

**by Albert T. Schuler
and Walter B. Wallin**

AN ECONOMETRIC MODEL OF THE U.S. PALLET MARKET



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NORTHEASTERN FOREST EXPERIMENT STATION
370 REED ROAD, BROOMALL, PA. 19008

The Authors

ALBERT T. SCHULER received his B.S. degree in forestry from Syracuse University and his Ph.D. degree in forest economics from Iowa State University. He began his career with the Forest Service in 1975 and is currently a research economist at the Northeastern Forest Experiment Station's Forestry Sciences Laboratory in Princeton, West Virginia.

WALTER B. WALLIN received his B.S. and Ph.D. degrees from the University of Minnesota. His experience includes 8 years' teaching and research, 5 years in consulting, and 5 years as technical advisor to the Bangladesh Forest Research Institute at Chittagong, Bangladesh. He is currently a research wood technologist at the Northeastern Forest Experiment Station's Forestry Sciences Laboratory in Princeton, West Virginia.

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Abstract

A need for quantitative information on demand and price has been expressed by the pallet industry. In response to this, an econometric model of the aggregate U.S. pallet market was developed. Demand was found to be affected by real pallet price, industrial and food production levels, and slipsheet prices. Supply was affected by real price, housing starts lagged 1 year, and productivity within the pallet industry. Industrial production activity had the strongest impact on pallet demand, while real price was the most influential supply variable. Consumption and price projections were developed to illustrate the model's use for providing long-term investment and resource planning information.

INTRODUCTION

THE U.S. PALLET INDUSTRY is composed of approximately 1,300 pallet manufacturing firms; about 50 percent employ less than 10 persons and fewer than 5 percent employ more than 50 persons (Bureau of the Census 1954-1977). The industry is a significant consumer of sawed wood products, accounting for 15 percent of total U.S. production and nearly 40 percent of U.S. hardwood production.

About 20 percent of the total movement of domestic products could be handled by pallets, and 5 percent is palletized.¹ Pallet production increased at an annual compound rate of 8 percent between 1960 and 1975 for a total increase of 271 percent, and the growth picture is equally as promising.

As with any competitive industry, the pallet industry needs quantitative market information. For instance, we know that pallet consumption is influenced by production activity, however, we do not have estimates of how much it will increase if industrial production increases. An analysis of a recent survey of National Wooden Pallet and Container Association members by Wallin and Hill² identified a specific need for demand and price information. Seventy-nine percent of the survey respondents said some research was needed while 35 percent said much research was needed. Groups most interested in this information were understandably the sawmill operators and pallet distributors.

Estimates of future demand and price levels should be major determinants of capital expansion in the industry. In addition, estimates of demand can be used to determine potential problems of resource supply and when they might occur. A major concern of the industry

is the availability of wood resources for pallet manufacture. Will future pallet production exert a serious strain on economically available wood resources? If so, when, and what can be done to avert potential problems? Will the currently used mix of sawed wood resources have to be changed?

The purpose of this study was to develop a method that can be used by the pallet industry to address such questions, and we used econometrics to develop a model of the U.S. pallet market. The specific objectives were: (1) to identify variables that are reliable predictors of pallet supply and demand by developing a demand-supply model; (2) to develop projection equations with which to quantify the relationships between these variables and pallet consumption and price; and (3) to illustrate how the model can be used to project estimates of annual equilibrium pallet consumption and price levels for the United States.

METHODS AND ANALYSIS

An equilibrium model, consisting of a demand and a supply equation and an identity, was developed. Initially it appeared that the relationship might be logarithmic, since preliminary plots of pallet production over time suggested a logarithmic trend. However, similar plots of pallet production versus other explanatory variables did not show a definite logarithmic relationship.

A further check on the functional form of the model was carried out by estimating a linear version and analyzing it for evidence of serial correlation. Evidence of serial correlation would be an indication that the functional form was incorrect. The residual plots showed no apparent patterns or trends. In addition, the Durbin-Watson D statistic was insignificant, thus lending further evidence of no serial correlation. Therefore, the authors felt that there was not a strong case for using a nonlinear model, and a linear model was adopted.

¹Wallin, Walter B. 1977. Characteristics of the U.S. pallet industry. Unpubl. rep. on file at For. Sci. Lab., Princeton, W. Va. 78 p.

²Wallin, W. B., and M. E. Hill. 1978. Report on NWPCA research survey. Unpubl. rep. on file at For. Sci. Lab., Princeton, W. Va. 107 p.

The general form of the model is:

$$\text{Demand} = \alpha_d P + \beta_0 + \beta_1 X_{d1} + \dots + \beta_p X_{dp} + e_d$$

$$\text{Supply} = \alpha_s P + \gamma_0 + \gamma_1 X_{s1} + \dots + \gamma_q X_{sq} + e_s$$

Demand = Supply = Consumption
where:

Consumption =	domestic production
P =	pallet price
$X_{d1} \dots X_{dp} =$	demand predictor variables
$X_{s1} \dots X_{sq} =$	supply predictor variables
$\alpha_d, \alpha_s =$	regression coefficients for price
$\beta_1 \dots \beta_p =$	regression coefficients for independent demand variables
$\gamma_1 \dots \gamma_q =$	regression coefficients for independent supply variables
$e_d, e_s =$	error term for demand and supply equations, respectively
$\beta_0, \gamma_0 =$	intercept term for demand and supply equations, respectively

The equilibrium model accounts for the interaction between demand and supply, and the interdependence of price and consumption levels. The data base was annual observations of each variable over the sample period 1960 to 1975. Observations for 1976 to 1978 were reserved to test the predictive ability of the model. The data sources for pallet price (mill realization) and pallet production were annual reports of the National Wooden Pallet and Container Association, Washington, D.C.; for the industrial and food production index and housing starts, the Bureau of the Census, 1960-1975; for productivity in the pallet industry, the Bureau of the Census, 1954-1977; and for slip-sheet prices, the Fibre Box Association annual report, 1978.

The three-stage least squares (3SLS) procedure was used to estimate the parameters in the demand and supply equations. Three-stage least squares was selected over other simultaneous equation procedures because it reduces computation and because computer algorithms, such as the SYSREG routine in SAS-76 (Barr et al. 1976), are readily accessible and inexpensive to use.

SPECIFICATION OF PALLET MARKET MODEL

Specification of a model includes the identification of major factors affecting demand and supply. Economic theory provided a basic framework that was augmented by discussions with experts in pallet marketing. Specification also includes assumptions about the simultaneity—or lack of—in the market system. We believe that the pallet system is a simultaneous system because pallet price and quantity appear to be determined jointly.

An alternate market structure would be a recursive system, where quantity in period (t) is a function of lagged prices. Evidence from substantial information on market prices available to pallet producers and users indicates that the simultaneous system more nearly approximates the structure of the pallet market.

For purposes of this study, pallets can be considered producer goods as opposed to consumer goods. McKillop (1967) described the demand for such goods as a function of their price, the price of substitutes, and the output of the user. Supply is a function of the price of goods and the costs incurred in the production process.

Our discussions with marketing people in the industry led us to consider two additional factors for the demand relationship: (1) availability of capital as a measure of business' ability to buy pallets; and (2) an automation index to measure the feasibility of the manufacturing industry to implement a unitized handling system. On the supply side, we also included a factor to measure the availability of wood raw materials to the pallet industry.

Next, variables had to be selected that could represent the identified factors. Selected variables had to be measurable, and projections of them had to be available for use in the consumption and price forecasting equations.

Tables 1 and 2 list the major factors assumed to affect pallet demand and supply, initial candidate variables selected to represent these factors, the expected relationships between the variables and supply and demand, and their units of measurement.

Table 1.—Major demand factors, variables, expected relationships between variables and demand, and units for the pallet model. The designations in parenthesis in the variable column represent the same variables in equations 1 through 4

Factor	Variable	Expected relationship	Unit
U.S. industrial and food production activity	An index of the weighted average production of durable and nondurable manufactured goods (Ind. production)	Positive	Index (1967 = 100)
Automation index in materials handling field	Shipments of electric industrial trucks (Automation index)	Positive	1000 units
Capital availability in U.S. manufacturing industry	Weighted average of profit after taxes of U.S. manufacturing corporations (durables and nondurables) (Capital)	Positive	\$ billion 1967
Pallet Price	Mill realization price which equals total dollar volume of sales ÷ total units produced. This was then converted to an index and deflated by the Wholesale Price Index (Pallet price)	Negative	Index (1967 = 100)
Price of substitute	Weighted average of corrugated and solid fiber value of shipments ÷ volume of shipments. (Slipsheet price)	Positive	Index (1967 = 100)

Table 2.—Major supply factors, variables, expected relationships, and units for the pallet model. Designations in parenthesis in the variable column represent the same variables in equations 1 through 4

Factor	Variable	Expected relationship	Unit
Production costs	Weighted average price of 3A Common hardwood lumber and Douglas-fir utility grade (Wood)	Negative	Index (1967 = 100)
	Wage rate in pallet industry (Wages)	Negative	Wages per man-hour \$ 1967
	Price of electric power (Power)	Negative	Index (1967 = 100)
	Productivity in pallet industry (Productivity)	Positive	Value of shipments in \$ 1967 per man-hour production worker
Availability of wood raw materials	Housing starts lagged 1 year (Housing starts)	Positive	1000 units
Pallet price	Mill realization price which equals total dollar volume of sales ÷ total units produced. This was then converted to an index and deflated by the Wholesale Price Index (Pallet price)	Positive	Index (1967 = 100)

ESTIMATED DEMAND AND SUPPLY EQUATIONS

Parameters in the model were estimated by the 3SLS procedure of Zellner and Theil (1962). The information used to judge whether candidate variables should be retained in the final model were: (1) the size of the beta coefficient in relation to its standard error—the coefficient should be greater than its standard error (ordinarily the “t-statistic” is used, however, this statistic, as well as the R^2 statistic, is only asymptotically valid with 3SLS); (2) the significance of the Durbin-Watson D statistic—it was used to test for serial correlation in the residuals; (3) whether the estimated model met identification requirements; and (4) whether the parameters in the model had the expected sign. The sign was considered important in this study because clear economic interpretation of the model was desired. We were willing to sacrifice some explanatory power (reduction in R^2) to accomplish this goal if necessary.

In the process of estimating the demand equation, we experienced some serious multicollinearity problems because some of the variables are related to the general level of activity in the overall economy. The variable for capital and for the automation index were both highly correlated with industrial production with correlation coefficients greater than .9. We felt that industrial production was a more important explanatory variable, hence, we deleted the other two. Deletion was necessary because high multicollinearity could cause difficulty in interpreting the resulting parameters in the demand equation. The remaining variables in Table 1 (industrial production, pallet price, and slipsheet price) were retained in the proposed demand equation. This equation provided clear economic interpretation and had good explanatory power with an R^2 of .94. Each of the retained variables had a beta coefficient at least twice its standard error and had the expected sign.

Slipsheets are an alternative, or substitute, for the conventional wood pallet used in transportation and storage of goods. Economic theory suggests that prices of substitutes be included in a demand equation for a product.

In addition, one must decide whether the prices of substitutes and pallet demand, for example, are determined jointly during the same time period. If they are determined jointly, the model must be so specified.

We concluded that slipsheet prices are not determined jointly with pallet demand and can be treated as an independent variable. Slipsheet prices are determined primarily by economic activity in the paperboard industry as suggested by marketing experts with the American Paper Institute. In addition, we felt that pallet price, not slipsheet price, determines the feasibility of substitution. In essence, although slipsheets are substitutes, their price level is determined by forces outside the pallet system.

On the supply side of the model, three of our production cost variables were not significant. The price of wood raw materials used in pallet manufacture (weighted average of 3A Common hardwood lumber and Douglas-fir utility grade lumber) was not significant. There are two reasons suggested for this: (1) the price of lower grade hardwood lumber does not fluctuate nearly as much as that of the higher grades, hence the price series may not be a good explanatory variable; (2) more important, wood raw materials used in pallet manufacture are often a byproduct of the production of lumber for use in higher grade products such as furniture. Therefore, perhaps the availability of wood raw materials, rather than their price, has a stronger impact on the supply of pallets.

We felt that housing starts, lagged 1 year, were a representative measure of the availability of hardwood lumber. Justification for this assumption rests on the frequency of joint production between pallet raw materials (lumber) and materials for the furniture and cabinet industry. Furniture and cabinet production lags housing starts by a period of 6 months to 1 year, hence the rationale for lagging housing starts. Discussions with pallet manufacturers substantiated this assumption. Therefore, we included housing starts, lagged 1 year, as a supply variable in lieu of lumber prices.

Neither the price of electric power nor wage rates in the pallet industry were considered to be statistically significant. We believe that the productivity variable included probably ac-

counts for most of the variation in pallet supply that is due to the changing wage rates. As wage rates increase, this encourages technological improvements needed to keep production costs down. McKillop (1967) offered a similar explanation for nonsignificance of wage rates in other wood products industries.

Electric power costs did not fluctuate much prior to 1973, and perhaps the price series is really not a good explanatory variable over our data base. However, power costs have been increasing at the relatively rapid rate of 15 to 20 percent per year over the past 6 years. This suggests that the cost of power may play a more important role in supply decisions in the future.

The proposed supply equation included pallet price, housing starts, lagged 1 year, and a productivity variable. The productivity variable was weakest in terms of statistical significance, however, it met our retention criteria. The other variables were statistically stronger with beta coefficients twice their standard errors. The proposed equation offers adequate explanatory power with an R^2 of .83, and provides clear economic interpretation.

Serial correlation in the proposed model was not significant, which suggests that the linear model is adequate, and that no major variables were missing.

Proposed model

The proposed model was obtained by the 3SLS estimating procedure (standard error in parentheses):

$$(1) \text{ Demand} = -16961 - 2140 \text{ Pallet price} \\ (917)$$

$$+ 2845 \text{ Ind. production} \\ (520)$$

$$+ 501 \text{ Slipsheet price} \\ (189)$$

$$D = 2.07 \quad R^2 = .94$$

$$(2) \text{ Supply} = -233047 + 1965 \text{ Pallet price} \\ (978)$$

$$+ 6965 \text{ Productivity} \\ (5990)$$

$$+ 57.5 \text{ Housing starts} \\ (17.7)$$

$$D = 1.50 \quad R^2 = .83$$

PROJECTION EQUATIONS AND ELASTICITIES

The demand and supply equations (1 and 2) were solved simultaneously to yield reduced form equations suitable for projecting pallet consumption and price.

$$(3) \text{ Consumption} = -129635 + 1361.5 \text{ Ind.} \\ \text{production} + 239.8 \\ \text{Slipsheet price} + 3631.8 \\ \text{Productivity} + 30.24 \\ \text{Housing starts}$$

$$(4) \text{ Price} = 52.63 + .693 \text{ Ind. production} + \\ .122 \text{ Slipsheet price} - 1.696 \\ \text{Productivity} - .014 \text{ Housing} \\ \text{starts}$$

Elasticities for the pallet model

The relative importance of each variable in the pallet model can be determined by its elasticity; that is, the percent change in the dependent variable associated with a 1 percent change in one of the independent variables, with everything else held constant. However, the reader is cautioned that elasticity is only a partial measure of impact because a change in one of the independent variables may affect other variables within and outside the pallet system that could offset or even amplify the resulting impact on the dependent variable.

Two types of elasticities were calculated: Consumption and price elasticities, which measure the impact of a change in an independent variable on the pallet system; and we also calculated the traditional elasticities which measure the impact of a change only on the demand or supply side of the market.

Again, the reader is cautioned that the demand and supply elasticities can be misleading. They do not integrate both sides of the market as do the system elasticities for con-

sumption and price (Patinkin 1965). However, they do provide useful information to the reader interested in analyzing one side of the market. Marketing analysts, for example, are often interested in identifying an independent variable that can be used as a good indicator of demand. Demand elasticities can provide such information as well as information on the sensitivity of demand or supply to pallet price changes. If one is interested in the total impact of the system of a change in an independent variable, then the consumption and price elasticities are appropriate. The elasticities are presented in Tables 3 and 4. The system elasticities are understandably smaller than the demand and supply elasticities.

Table 3.—Consumption and price elasticities for the pallet model. Elasticities are based on average values for each variable over the sample period

Variable	Consumption	Price
Industrial production index	1.19	.722
Housing starts (lagged 1 year)	.42	-.231
Productivity	.31	-.174
Slipsheet price	.22	.134

Table 4.—Demand and supply elasticities for pallet model. Elasticities are based on average values for each variable over the sample period

Equation	Variable	Elasticity
Demand	Pallet price	-1.84
	Industrial production	2.48
	Slipsheet price	.46
Supply	Pallet price	1.69
	Housing starts	.79
	Productivity	.60

The pallet system is most sensitive to industrial production with an elastic (≥ 1) consumption elasticity of 1.19 and an inelastic (≤ 1) price elasticity of .722. The consumption elasticity suggests that if industrial production

increased by 1 percent, pallet consumption could increase by 1.4 million units. The pallet system does not seem to be sensitive to any of the other independent variables as suggested by the low elasticities. The negative price elasticities for housing starts ($-.231$) and productivity ($-.174$) indicate that increases in these variables will lower real pallet prices, but by less than the increase in these variables.

The demand and supply elasticities listed in Table 6 again indicate the sensitivity of the pallet market to industrial production. The elasticities also suggest that demand and supply are sensitive to changes in real pallet price levels. The low demand elasticity for slipsheet price was expected because we had originally felt that pallet price was the dominating factor.

ILLUSTRATION OF MODEL USE

This section describes a procedure to develop projections for pallet consumption and price, and to validate the model. The assumptions we made can be modified easily to reflect changing market conditions and varying degrees of market knowledge possessed by potential users of the model. In addition, we describe some potential uses of the projections for developing scenarios of future pallet market conditions.

Projections for independent variables

Projections had to be obtained for the independent variables before projections beyond the data base could be made for consumption and price of pallets. It should be emphasized that accurate independent variable projections are critical to the model. We used Marcin's (1977) projections for housing starts, and made our own projections for the other variables.

A scenario of three sets of economic conditions was used to develop the projections: (1) medium level conditions, which assume these variables will continue their recent historical growth rate established over the period 1970 to 1977; (2) high level, which assume future rates of growth will be 15 percent greater than the historical rate; and (3) low level, which

assume future growth rates will be 15 percent lower than the corresponding historical rate. Fifteen percent was used because these variables have fluctuated by this amount over their established norms.

Table 5 shows the compound rates of growth assumed for each of the independent variables over the projection period.

Assessment of predictive ability

The projection equations (3 and 4) were evaluated for predictive ability by comparing predicted values (P) with observed values (A) for 1976-1978 (Table 6). We were interested in evaluating three aspects of the model's pre-

Table 5.—Assumed compound rates of growth for the independent variables under three sets of economic conditions

Variable	High	Medium	Low
	<i>percent</i>		
Industrial production			
Index	4.81	4.19	3.56
Actual slipsheet price	7.83	6.81	5.79
Productivity ^a	3.39	2.95	2.51

^aProductivity is measured in constant dollars (value of product shipment in \$ 1967 per man-hour of production worker).

Table 6.— v -coefficient, mean percentage error (MPE), and mean absolute percentage error (MAPE) for the projection period 1976-1978. Values near zero imply good forecasts

Projection	v -coefficient ^a	MPE ^b	MAPE ^c
	<i>percent</i>		
Consumption	.42	-14.3	14.3
Price	1.88	39.0	39.0

$$^a v = \frac{\sum_{i=1}^N \left[\left(\frac{P_i - P_{i-1}}{P_{i-1}} \right) - \left(\frac{A_i - A_{i-1}}{A_{i-1}} \right) \right]^2}{\sum_{i=1}^N \left(\frac{A_i - A_{i-1}}{A_{i-1}} \right)^2} \quad 1/2$$

$$^b \text{MPE} = \frac{1}{N} \left[\sum_{i=1}^N \frac{P_i - A_i}{A_i} \right] * 100$$

$$^c \text{MAPE} = \frac{1}{N} \left[\sum_{i=1}^N \frac{|P_i - A_i|}{A_i} \right] * 100$$

where:

A = Actual values
P = Predicted values
N = Sample size = 3

dictive ability: (1) ability to project the percentage annual change in consumption and price—Theil's (1975) v -coefficient was used in this assessment; (2) ability to project annual levels of consumption and price—the mean absolute percentage error (MAPE) and mean percentage error (MPE) were used in this assessment; and (3) ability to project changes in trend direction—turning point analysis was used for this purpose.

Results listed in Table 6 indicate that the pallet model projects consumption levels and percentage changes in these levels more accurately than those for real price. However, the model did not perform well over the test period. Consumption was underestimated by 14 percent, while price was overestimated by a rather large 39 percent. Due to these large forecast errors, we adjusted the projections beyond the test period (1979-1990). One adjustment process is discussed in the next section.

Turning point analysis for consumption was encouraging because there were no actual turning points (changes in trend direction) and the model predicted no turning points. The real price decreased from 1975 to 1976, continued to decrease in 1977, and then increased in 1978. The model missed the first turning point; however, it accurately predicted the second change (price).

Adjustment of projections

The authors were concerned with the large mean absolute percentage errors (MAPE) for both consumption and price over the test projection period. Therefore, we analyzed the residuals for the pallet model over the sample period 1960-1975. This analysis suggests that the model fits the sample data well with forecast errors of 6 and 3 percent, respectively, for consumption and price. We therefore concluded that a significant change had taken place in the pallet market between 1975-1978. Before projecting consumption and price beyond 1978, we felt that this change had to be incorporated into our projections.

Between 1975 and 1978, pallet consumption has been increasing at a compound annual rate of 21 percent, while the rate over the sample period was 8 percent. We felt that this

dramatic increase was largely due to the rapidly escalating energy costs since 1973. Increasing energy costs have forced many manufacturers to look for less costly materials handling systems—such as the pallet system. Another aspect of this increased demand is the fact that many of the new users of pallets are purchasing the cheaper, lower quality pallets because of budget limitations. These pallets must be replaced more frequently, thus further increasing demand.

Rapidly increasing energy costs were also affecting our pallet price projections. Pallet price used in the model was real price (actual price deflated by the Wholesale Price Index of all goods). The Wholesale Price Index (WPI) has been increasing much faster than actual pallet prices between 1975 and 1978. This has resulted in a decrease in real pallet prices over the test projection period. This is probably because items in the WPI are more energy dependent than pallet production.

Due to this dramatic change in pallet consumption and real price over the test period, we adjusted our projections for the period 1979 to 1990. The adjustment process is described below (McKillop 1967):

Adjusted forecast_(t) =

$$\hat{y}_t \left[\left(\frac{y_1}{3} + \frac{y_2}{3} + \frac{y_3}{3} \right) / \left(\frac{\hat{y}_1}{3} + \frac{\hat{y}_2}{3} + \frac{\hat{y}_3}{3} \right) \right]$$

where:

$\hat{y}_t$ = unadjusted forecast for year (t)

y_1 = actual value for 1976

y_2 = actual value for 1977

y_3 = actual value for 1978

$\hat{y}_1$ = unadjusted forecast for 1976

$\hat{y}_2$ = unadjusted forecast for 1977

$\hat{y}_3$ = unadjusted forecast for 1978

The projections were adjusted, upward or downward, by the average amount that the actual values for consumption or price differed from the unadjusted projections over the test period. Using this procedure, we attempted to bring the projections in line with the changes that took place over the test period. In essence, we changed the intercept but left the slope unchanged. Although we did not anticipate the need for such an adjustment process during the early development of this example,

it gave us an introduction on how to adjust projections if the need arises.

Adjusted projections for consumption and price

In this example, pallet consumption and price are projected to the year 1990 (Figs. 1 and 2). Consumption is projected to increase (1978 base) between 67 percent (low level) and 106 percent (high level). The medium level projection is for an 87 percent increase. The corresponding compound rates of growth are 4.3, 5.3, and 6.2 percent for the low, medium, and high projections. The real price index is projected to increase (1978 base) between 36 percent (low level) and 58 percent (high level). The medium level is projected to increase 46 percent. The compound rates of growth are 2.6, 3.2, and 3.9 percent, respectively.

Pallet consumption grew at a compound rate of 8 percent for the 15 years between 1960 and 1975, but our projections indicate that the growth rate may moderate in the future.

The data on future consumption and price levels provide an interesting basis for analyzing future pallet market developments. Potential users of the model can develop scenarios to describe various market conditions, anticipated technological changes in pallet use, future availability of wood raw materials, etc. These scenarios can be integrated with our projections, or with their independent projections, to evaluate alternative courses of action to avoid gross misallocation of resources.

One such scenario is that future raw materials supply will remain at historical levels and that technology of pallet use will remain the same, where the ratio of expendable pallets to returnable pallets is roughly one to one. Both of these assumptions are simplistic, but they serve to illustrate how the model can be used to analyze circumstances facing the pallet industry.

If the above scenario did in fact materialize, our projections of 500 million pallets by 1990 would approximate the wood raw materials currently economically available to the pallet industry. Of course, the weakness of such a scenario is that the supply of raw materials will not remain constant. Forest survey data

Figure 1.—U.S. pallet consumption projections under three sets of economic conditions. U.S. consumption=domestic production.

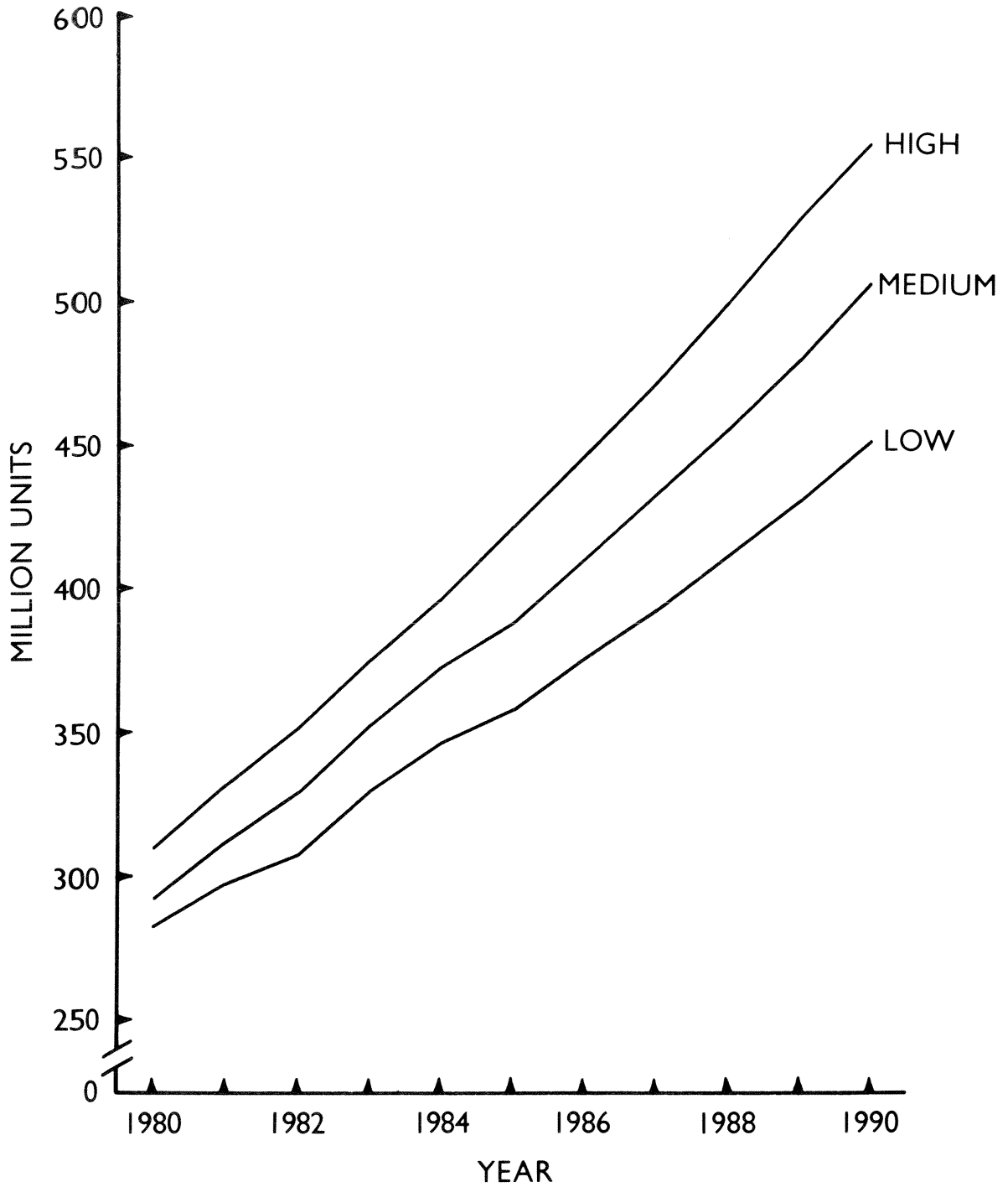
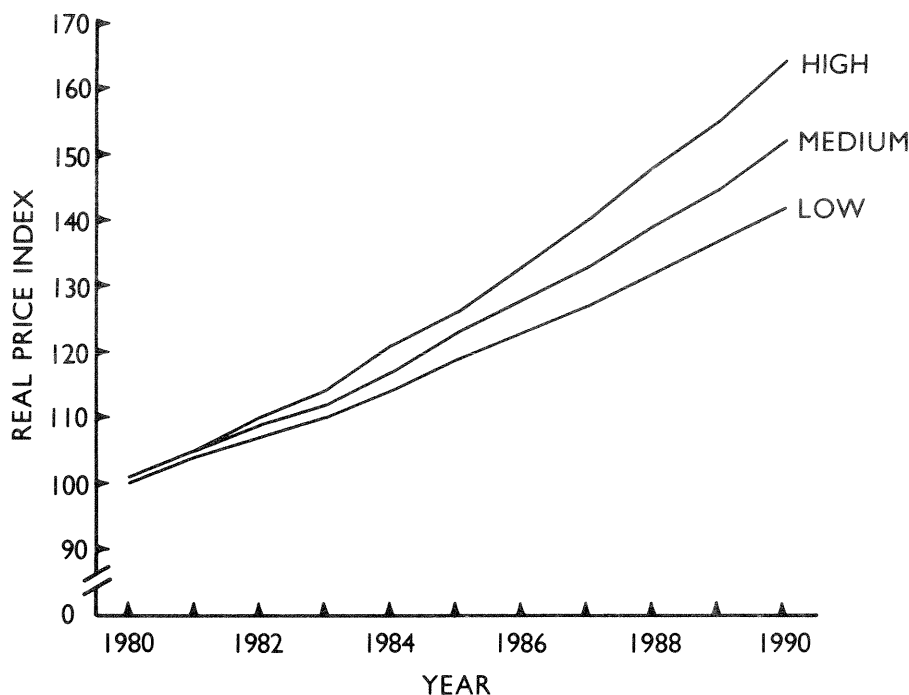


Figure 2.—Domestic real pallet price index projections under three sets of economic conditions. Real pallet price = mill realization price which is equal to total dollar volume of sales (\$ 1967) divided by total U.S. production. This was then converted to an index with 1967 = 100.



(U.S. Forest Service 1978) show substantial increases in hardwood volumes as more eastern hardwood stands move from polesize to small sawtimber sizes. The raw materials supply will not remain constant because wood suppliers can be expected to respond to an increased demand for their products.

The other assumption, implicit in this scenario, is that technology of pallet use will remain the same. However, it will not remain the same. Low-quality expendable pallets will give way to returnable pallets; the present designs will give way to more effective designs that use the resource more efficiently. Increasing production costs, particularly those arising from increasing costs of raw materials, are likely to mandate these changes.

The point to be made is that econometric models such as this pallet model can be used by the industry to assess future markets. Such an analysis will provide useful insights into the need for the development of alternative courses of action to effectively deal with changing market conditions. Projections from such models can also provide wood suppliers with

useful information on the magnitude of future markets for their products. Such knowledge can be used to profitably guide investment levels in land and other capital resources.

CONCLUSIONS

Projections of pallet consumption and price can be developed from this econometric model in conjunction with alternative scenarios. Elasticities calculated from the model can be used by the industry to monitor changing economic conditions and evaluate their impact on the pallet market. For example, we found that pallet demand is most sensitive to changes in industrial production activity. Industry planners can use such information to detect early warning signs of changing market conditions, and thus help pallet producers operate more efficiently to the mutual benefit of consumers and the industry itself.

The major limitation of the model is its small data base, however it is the best information available at this time.

The validity of the projections beyond the data base will ultimately depend upon: (1) the accuracy of the forecasts of the independent variables; and (2) whether there are any major future structural changes in the industry. A variety of developments could significantly change the estimated relationships among the variables in the demand and supply equations. If changes occur, such as a change in the technology of pallet use, altered conditions will necessitate a new look at any conclusions drawn from the study. There may be a need to reestimate the model and reproject consumption and price periodically.

Need for future studies

The model developed in this study is an aggregate model that is national in scope. However, the pallet market should be segmented according to two criteria: (1) geographic region of resource supply—hardwoods are the major resource east of the Mississippi while softwood lumber is the major resource used in pallet manufacture west of the Mississippi River; and (2) end product market—there are numerous potential markets such as the food pallet market, the construction industry market, the automobile industry market, the U.S. Government market, and the general industrial market. Econometric models that specifically address each of these markets would provide more useful information to pallet producers operating in these markets. The authors are currently addressing this need.

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Headquarters of the Northeastern Forest Experiment Station are in Broomall, Pa. Field laboratories and research units are maintained at:

- **Amherst, Massachusetts, in cooperation with the University of Massachusetts.**
 - **Beltsville, Maryland.**
 - **Berea, Kentucky, in cooperation with Berea College.**
 - **Burlington, Vermont, in cooperation with the University of Vermont.**
 - **Delaware, Ohio.**
 - **Durham, New Hampshire, in cooperation with the University of New Hampshire.**
 - **Hamden, Connecticut, in cooperation with Yale University.**
 - **Kingston, Pennsylvania.**
 - **Morgantown, West Virginia, in cooperation with West Virginia University, Morgantown.**
 - **Orono, Maine, in cooperation with the University of Maine, Orono.**
 - **Parsons, West Virginia.**
 - **Princeton, West Virginia.**
 - **Syracuse, New York, in cooperation with the State University of New York College of Environmental Sciences and Forestry at Syracuse University, Syracuse.**
 - **University Park, Pennsylvania, in cooperation with the Pennsylvania State University.**
 - **Warren, Pennsylvania.**
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