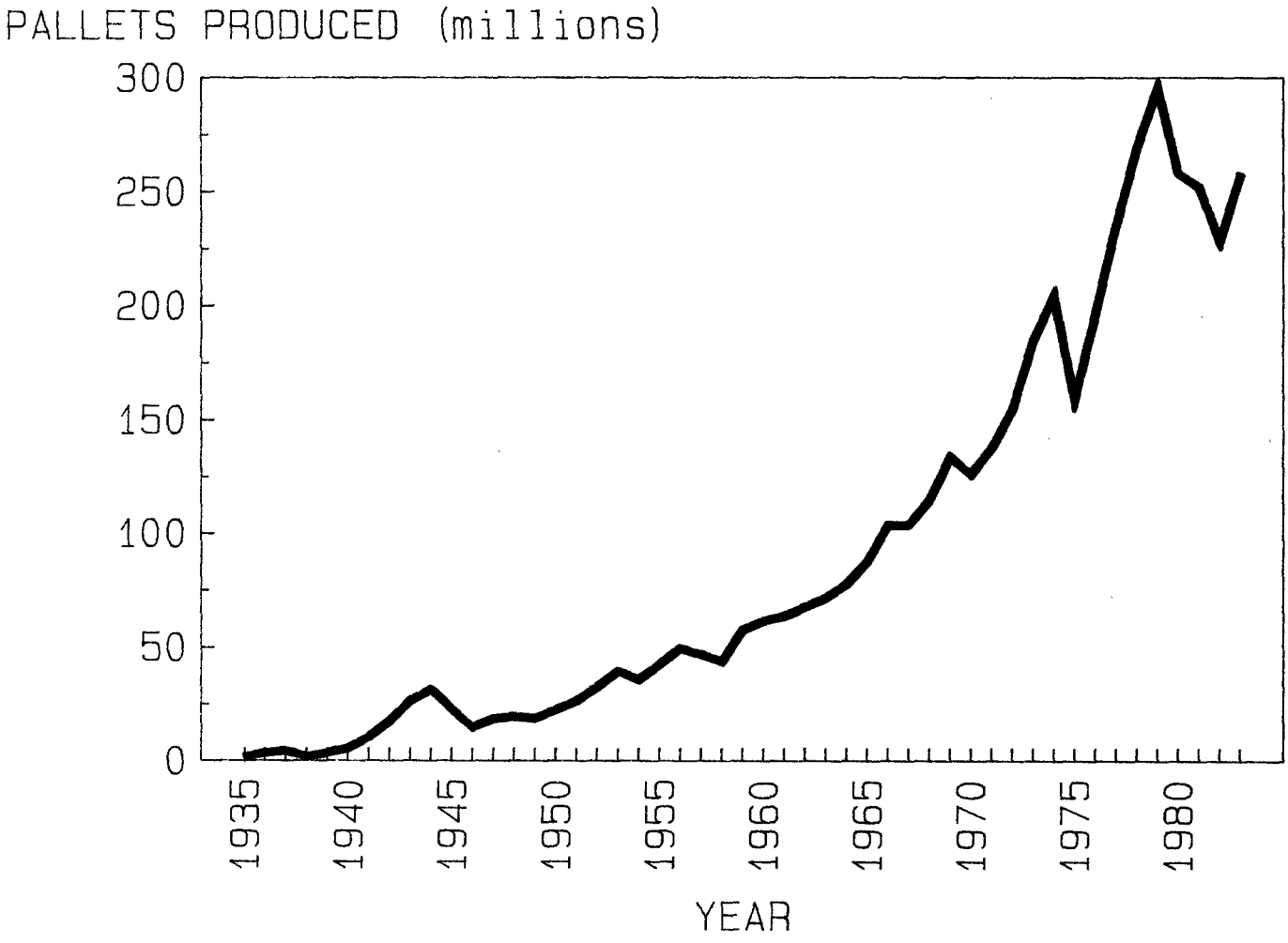

Figure 1.—Pallet production 1935-83.

The Pallet Market

Pallets are produced nationwide at approximately 1,800 plants employing more than 23,000 workers (U.S. Department of Labor 1984[1]). Pallets are an inexpensive product produced from low-grade lumber at relatively small plants that employ unskilled or semi-skilled labor. However, the cost of transporting pallets is high relative to the cost of pallet production. Therefore, pallets are normally produced in close proximity to the purchaser.

Pallet firms tend to produce for local or regional markets, depending in part on the size of the firm. Very small firms tend to compete solely in local markets, while the larger firms tend to compete in larger geographic areas. In a study of pallet firms in the Northeast by Bond and Sendak (1970), nearly 50 percent of the firms employed fewer than 10 persons and competed entirely in local markets.

Factors Affecting the Supply and Demand of Pallets

The major factors that affect pallet demand and supply—along with the variables that represent these factors, the influence of these factors on demand or supply, and the time it takes for a change in these factors to affect the pallet market—are listed in Tables 1 and 2, respectively.

Because pallets are low-value products with relatively high transportation costs, it is assumed that regional pallet demand equals regional pallet supply. This assumption implies a separate set of demand and supply equations for each region. Therefore, quarterly equations were estimated for each of eight census regions of the United States. These regions as defined by the U.S. Department of Commerce are:

Region	*State*
New England	ME, NH, VT, MA, RI, CT
Middle Atlantic	NJ, NY, PA
East North-Central	OH, IL, IN, MI, WI
West North-Central	MN, IA, MO, ND, SD, NB, KS
South Atlantic	DE, MD, VA, WV, NC, SC, GA, FL
East South-Central	AL, KY, TN, MS
West South-Central	AR, LA, OK, TX
Pacific	CA, OR, WA

[1]U.S. Department of Labor, Bureau of Labor Statistics. ES-202 program, employment and wages, SIC 2448, quarterly data for period 1975 through 1983. Unpublished report. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics; 1984. 58 p.

The factors affecting the demand and supply of pallets are derived from economic theory and observation of the pallet market. Using economic theory, we ascertain that pallet demand is positively affected by the price pallet users receive for their product (output price) and negatively affected by the price of pallets and the price of labor. The ratio of wage rates to capital is included in the demand equation to account for the trade-off between a labor-intense system employing manpower and a capital-intense system employing pallets.

Economic theory also indicates that the supply of pallets is positively affected by the price of pallets and negatively affected by the price pallet producers pay for labor and lumber. Pallet supply is also affected by changes in production processes leading to greater labor productivity. To account for this change, a labor productivity index has been included in the supply equations.

A mathematical representation of the demand and supply equations, along with a full description of the variables in these equations, is presented in Appendix A. The weight scheme used to develop the regional output price and demanders' wage rates is in Appendix B. The species used to calculate regional lumber price are in Appendix C.

The impact time periods associated with the different variables in the demand and supply equations represent the time it takes pallet users or producers to react to changes in the variables listed in Tables 1 and 2. The choice of the length of the impact times was based on observation of the pallet production and purchasing decisions and empirical evidence gained through statistical estimation of the demand and supply equations. These impact times may or may not be representative of the behavior of any particular pallet producer or user, but are representative of the aggregate or total demand and supply forces at work in the pallet market.

The impact period of 4 to 6 quarters associated with pallet price in the demand equation (Table 1) indicates that after a change in pallet price, it takes pallet users about a year to start to react and another 4 quarters to fully react to this change. The length of time it takes pallet users to react to changes in pallet prices is affected by the way in which pallets are purchased. Because pallets are a minor input in the manufacturing and distribution costs for pallet-using industries, the decision to purchase pallets is made on an annual or semi-annual basis and is, therefore, probably based on expected future pallet price. The expected price is, in turn, probably based on past pallet prices. The reaction time between changes in pallet price and pallet demand is further retarded by the 1- to 6-month time period between the decision to purchase pallets and the actual ordering of pallets.

Table 1.—Major factors affecting pallet demand, the impact of these factors on pallet demand and the length of time it takes these factors to impact demand. The names of variables used to represent the factors are in parentheses

Factor	Impact of factor	Impact time
Regional price index of products produced by industries that use pallets (output price)	Positive	Immediate
Price of pallets (pallet price)	Negative	4 to 6 quarters
Regional wage rates in industries that use pallets (demanders' wage rate)	Negative	Immediate
Ratio of wage rates to interest rates (wage interest ratio)	Positive	9 to 12 quarters

Table 2.—Major factors affecting pallet supply, the impact of these factors on pallet supply, and the length of time it takes these factors to impact supply. The names of variables used to represent the factors are in parentheses

Factor	Impact of factor	Impact time
Price of pallets (pallet price)	Positive	Immediate
Regional price of low-grade lumber (lumber price)	Negative	3 to 6 quarters
Wage rates in the pallet industry (suppliers' wage rates)	Negative	3 to 6 quarters
Index of labor productivity in the pallet industry (index of productivity)	Positive	3 to 6 quarters

The impact time associated with a change in wage rates relative to interest rates (the wage rate/interest rate ratio) is lengthy because of the time it takes to recognize the potential of palletizing, develop a palletized handling system, and implement such a system. We assume that it takes potential pallet users 1 year to recognize the need for a pallet system, another year to plan for a materials handling system that uses pallets, and a third year to implement the system.

The impact time period associated with lumber price, wage rates, and labor productivity variables in the supply equation is 3 to 6 quarters. Work by Schuler and Wallin (1983) and Luppold (1984) has indicated that past input prices affect current pallet production. The length of time it takes pallet producers to react to changes in prices results from a number of factors, including the tendency of pallet firms to stockpile materials and price inventories on a first-in/first-out basis. Because many pallet producers tend to inventory lumber, past lumber price affects current pallet supply. Another factor that causes delayed responses in pallet production after a change in production costs is the lack of precise day-to-day data on the cost of production and net revenue.

Statistical Results

The statistically estimated regional demand and supply equations are shown in Tables 3 and 4, respectively. All dependent and independent variables were transformed by taking the natural logarithm, resulting in equations of multiplicative form.

The estimated demand equation fitted the data well; the multiple correlation coefficients (R^2's) ranged between 0.79 and 0.94. The signs of all coefficients in all regional equations were as expected—coefficients associated with output price and the labor/capital ratio were positive and the coefficients associated with pallet price and wage rates were negative. The coefficients associated with pallet price, output price, wage rates, and the ratio of wage rates to interest rates were significant across all regions at the 0.05 alpha level or higher.

The estimated supply equation also fitted the data well; the R^2 ranged between 0.86 and 0.97. Again, the signs of all supply equation coefficients were as expected—the coefficients associated with pallet price and the labor productivity index were positive and the coefficients associated with lumber price and wage rates were negative. The coefficients associated with all variables in the eight supply equations were significant at the 0.05 alpha level or higher, except for the coefficient associated with lumber price in the Pacific Region. The insignificant coefficient associated with lumber price in the Pacific Region probably resulted from the fact that no satisfactory lumber price series could be found to reflect the type of lumber used by western pallet manufacturers.

The Durbin Watson (DW) statistics indicate some degree of first-order autocorrelation in the South Atlantic supply regions. All other DW statistics fell within the indeterminate area of the DW table. Because autocorrelation is an efficiency problem and the individual coefficients of the South Atlantic supply equation are statistically significant, no adjustment for autocorrelation was completed.

Analysis of Results

The coefficients in Tables 3 and 4 were estimated to allow direct interpretation. The technical name for these coefficients is elasticities. An elasticity represents the percentage impact on a dependent variable (in this instance, pallet usage or production) caused by a 1-percent change in an independent variable (the variables outlined in Tables 1 and 2). Elasticities are useful because they provide information on the relative importance of a particular factor on demand or supply. For example, if the price of pallets were increased by 1 percent, the demand for pallets in the New England Region would decrease by 1.23 percent. Likewise, if the price of output increased by 1 percent in the New England Region, pallet demand would increase by 5.26 percent.

In Table 3, the size of the output price elasticity compared to the other price elasticities indicates that output price tends to heavily influence pallet demand. A strong gain in pallet demand tends to be linked to periods of high economic activity, while slumps in the pallet market correspond to low economic activity.

The second most influential variable affecting pallet demand, as indicated by the coefficients in Table 3, is wage rates in the industries demanding pallets. The wage-rate elasticity of demand is higher than the pallet-price elasticity of demand in every region where the coefficient associated with wage rates is statistically significant (valid).

The coefficient associated with the ratio of wage rates to interest rates is difficult to interpret. However, this variable indicates that capital is substituted for labor as the relative cost of capital decreases in relation to the relative cost of labor. The rather small coefficient and length of the reaction time associated with this variable indicate that this substitution occurs slowly.

Table 3.—Results of the demand equation estimation, by region

Region	Price output	Pallet price	Wage rates	Wage/interest ratio	R^2	DW
New England	5.26 (3.85)	-1.23 (-4.86)	-3.90 (-3.50)	0.50 (9.93)	0.82	1.56
Mid-Atlantic	5.21 (5.83)	-1.40 (-7.18)	-1.93 (-4.42)	0.53 (12.39)	0.94	1.51
East North-Central	3.59 (2.10)	-1.27 (-5.62)	-2.60 (-2.72)	0.38 (8.68)	0.79	1.28
West North-Central	5.71 (2.89)	-1.14 (-2.96)	-3.93 (-2.44)	0.66 (9.36)	0.87	1.19
South Atlantic	3.34 (3.79)	-1.22 (-6.63)	-1.87 (-2.79)	0.49 (11.79)	0.89	1.46
East South-Central	3.76 (2.95)	-1.36 (-5.45)	-3.00 (-2.84)	0.49 (10.41)	0.84	1.33
West South-Central	3.40 (2.78)	-1.15 (-4.19)	-1.93 (-1.97)	0.53 (10.41)	0.88	1.53
Pacific	4.71 (3.32)	-1.02 (-3.64)	-3.43 (-2.96)	0.48 (9.49)	0.84	1.48

t values are in parentheses.
t = 2.479 at 0.01 level of significance.
t = 1.706 at 0.05 level of significance.

Table 4.—Results of the supply equation estimation, by region

Region	Pallet price	Lumber price	Wage rates	Productivity index	R^2	DW
New England	1.98 (12.0)	-0.80 (-4.46)	-0.85 (-2.91)	1.62 (4.36)	0.89	1.19
Mid-Atlantic	2.07 (16.6)	-0.52 (-6.23)	-0.58 (-3.12)	1.53 (5.82)	0.97	1.13
East North-Central	2.06 (17.6)	-0.78 (-10.01)	-1.23 (-7.07)	1.45 (5.89)	0.92	1.39
West North-Central	2.45 (13.2)	-0.22 (-1.82)	-1.37 (-4.94)	2.29 (5.84)	0.95	1.44
South Atlantic	1.86 (13.0)	-0.61 (-6.46)	-0.72 (-3.39)	1.05 (3.49)	0.91	1.01
East South-Central	2.34 (17.9)	-0.83 (-9.59)	-1.66 (-8.52)	1.53 (5.55)	0.92	1.40
West South-Central	2.25 (13.2)	-0.65 (-5.76)	-0.71 (-2.77)	1.27 (3.53)	0.93	1.37
Pacific	1.52 (4.96)	0.02 (0.005)	-1.12 (-3.11)	1.68 (4.08)	0.86	1.08

t values are in parentheses.
t = 2.462 at the 0.01 level of significance.
t = 1.699 at the 0.05 level of significance.

Pallet price elasticity of demand is near or below 1 in every region, indicating that the demand for pallets is relatively insensitive to changes in pallet price. The fact that the demand elasticities of factors that are determined outside of the pallet market—output price and wage rates—are larger than pallet price elasticity indicates that general economic forces influence pallet demand more so than forces within the pallet market.

The information in Table 4 indicates that pallet price is the single most influential factor affecting pallet supply. The relative value of pallet-price elasticity to lumber-price elasticity and wage-rate elasticity indicates that, unlike pallet demand, pallet supply is very much affected by forces within the pallet market. In fact, in all but the East South-Central Region, the pallet-price elasticity of supply exceeded the sum of the lumber-price and wage-rate elasticities of supply.

Wage-rate elasticity of supply and lumber-price elasticity of supply are very similar for half of the regional supply equations. There seems to be a marked difference between the central regions and eastern regions. The one exception to this rule is the West South-Central Region, which is primarily the state of Texas. Since the central regions are associated with heavy industry and a large degree of unionization, it is expected that the larger wage-rate elasticity of supply is a result of the degree of unionization in the central regions.

The index representing changes in labor productivity on the supply of pallets indicates that a great deal of labor-saving capital investments occurred in the pallet industry during the last 10 years. This degree of labor productivity is indicated by the fact that employment in the pallet industry increased by 42 percent between 1975 and 1983, while pallet production has increased by 62 percent.

Regional differences were observed in the magnitude of some of the estimated elasticities. For example, pallet users in the industrialized regions of the North (New England, Mid-Atlantic, and West North-Central) were more sensitive to changes in output price than pallet users in other regions. In the industrial North, the pallet-using industries are concentrated in the primary and fabricated metal manufacturing and machinery manufacturing areas. These industries may be sensitive to the general economic climate and adjust their pallet purchases with each change in the economy.

Price elasticity of supply for pallets is relatively large in all regions. Pallet producers are expected to adjust levels of production rather quickly in response to changes in the market price of pallets. To be competitive, some pallet producers must adjust their levels of production by entering or leaving the market.

Summary and Conclusions

Eight regional demand and supply equations were developed in this study. In these equations, pallet demand is developed as a function of the prices of the demander's inputs used with pallets and the price of the pallet demander's output, and pallet supply was developed as a function of the prices of inputs used in the pallet production process and the price of pallets.

The results of these equations indicate that significant variation exists in pallet demand and supply in the eight different regions. Regional equations can be considered as opposed to a national equation that would ignore regional variation. The estimated demand and supply equations fitted the data well—the R^2 ranged from 0.76 to 0.97. Estimates of output-price elasticity, wage-rate elasticity of demand, and pallet-price elasticity of supply indicate that these are major factors influencing the quantities of pallets in each of the regional markets.

In the demand equations, output-price elasticity is always larger than either of the input elasticities, that is, the wage-rate or pallet-price elasticities. In six of the eight regions, output-price elasticity is also larger than the sum of these two input-price elasticities. Additionally, the wage-rate elasticity of demand is generally higher than pallet-price elasticity. As noted before, output price and pallet demanders' wage rates are determined outside the pallet market. Thus, general economic forces that determine the level of these variables have a greater effectd on the pallet demand than the effect of forces within the pallet market.

In the supply equations, the relative magnitude of the pallet-price elasticity in comparison to input-price elasticities for lumber price and wage rates indicates that, unlike pallet demand, pallet supply is very much affected by forces within the pallet market. As noted earlier, in all but one region, pallet price elasticity is larger than the sum of lumber-price and wage-rate elasticities. Thus, pallet price exerts a greater influence on the quantity of pallets supplied than the other forces within the pallet market.

The analysis shows that differences exist among regions with respect to pallet demand and supply. Factors that influence these differences include pallet price, price of outputs, and wage rates of pallet demanders. This analysis should provide a sound basis for future assessments of regional pallet demand, supply, and price.

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Appendix A

Demand and Supply Equations

Demand Qd = f(PO, PPID3, ED3, EID4)
Supply Qs = g(PPI, PLUD2, PLSD2, ILPRD2)

where:

Qd =	Regional quantity of pallets demanded in quarter t.
Qs =	Regional quantity of pallets supplied in quarter t.
PO =	Weighted regional producer price indexes for industries that use pallets. Source of price indexes: Bureau of Labor Statistics. Weights used to calculate regional indexes are in Appendix B.
PPID3 =	Pallet price index specified as a polynomial distributed lag t-4 to t-7. Source of price index: Bureau of Labor Statistics.
ED3 =	Weighted regional wage rates for industries that use pallets, specified as a polynomial distributed lag t-4 to t-7. Source of wage rates: Bureau of Labor Statistics. Weights used to calculate regional wage rates are in Appendix B.
EID4 =	Ratio of regional wage rates in industries that use pallets to the interest rate on 90-day commercial paper, specified as a polynomial distributed lag t-9 to t-12. Source of interest rates: Survey of Current Business.
PPI =	Price index of pallets. Source: Bureau of Labor Statistics.
PLUD2 =	Regional price of lumber specified as a polynomial distributed lag t-3 to t-6. Source of lumber prices: Hardwood Market Report. Specific species used in calculating regional lumber prices are in Appendix C.
PLSD2 =	Wage rates in the pallet and wood container industry, specified as a polynomial distributed lag t-3 to t-6.
ILPRD2 =	Index of labor productivity in the pallet industry measured as the value of shipments per man-hour, specified as a polynomial distributed lag t-3 to t-6.

Appendix B

Weights Used to Calculate Regional Indexes for Pallet-Using Industries

Industry	Region							
	New England	Mid-Atlantic	East North-Central	West North-Central	South Atlantic	East South-Central	West South-Central	Pacific
Food	0.07	0.12	0.09	0.21	0.13	0.14	0.17	0.17
Textiles	0.09	0.06	0.00	0.01	0.31	0.11	0.01	0.01
Paper	0.09	0.06	0.04	0.05	0.06	0.06	0.05	0.05
Chemicals	0.04	0.10	0.05	0.04	0.09	0.12	0.12	0.05
Rubber, plastics	0.08	0.06	0.07	0.06	0.03	0.06	0.06	0.06
Stone, clay, glass	0.02	0.05	0.03	0.06	0.06	0.05	0.06	0.05
Primary metal	0.06	0.14	0.13	0.04	0.06	0.10	0.07	0.06
Fabricated metal	0.16	0.13	0.17	0.12	0.07	0.12	0.15	0.13
Machinery	0.24	0.19	0.22	0.27	0.09	0.12	0.19	0.16
Transportation equipment	0.15	0.09	0.20	0.14	0.10	0.12	0.12	0.26

Appendix C

Specific Species Used in Calculating Regional Lumber Prices

Region	Species[a]
New England	Northern red oak (Grades 2C and 3A) and Northern hard maple (Grade 2C)
Mid-Atlantic	Northern red oak (Grades 2C and 3A)
East North-Central	Northern red oak (Grades 2C and 3A)
West North-Central	Northern red oak (Grades 2C and 3A)
South Atlantic	Southern red oak (Grades 2C and 3A)
East South-Central	Southern red oak (Grades 2C and 3A)
West South-Central	Southern red oak (Grades 2C and 3A)
Pacific	Softwood lumber price index, from Fingertip Facts and Figures, published by NFPA, Washington, D.C.

[a]Prices for individual species taken from *Hardwood Market Report* (Lemsky 1972-84), first week in each quarter.

Luppold, William G.; Anderson, R. Bruce. **A regional analysis of pallet supply and demand.** Res. Pap. NE-580. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1986. 8 p.

This paper examines the factors that affect regional pallet supply and demand by developing, estimating, and interpreting models for the eight major census regions with viable pallet markets.

ODC 721

Keywords: Econometric; production; usage

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