AN ECONOMETRIC ANALYSIS OF MARKET FACTORS DETERMINING SUPPLY AND DEMAND FOR SOFTWOOD LUMBER

Thesis for the Degree of Ph. D.

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AN ECONOMETRIC ANALYSIS OF MARKET FACTORS
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presented by

Thomas J. Mills

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ABSTRACT

AN ECONOMETRIC ANALYSIS OF MARKET FACTORS DETERMINING
SUPPLY AND DEMAND FOR SOFTWOOD LUMBER

By

Thomas J. Mills

This study was undertaken to provide statistical estimations of the impact of various market system variables upon price and consumption levels of Douglas-fir, Southern pine, and "structural species" lumber. Lumber market variables are statistically treated as supply and demand function shifters. Quantitatively identified supply and demand functions are then evaluated in terms of their relative importance as determinants of lumber market price and consumption levels. Analysis using this model clearly indicates that supply conditions are the principal price determinants while consumption is almost exclusively controlled by the level of demand.

The derived demand scheme of successive market interactions is the framework within which specific variables were grouped for analysis. Two independent demand function estimates were drawn from separate groups of variables, one from consumption level variables in lumber using markets and a second from the supply and demand determinants of these

consumption levels in lumber using markets. Two partially independent supply equations were estimated, one from domestic sawmill and foreign source variables and a second from the same group with sawlow price replaced by its stumpage sector determinants.

The equations were estimated by applying the two stage least squares statistical model to modeled subsets, each containing a single supply and demand equation for a single species group. Tests showed that the equations were properly identified, contained no serial correlation among residuals, and showed little evidence of misspecification. Multicollinearity was handled by excluding from the equations all collinear variables but one of a collinear group.

Demand variables were all inelastic. The most important demand function shifters, as measured by elasticity and average associated percentage shift of the function, were volume of residential construction and the price of softwood plywood.

Supply variables were somewhat more elastic than demand variables with four elasticities above unity. Average sawmill establishment size, which is highly correlated to labor productivity and sawmill wage rates, showed only moderate importance. Log expert volume, lumber tariffs, and U.S./Canada money exchange rate demonstrated low importance. British Columbia lumber production proved very important. Raw material variables (sawlog price, peeler log price, pulpwood price, and residue utilization) were the most important supply function shifters, especially sawlog price. Pulpwood price demonstrated greater impact upon the lumber market than peeler log prices.

Demand price elasticities fall in the very inelastic range below -0.50 and do not vary by species group. Average supply price elasticities over the 1947-70 period are estimated to be within the 1.2 to 1.6 range, again with little species variation.

Analysis of shifts in the estimated supply and demand positions from 1947-70 at an assumed price of $100 per thousand board feet showed a species difference in longer run supply response. Douglas-fir supply shifts to the left in response to a rightward demand shift while Southern pine supply shifts to the right in response to a similar shift. By using connection lines between successive price and consumption points as an index of longer run supply response, the longer run Douglas-fir supply elasticity is about 1.0 and for Southern pine as high as 2.0. The reason for this difference probably lies in regional differences in forest ownership patterns, log use alternatives, and barriers to entry.

The "structural species" group displays an average of the Douglas-fir and Southern pine longer run supply price elasticity through 1965 and then demonstrates the less elastic supply response typical of the inflexible Douglas-fir species. This supply and demand analysis also demonstrated quite clearly that demand is essentially the sole consumption determinant while supply dominates the price level.

Price and consumption projections from 1971 through 2000 showed a price differential between Douglas-fir and Southern pine in the year 2000 of \$192 versus \$118 per thousand board feet respectively which indicates the economic pressure for regional balancing.

"Structural species" consumption is projected to decline from a 1975 high at 1.2 percent annually through 1987 and decline thereafter at a very slow 0.02 percent annually. Projected price declines to a \$102 low in 1985 and then rises sharply to \$135 by 2000. The 1987 to 2000 rate of increase is 2.25 percent annually.

Sensitivity of the "structural species" price projection to possible sawlog and log export changes was tested. These tests showed that the price projection can be lowered but the 1987 to 2000 year trend, which is controlled in the projection by the level of British Columbia lumber production, is unmitigated by sawlog price and log export volumes. Consequently, if lumber prices are to be maintained at low levels beyond the middle 1980's the void currently filled by British Columbia production must be filled in another way.

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CHAPTER I

INTRODUCTION

Considerable conjecture and piecemeal evidence has been accumulated about the effect of supply and demand conditions upon price and consumption levels of wood products. Some of this conjecture centers upon the underlying shifters of market supply and demand functions. Information about these shifters is usually derived from descriptive studies or from studies that project consumption levels.

The Congressional hearings originating over concern for the 1968-69 rise in lumber and plywood prices demonstrate how information from these sources is often utilized (U.S. Congress, 1968 and 1969). Conclusions about the relative impact of variables ranging from log exports to housing starts upon wood product price and consumption levels were drawn almost exclusively from descriptive information. Major public policy decisions were based upon these conclusions such as the need for a partial log embargo and an increase in the intensity of management on Federal forest land.

OBJECTIVE AND SCOPE

The thrust behind this study is the contention that an integrated system of the wood product markets containing statistically measured interactions among the system variables will provide more reliable information for similar policy decisions. This study attempts to accomplish the construction of such an integrated system. It provides supply and demand equations for a particular wood product group as a means of determining the impact of various factors upon price and consumption levels. The products of concern are Douglas-fir, Southern pine, and "structural species" lumber. Four principal objectives are:

(1) to determine the extent that potential statistical difficulties inherent in the multi-equation approach are present in the developed model and the extent to which they impair interpretation of results,

(2) to determine the relative importance of specific variables as supply and demand shifters,

(3) to study the importance of supply versus demand conditions in terms of their importance as price and consumption level determinants, and

(4) to utilize the estimated supply and demand relations to project consumption and price levels, and study the sensitivity of these levels to changes in the magnitude of some policy-sensitive variables.

Lumber as a commodity was chosen for three reasons. First, lumber production represents approximately 45 percent of all domestic roundwood consumed in the U.S. (Hair and Ulrich, 1971, p. 39). Second, lumber is a relatively homogenous primary product. Third, time series data are readily available for the lumber industry. The latter item is particularly important as lack of data often precludes use of a multi-equation model (Hair and Josephson, 1971, p. 19).

Within the lumber industry three species groups are identified for detailed study: Douglas-fir, Southern pine, and a group of "structural species" composed of lumber cut from Douglas-fir, Southern pine, hemlock, true fir, and larch. These groupings allow for fairly specific producing and consuming industry identification and for regional comparisons.

PROCEDURE

The statistical procedure employed to meet the study objectives consists of regression estimated supply and demand functions for each of the species groups. Each function is represented by an endogenous or system determined price-quantity relationship shifted by a group of relevant exogenous or external factors. These relationships can be statistically characterized as:

$$y_D = b_0 + b_1 Y_D + \sum_{i=1}^{n} b_i x_i + e \qquad \text{demand function}$$

$$y_S = c_0 + c_1 Y_S + \sum_{j=1}^{n} c_j x_j + v \qquad \text{supply function}$$

where:

y_D and y_S = quantity of lumber demanded and supplied, respectively

Y_D and Y_S = price of lumber demanded and supplied, respectively

x_i and x_j = exogenous variables that shift the demand and supply function, respectively

e and v = unexplained variation of y_D and y_S

b's and c's = structural coefficients estimating the change of quantity demanded or supplied associated with a one unit change of the variable while all other factors are held constant

For reasons discussed later, this two equation model was applied separately to each of the species groups considered. Time series of annual observations from 1947 through 1970 were employed in this study for estimation of structural coefficients. Data availability, the desire to avoid the 1940-46 price control period, and the desirability of obtaining observations from a relatively consistent market structure were all reasons for excluding data before 1947.

The principal advantage of the econometric method used in this study is that it allows explicit statistical consideration of a number of system parameters directly within the framework of an analytical model. But there are a number of potential disadvantages such as problems of data availability, identification, serial correlation, multicollinearity, and model misspecification. These problems and the extent of their presence are discussed in detail in Chapter III.

The relative importance of various parameters as supply and demand function shifters is measured by three indexes: 1) statistical significance of its estimated coefficient, 2) elasticity with respect to lumber quantity, and 3) elasticity times the average annual percentage change of the variable. Each of these measures is applied and discussed in Chapter IV.

Once the equation coefficients are derived, the estimated position of the supply and demand functions during the sample period are produced by applying these equation estimates to the actual observations of exogenous variables from 1947-70. Conclusions about the relative impact of supply and demand shifts upon price and consumption levels are then drawn from the estimated annual shift in position of the two functions. This analysis is presented in Chapter V.

Lumber consumption and price projections are provided in Chapter VI. These are derived by applying estimated structural coefficients to the projected exogenous variables to determine the price level where the supply and demand curves cross. Alternative levels of some policy-sensitive exogenous variables are then used to project the resulting consumption and price changes.

RELATED STUDIES

Past studies related to this one can be aggregated into four groups: consumption projections, price projections, short term econometric analysis, and long term econometric analysis.

Consumption Projection

Studies undertaken to project the consumption level of wood products generally have employed one of two rather simple techniques, regression analysis or end-use ratios. Regression projections such as those used by Stanford Research Institute (1954), Guthrie and Armstrong (1961), Frazier (1965) and Hair (1967) usually involved regressing consumption of the wood product against some relatively gross economic indicator such as Gross National Product (GNP) or population. Consumption is projected by applying the estimated structural relationship between the indicator variable and consumption to an exogenously derived projection of the indicator variable. Hair's (1967) projection of per capita consumption of numerous paper products probably represents the most detailed wood products application of this technique.

In the second approach, end-use ratios are estimated for timber products as they are utilized in their various end-uses such as lumber use per dwelling. Consumption is then projected by applying this use ratio to the projected consumption level in the markets for goods that employ wood products. This technique has been utilized by Stanford Research Institute (1954), U.S. Forest Service (1958, 1965), Landsberg et al. (1963) and Nathan Associates (1968).

Price Projection

Attempts to project the price of forest products have usually been applied to a limited number of specifically defined products. Dutrow (1971) projected the price of cottonwood stumpage from a three equation recursive model using quarterly data. The level of the endogenous variables in the first two equations, stumpage price in period t-1 and agricultural wages in period t-1, are used in the third equation as regressors of that endogenous variable, stumpage price in period t. Anderson (1969a, 1969b) prepared two single equation models which project pine sawtimber and Southern pine pulpwood stumpage prices, respectively. The two studies are quite similar and entail regression of stumpage price upon timber characteristics, number of buyers, and a time trend. Since individual timber sales were the unit of observation, multiple observations at the same time point were utilized.

Short-Run Econometric Models

The single most important characteristic of short-run econometric models is the use of monthly or quarterly observations. Explicit consideration must be made for the nature of short-run market equilibrium (or more accurately, disequilibrium) and decision parameters. It is often the case with monthly observations that demand is registered at a price agreed upon by both the supplier and demander but the commodity is not physically supplied until a later date. This short-run disequilibrium situation, due to violation of the economic model assumption of instantaneous production in a point market, must be considered with such indexes as unfilled orders and can not be depicted by supply and demand functions alone. Different system parameters are decision signals in the short-run than in the long-run due to the effect of time period upon input variability. For example, the input schedule is relatively fixed in the short-run so changes of input costs may have much less effect upon production decisions than the past level of new orders.

McKillop (1969) developed a six equation short-run recursive model of the redwood lumber industry using monthly data. One equation was prepared for each of the following endogenous variables: unfilled orders, mill stocks, production, shipments, new orders, and price. He then used these equations to forecast the endogenous variables in more recent time periods where actual observations were available but not used in model construction. Simpson and Halter (1963) constructed a four equation model of the sanded and unsanded Douglas-fir plywood market using quarterly data. The four equations include specifications for demand, supply, inventory, and unfilled orders.

Gregory (1960, 1965) prepared a short-run recursive model of the hardwood flooring market including equations for supply, demand, and price. Gregory estimated the structural relations for the same three equations using six consecutive and non-overlapping monthly time series data sets from 1947 to 1963. He concluded that different coefficient estimates (some of which changed sign as well as magnitude) ". . . might indicate substantial change in the structure of the industry . . ." (Gregory, 1954, p. 203) but unfortunately conducted no tests to see if a statistical difference occurs.

Long-Run Econometric Models

Given that length of run is based upon the proportion of inputs that are variable, one year observations of the primary wood product industries gives adequate allowance for variation of most inputs and thus constitutes a moderately long-run. Similarly, because one year usually surpasses the production and delivery time for primary wood products, supply and demand relations can be estimated directly with disequilibrium conditions due to production and delivery time quite safely ignored.

Holland (1955) provided one of the pioneering attempts at an econometric analysis of a wood product using annual observations. His model contained supply and demand equations for softwood lumber. The structural relationships tested the importance of very few shifters, however, and according to McKillop (1967, p. 10), may have been improperly specified.

McKillop (1967) constructed what is probably the most comprehensive long-run econometric study of wood product markets to date. Annual observations were utilized in the estimation of supply and demand curves for "all" lumber, softwood lumber, paper, paperboard, building paper and board, and softwood plywood. He used the estimated equations to project price and consumption levels through 1975. A study similar to McKillop's analysis in terms of product aggregations is currently being analyzed by Talhelm and Holland (1971). Monthly observations are being utilized in the estimation of supply and demand functions directly, however, while short-run disequilibrium conditions are being ignored.

Relationship to Other Studies and Techniques

While all of the studies discussed above are related to this analysis only two of the four groups, the consumption projection and long-run econometric approaches, have close relationships. The

consumption projection models have the advantages of analytical simplicity and less severe data requirements. This simplicity allows, and even necessitates, large inputs of investigator judgment, however. For example, the Forest Service has repeatedly assumed that relative prices between a particular wood product and its substitutes would remain constant (U.S. Forest Service, 1948; 1958, p. 371; 1965, p. 9; and Hair, 1967, pp. 24-25). The economic plausability of the constant price assumption has been questioned since it means that (1) there is a horizontal supply function, (2) the supply curve can be induced to shift to the right such that it intersects the new demand function at the current price level (Vaux and Zivnuska, 1952; Gregory, 1955), or (3) that the price level of each product and its competing group move identically.[1]

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[1]The 1946 Reappraisal study (U.S. Forest Service, 1946a and 1946b) which precipitated the articles by Vaux and Zivnuska (1952) and Gregory (1955) did not explicitly assume the constant price relationship. The Reappraisal did define the requirement quantity projected, however, as that quantity which ". . . might be used by consumers afforded reasonable latitude in choice of readily available materials . . ." (U.S. Forest Service, 1946a, p. 1) and further defined the production goal as ". . . at least as much timber as a prosperous people might use if the supply were sufficient to keep forest products available at reasonable prices" (U.S. Forest Service, 1946b, p. 3).

Both Vaux and Zivnuska, and Gregory interpreted this as an implicit assumption of constant relative prices between wood products and all commodities. To the extent that this is a correct interpretation of the Reappraisal study, the articles of criticism are correct except that Vaux and Zivnuska seem to ignore the second possible cause of constant relative prices, i.e. a shift of the supply function, mentioned by Gregory.

The two more recent Forest Service studies (U.S. Forest Service, 1955 and 1963) make the assumption explicit that constant

An even greater restriction is the inability of the consumption model to explicitly and internally implement alternative assumptions. For example, the Nathan Associates study (1968, p. 161) assumes that future price induced substitution rates will be extensions of past rates rather than the more limited substitution assumed by the Forest Service (1965, p. 9). Nathan Associates implemented this alternative price assumption by lowering the projected wood product end-use ratios below those used by the Forest Service. This use ratio adjustment was based solely upon judgment of evidence external to the model. There is no way such price relatives can be specifically inputed into the model.

Therefore, the most serious limitation of the consumption projection models is not their failure to produce information concerning the interrelation between numerous exogenous and endogenous variables. The consumption models were not built to supply such information. Likewise, the extensive use of assumptions is not their major weakness since all methods require assumptions of varying stringencies. Rather, the major weakness is that there is no explicit analytical consideration of parameter interactions internal to the model through which the effect of alternative assumptions can be measured. The econometric approach employed here allows internal consideration of relative parameter importance.

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relative prices will occur among the substitutes alone and not relative to all commodities. Thus, it becomes necessary to consider the third possible cause, i.e. that all prices of commodities in the substitute group change the same.

The method utilized in this study and the information produced is very similar to that found in McKillop's 1967 study. McKillop did not include some system parameters tested in this study, however, and his estimates for softwood lumber price elasticities had questionable magnitudes and wide confidence intervals. Possible causes of these problems may have been the wide industry aggregations and retention of colinear variables. In some respects this study can be viewed as an attempted refinement of an approach handled very well by McKillop.

CHAPTER II

MODEL STRUCTURE

Lumber manufacture is only one stage in the processing chain between the forest and the final market in which timber derivatives are utilized. The sequential interaction in the derived demand flow is the system representation used in this study as the framework within which specific variables are placed. A very basic schematic representation of the derived demand interactions is shown in Figure 1.

The demand for any product is a function of the consumption levels in all markets that use the product as an input. For example, the demand for lumber is a function of the consumption level of residential construction, shipping containers, railroad ties, and other products. Similarly, the demand for logs is a function of such factors as the consumption of lumber, plywood, and pulpwood. Generalized this becomes:

$$\text{Demand}_B = f(\text{consumption}_{A_1}, \ldots, \text{consumption}_{A_i})$$

where "A" is the product (residential construction) in which "B" (lumber) is used and there are i different industries or products "A." The same demand can be expressed alternatively as a function of the determinants of the consumption level in markets using the product:

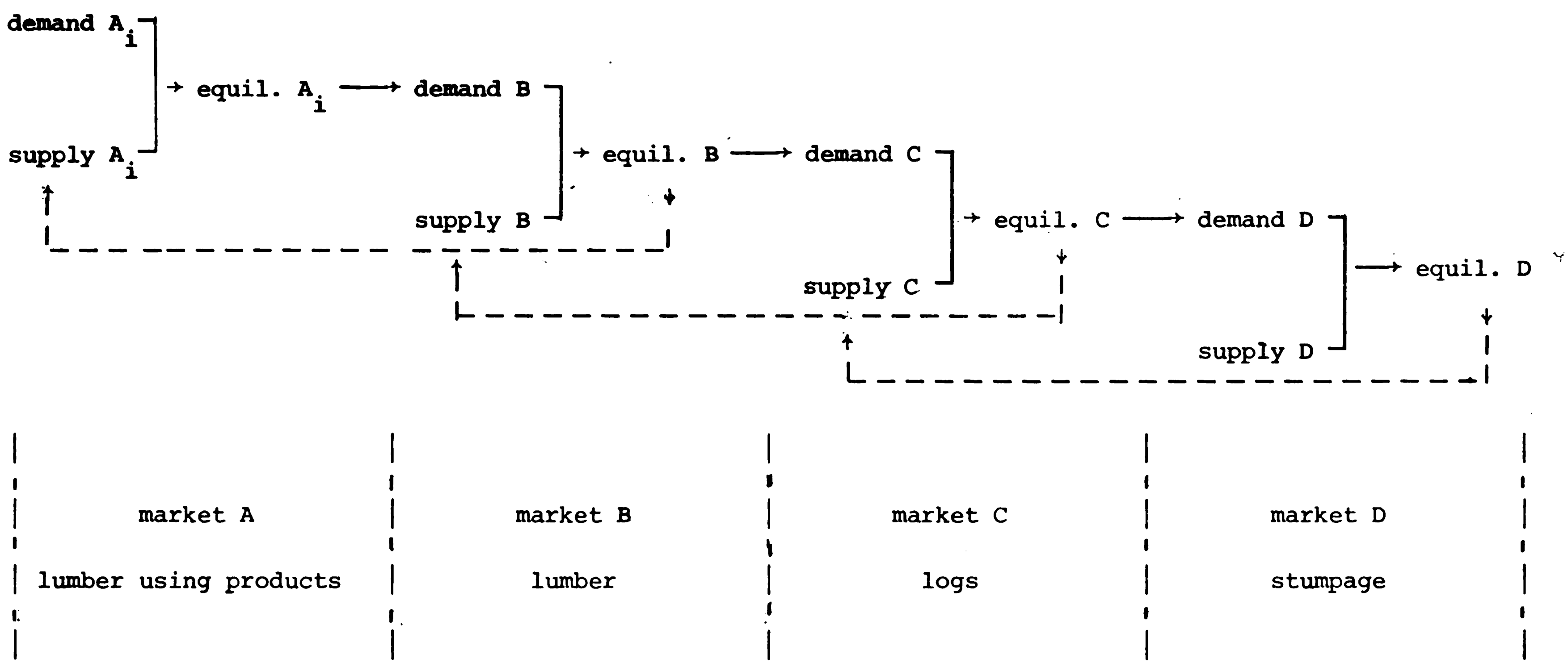

Fig. 1.--Schematic representation of market interactions in a derived demand framework.

$$\text{Demand}_B = f(\text{supply}_{A_1}, \text{demand}_{A_1}, \ldots, \text{supply}_{A_i}, \text{demand}_{A_i})$$

As diagrammatically shown in Figure 1, the effect of higher markets is transmitted through the demand functions of lower markets. The effect of lower markets is transmitted upward through the supply functions of higher markets. The products of lower markets are inputs for higher markets. With reference to Figure 1, for example, logs are inputs into the lumber industry, and to the extent that input costs affect supply, the lower (log) market has an impact on the higher (lumber) supply function. Just as it is possible to replace consumption of higher level products with its supply and demand determinants, the input price can be replaced by its supply and demand determinants as an alternative means of showing lower market effect. Note then that one market equilibrium variable, consumption, transmits the impact of higher markets downward while the second market equilibrium variable, price, carries the impact of lower markets upward through the derived demand chain. It is within this general framework of interrelated markets that the data classification discussed below is presented.

DEMAND AND SUPPLY VARIABLE GROUPS

Based upon the derived demand system described above, three groups of demand variables were initially segregated for analysis.

These groups are discussed below and presented schematically in Figure 2:

(1) demand level 1, consumption levels of lumber using products, equivalent to equilibriums A_i in Figure 1. Residential construction consumption is also represented by the percentage of structures started which contain three or more dwelling units because of the heterogeneity of housing consumption and its effect upon the amount of lumber demanded.

(2) demand level 2, major supply and demand determinants of the consumption levels in various lumber using markets, equivalent to supply A_i and demand A_i in Figure 1.

(3) demand level 3, more detailed representations of the level 2 factors or determinants of the same.

Two groups of supply variables were utilized. They are discussed below and presented schematically in Figure 3:

(1) supply level 1, level 1a which includes determinants of domestic supply conditions and

level 1b which contains gross indicators of foreign supply factors. These two sublevels together are equivalent to supply B in Figure 1.

(2) supply level 2, level 2a which includes determinants of sawlog prices as influenced by stumpage price or stumpage conditions, equivalent to market D in Figure 1, and

level 2b which contains monitors of the demand from other markets for logs, equivalent to some demand D_i in Figure 1.

Parameters for transportation cost were included on the supply side. This is opposite to the traditional approach of placing them on the demand side but is done under the assumption that lumber sellers

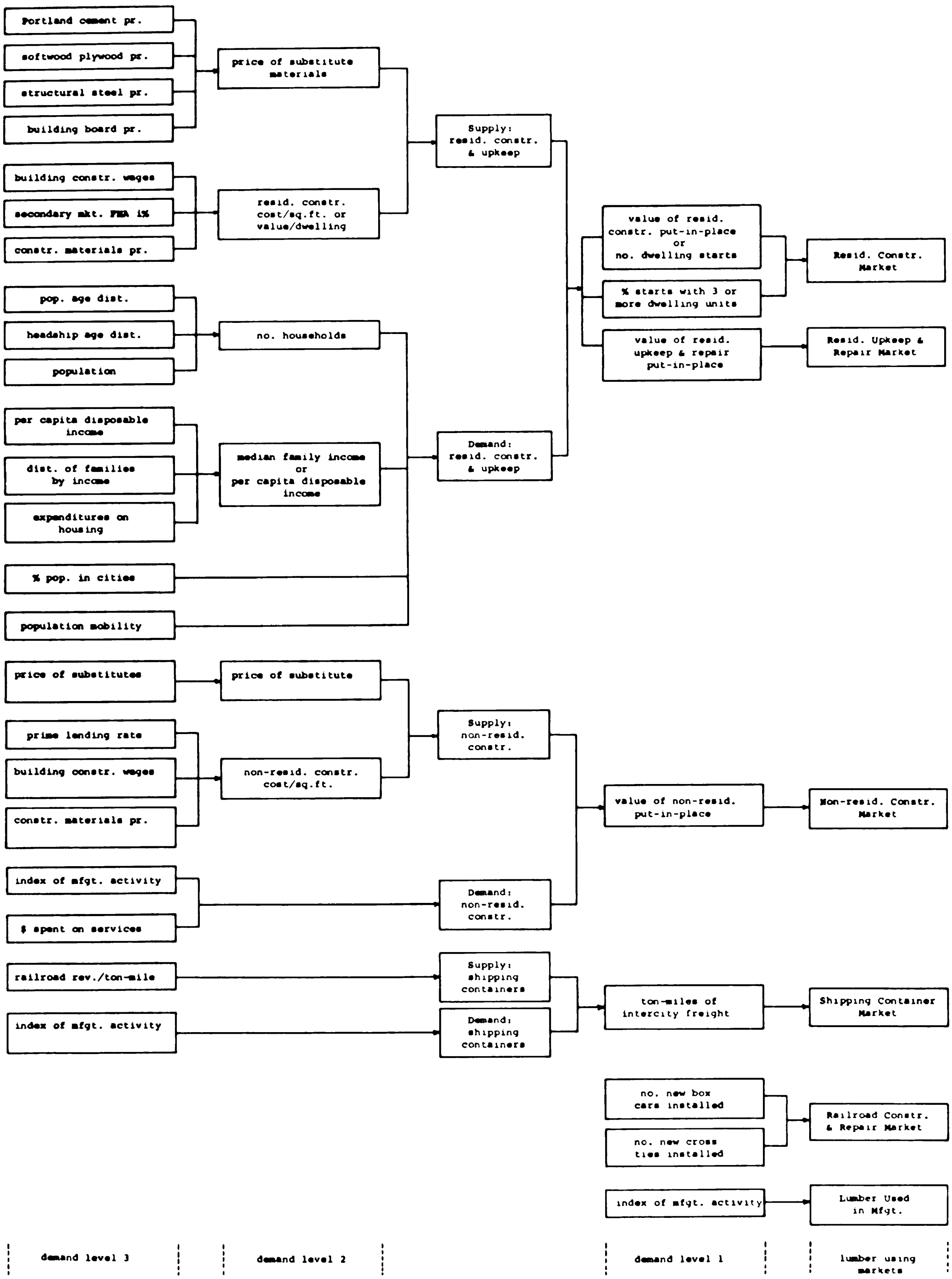

Fig. 2.--Interrelationship between factors hypothesized to affect the demand side of the softwood lumber market.

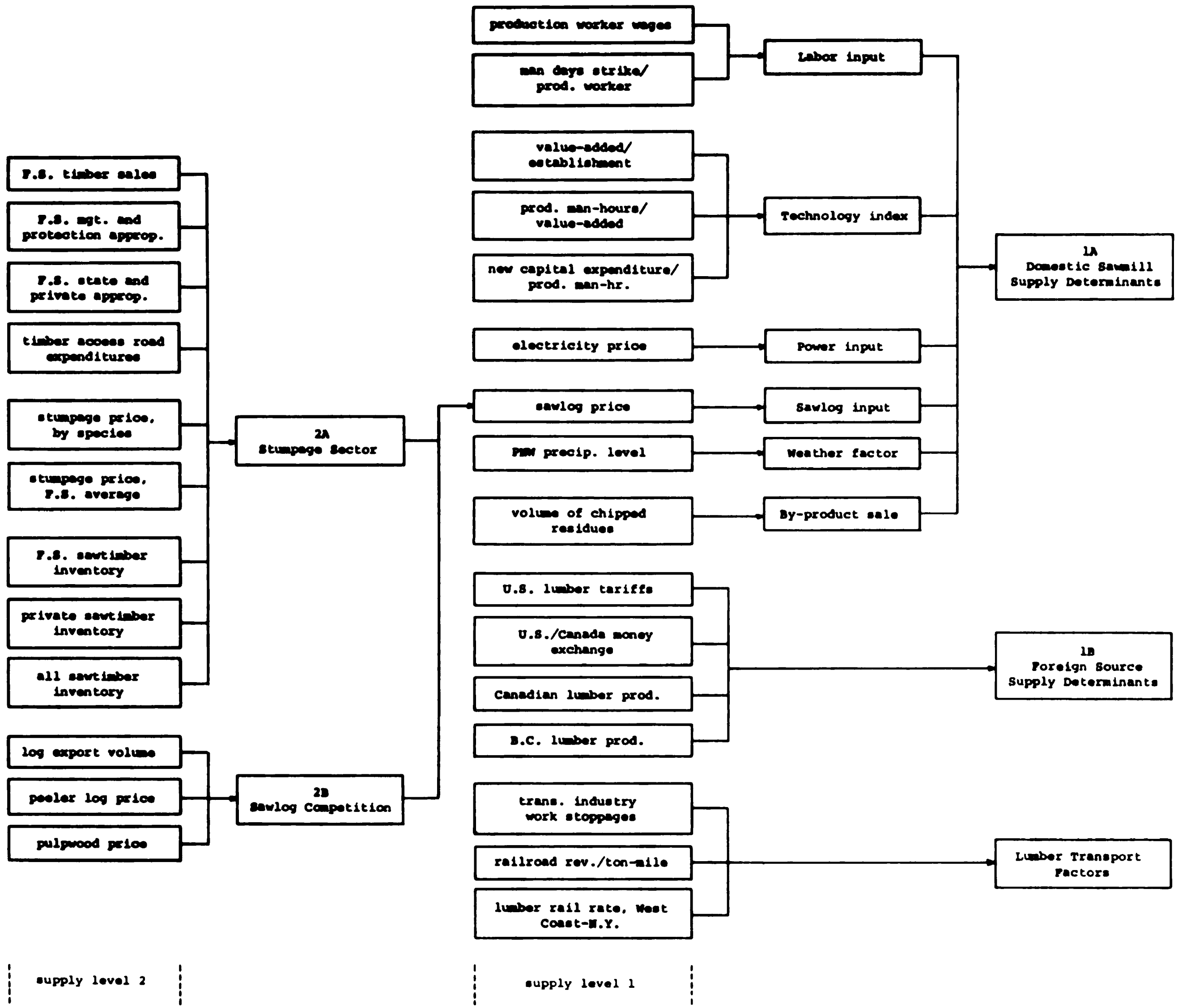

Fig. 3.--Interrelationship between factors hypothesized to affect the supply side of the softwood lumber market.

price to compete in the market of concern whether the prices are listed f.o.b. mill or not.

When these variable categories were first developed, the intention was to estimate three separate demand functions for Douglas-fir, Southern pine, and the "structural species" group from each of the three groups of demand variables. Similarly, it was originally intended that two supply functions would be estimated for each species group, one using supply level 1 variables and a second using supply level 1 variables with the sawlog price replaced by its supply level 2 determinants.

Preliminary analysis of multicollinearity between variables and variable significance lead to substantial regrouping and removal of some variables presented in Figures 2 and 3, however. Two major rearrangements occurred. Demand level 2 variables were highly correlated among themselves so demand level 2 and demand level 3 variables were combined as a single group from which significant and independent variables could be selected. On the supply side the sawlog competition variables of supply level 2b proved to have sufficient explanatory power beyond their influence upon sawlog price to warrant placement of the sawlog competition variables in supply level 1 along with the sawlog price itself.

Given these two major changes in the arrangement of variables shown in Figures 2 and 3, and given exclusion of individual variables because of the multicollinearity and significance tests discussed in the next chapter, the two groups of demand variables and two groups of supply variables shown in Figure 4 result. Two demand equations were estimated for each species group, one from the primary demand variables or consumption levels in lumber using markets and one from the secondary demand variables or supply and demand determinants of these consumption levels in lumber using markets. Likewise, two supply equations were estimated, one from the primary supply variables or lumber market supply factors and one from the primary supply variables (excluding the sawlog price) plus the secondary supply variables or stumpage factors. Hereafter this second supply equation will be referred to as the primary + secondary supply equation and equations drawn from the other groups will be known by the market levels as shown in Figure 4. Not all of the variables shown in any one market level of Figure 4 were used in the equation for each species group but all were used in at least one species group.

DATA CHARACTERISTICS

Many variables pertinent to the lumber market have been excluded from Figures 2 and 3 and therefore from Figure 4 and the subsequent analysis. Parameters such as log quality, land tax and construction productivity were excluded because of the desire to represent the system in an operational form. Only those variables for which data are available are considered in the analysis. Thus variables exluded were not

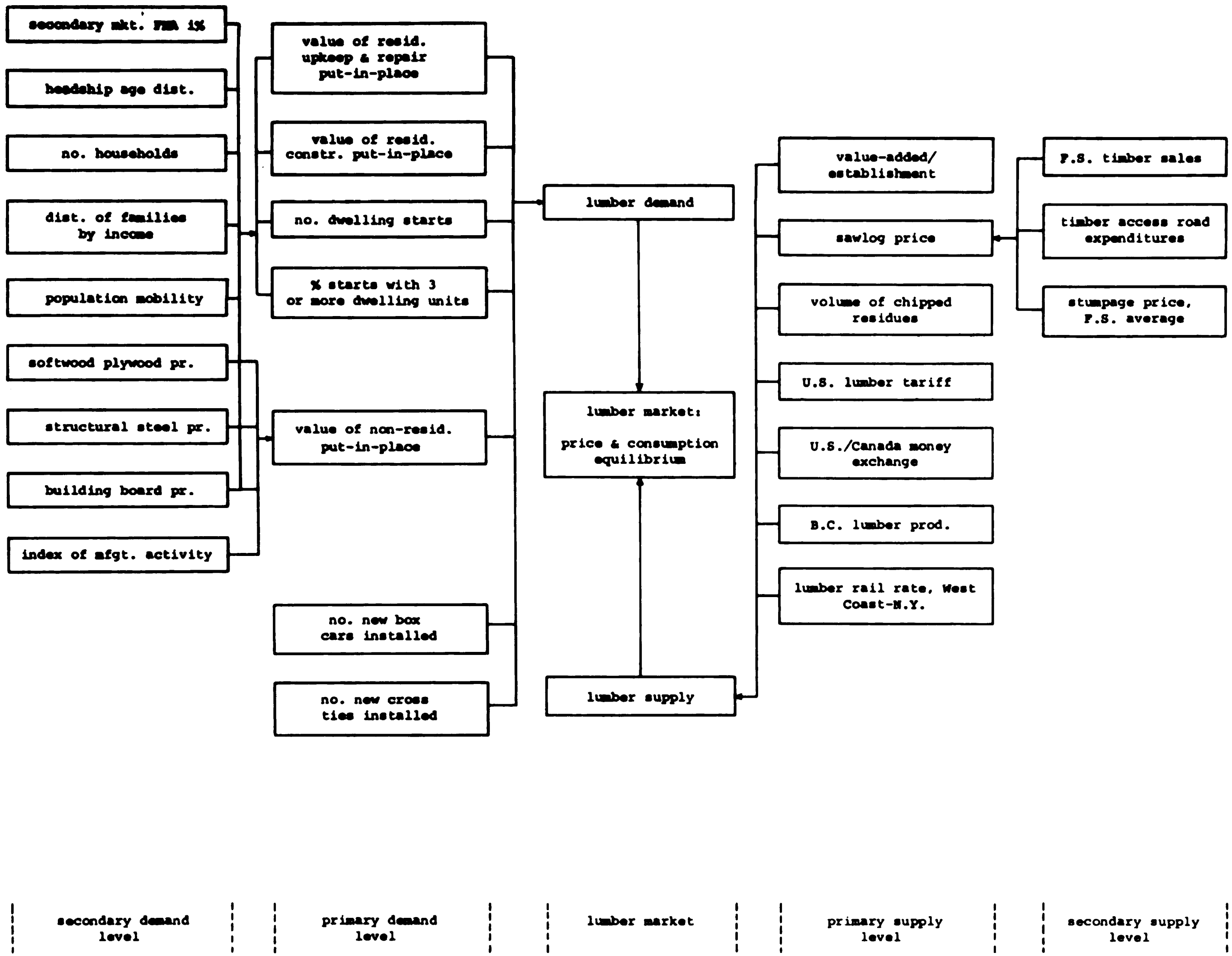

Fig. 4.--Flow chart of the modeled softwood lumber market.

always excluded because they were considered unimportant. Data restrictions also forced the use of proxy variables for some system parameters such as precipitation level in the Pacific Northwest rather than the number of days logs could not be removed from the woods due to wet conditions. Similarly, some time series could only be derived by splicing two overlapping partial series together.

Data corresponding to the variables identified in Figures 2 through 4 are presented in table form in Appendix A. Corresponding source notes and explanations of the variables are listed in Appendix B. All variables measured in dollar units or which contain dollar measured components were deflated by the "all commodity" wholesale price index, variable number B1 in Appendix A. This deflation holds the size of the money unit constant over time so that it can be validly compared to the other units of measure employed. The two exceptions to the deflation process were sawmill establishment size and sawmill productivity since the value-added component of each as measured in current dollars should be a better proxy for lumber production than value-added measured in deflated dollars.

That there are data problems, whether through variable exclusion or minor misrepresentations, can not be questioned. These problems are judged to be quite minor, however, and do not constitute the "lack of suitable data" problem which is sometimes cited as a reason why multi-equation models can not be employed. Whether this same conclusion of data adequacy could be made regarding a similar study of the plywood or paper industry is uncertain.

CHAPTER III

STATISTICAL METHOD

In this chapter attention is given to consideration of the presence of potential statistical problems which either impair the interpretation of results or completely block model implementation. These problems and explicit statements regarding their effect if they are present are discussed in this chapter. Of particular concern are questions of the appropriate statistical model, model completeness and identification, incidence of serial correlation and multicolinearity, determination of variable importance and model misspecification.

STATISTICAL MODEL SELECTION

As discussed briefly in Chapter I, supply and demand functions are represented in this study as endogenous price-quantity relationships shifted by a number of exogenous variables. Since both lumber quantity and lumber price are determined within the system simultaneously, they are correlated with the residual terms. The inclusion of two endogenous variables in a single equation violates the ordinary least squares (OLS) assumption that only one variable is correlated with the residual. If

OLS was applied to the above system regardless of the violation, the estimated structural coefficients would be biased and biased even on large samples, or in statistical terminology, inconsistent (Wonnacott and Wonnacott, 1970, pp. 152-153).

Four alternative statistical models are available which produce asymptotically or large sample unbiased and thus consistent estimates. Two of these approaches are single equation or limited information techniques: two stage least squares (2SLS) and limited information maximum likelihood (LIML). The remaining two are simultaneous equation or full information models: three stage least squares (3SLS) and full information maximum likelihood (FIML). The full information models are so named because they utilize information about variable levels and equation specification from all parts of the model in the estimation of coefficients for each equation. The limited information techniques are so named, obviously, because they do not utilize all this information from other equations.

Since we are dealing with a small sample here, the property of large sample unbias does not automatically reject OLS or lead us to a choice among the four alternatives. Monte Carlo simulation studies conducted to investigate the small sample properties of the five statistical models are summarized by Goldberg (1964, pp. 362-363) and Wonnacott and Wonnacott (1970, p. 399). Though the summaries presented by these authors are somewhat conflicting and inconclusive, they can be generally stated as follows:

(1) OLS has the largest bias but generally the smallest variance,

(2) 2SLS has the second smallest variance and generally a low bias, (Also important, it shows less sensitivity to problems of multicolinearity and model misspecification.)

(3) LIML provides quite unstable estimates,

(4) 3SLS and FIML sometimes out perform the other models but not always and, because of their full information approach, the multicolinearity or misspecification in individual equations is not segregated but affects other equations.

LIML was rejected because of its high cost and unstability. Since multicolinearity is almost always a problem with economic time series data and model misspecification is always a potential problem, 3SLS and FIML were also rejected. The model chosen was 2SLS. This technique was selected over OLS because lower bias was considered more desirable than the possible lower variance of OLS. The 2SLS model utilized here was also used by McKillop (1967). Talhelm and Holland (1971), however, used 3SLS.

TWO STAGE LEAST SQUARES OPERATION

The particular statistical operation of 2SLS utilized in this study is adequately described in Ruble (1969) and in more general form in numerous econometric texts (e.g. Wonnacott and Wonnacott, 1970, pp. 355-364; Goldberg, 1964, pp. 329-336). Conceptually, 2SLS involves the application of OLS in two sequential steps. In the first stage, the endogenous variable on the right-hand side of the equation (lumber price Y) is purged of its correlation with the residual term by estimating lumber price ($\hat{Y}$) as a linear combination of variables not correlated with the residual. This purge is accomplished by regressing lumber price on a number of exogenous variables called instruments. If the number of instruments exceeds the number of sample observations, we have a completely deterministic situation where $Y = \hat{Y}$ just as always the case in such a situation with OLS. Therefore, the first stage would accomplish nothing and the final estimates from the 2SLS process would be identical to the OLS estimates of the second stage alone (Ruble, 1968, p. 105).

To bypass this difficulty, a subset of instruments was selected which did not exceed the number of observations. The instruments in this subset were selected on the basis of including exogenous variables which have the most direct effect upon lumber price (Fisher, 1965, p. 627). Therefore, exogenous variables from the particular supply and demand equation for the species in question were used as instruments in the first stage estimation of lumber price of that species. In the second stage, since the replacement of Y by $\hat{Y}$ leaves only one variable (lumber quantity) correlated to the residual and thus removes the objection to using OLS, OLS is applied to the adjusted set of variables, adjusted in that $\hat{Y}$ replaces Y. It is the second stage that produces the structural coefficient estimates presented in the next chapter.

INITIAL REQUIREMENTS OF COMPLETENESS AND IDENTIFICATION

By using subsets of instruments in the first stage, the 2SLS model is actually applied to a number of subsystems of the lumber industry as described in Figure 4. Since each subsystem contains two equations, a single supply and demand function for a single species, and two unknowns, the appropriate lumber quantity and price, each subsystem is complete in a statistical sense.

Observations of lumber consumption are used in the estimation process to represent both the quantity demanded and supplied. Similarly, observations of the market equilibrium price are used to represent both the supply and demand price. In short, we have only a group of price-consumption points from which we must estimate two equations which are properly identified as supply and demand functions rather than some cross between the two (Wonnacott and Wonnacott, 1970, pp. 172-189).

Two conditions are required for identification (Goldberger, 1964, p. 316). First, there must be as many predetermined variables excluded from a particular equation E_1 which are included in other equations in the same equation subset as there are endogenous variables on the right-hand side of the equation E_1. By this condition each equation in the lumber industry model constructed here is over-identified by having more excluded predetermined than endogenous variables on the right side. Over-identification reduces to exact identification in the 2SLS operation, however, and causes no statistical problems (Wonnacott and Wonnacott, 1970, p. 190). Second, the predetermined variables excluded from each equation E_1 must in reality be excluded. That is their true coefficient in E_1 is zero. Initial inspection based upon economic logic suggested this condition was met. When this condition was later tested during equation estimation by an F statistic developed by Basmann (1960), the initial conclusion was substantiated. The null hypothesis that the coefficients were zero in respective E_1's could not be rejected in any equation at the 10 percent alpha level.

Given that each subsystem containing a single supply and demand equation is statistically complete, and both identification conditions are fulfilled, it is possible to proceed with equation estimation and investigation for the presence of statistical problems.

SERIAL CORRELATION AND MULTICOLLINEARITY

One potential statistical problem is serial correlation among residuals of an equation. The presence of serial correlation results in unbiased coefficient estimates but the estimated variance underestimates the true variance (Wonnacott and Wonnacott, 1970, pp. 136-143). If this correlation exists, the statistical framework of the equations must be modified. The Durbin-Watson statistic was utilized to test for the presence of serial correlation and in each case there proved to be no significant correlation or else the tabulated statistic lay in the uncertain range between the critical values of significant and nonsignificant serial correlation.

Another potential problem, multicollinearity, is a state of high correlation between the observations of two or more variables, meaning they are not linearly independent and a rather constant relationship exists between their sample observations (Wonnacott and Wonnacott, 1970, pp. 59-63). The statistical problem precipitated by multicollinearity is unbiased but unstable coefficient estimates as reflected in inflated coefficient standard errors. Therefore, addition of an observation slightly different from the consistent relation between observed variable levels, or removal of one collinear variable from a group of collinear variables in an equation may cause coefficient point estimates and standard errors to vary considerably.

Along with this statistical problem occurs an information problem of equal severity. If two variables are collinear, ". . . it becomes very difficult, if not impossible, to disentangle their separate influences and obtain a reasonably precise estimate of their relative effects" (Johnston, 1963, p. 201). Although this multicollinearity condition does not allow us to measure the independent relationship between collinear variables and the quantity supplied or demanded, this does not constitute an information loss. In fact, the entire problem is the lack of initial information. No analytical method can very well estimate independent relationships if no observations are supplied which demonstrate independent actions. Removal of all collinear variables but one does not overcome this information difficulty either. The coefficient of the retained collinear variable represents not only the effect of a one unit change of the retained variable but also the associated change of excluded collinear variables which occurred in the sample observations. Therefore, to the extent that multicollinearity occurs, we find ourselves faced with one of the most serious restrictions to the application of regression analysis results. Statistical confidence on the estimated model is measured only over the data range utilized in estimating the system structure, whether the data range in question is the range of observed levels of independent variables or the observed range of variable correlations.

There is no desirable solution to the multicollinearity problem if selective data transformations fail to remove collinearity. In this study transformations did fail. This problem was met by removing from the equation all but one variable of a collinear group such that all variables in each equation are independent of each other but one variable represents the associated effect of a collinear group. This provides for a stable coefficient estimate of the collinear group relationship to endogenous variables and allows a simpler equation that gives as much statistical explanation of the endogenous variable movements as an equation containing collinear variables.

Properly identifying the actual incidence of multicollinearity is difficult. Since in reality we deal with varying degrees of collinear interactions, the question comes to selecting those variables that introduce more harm from standard error inflation and thus coefficient instability than help from reduction in unexplained variation of the endogenous variable. Three partially reinforcing criteria of identifying multicollinearity were applied to variables found in the same equation. In the first step, one of a pair of variables was excluded from further analysis if the simple correlation, r, between the two was above approximately .95. This rejection was conditional upon their economic equivalence, however. If both were somewhat equivalent, such as medium family income and per capita income (r = .99), one was dropped. If the economic relation was much more indirect, such as sawmill wages and establishment size (r = .95), both were retained for further study.

Factor analysis was applied as a second tool to identify multicollinear variables. One of a pair of variables was excluded as being collinear if both had a high loading in one factor such as .90 or higher and neither had a moderate loading such as .25 or above in other factors.

In the third test, variables not excluded as being collinear by their simple correlations or factor analysis were combined in test run equations. Variables suspected of being collinear were then sequentially removed and the structural relations re-estimated. The presence of multicollinearity was identified by a small decrease in the equation's R^2 (coefficient of determination) associated with a substantial decrease of the standard errors of other variables. A small change in R^2 indicates that the removed variable adds nothing to the reduction of unexplained variation not already accounted for by other variables. The associated decrease of standard errors does signal that the variable was collinear, however, and not just non-significant, which a small decrease in R^2 might also indicate.

Certain rather important policy variables as well as variables usually used to depict the system had to be removed by test run screening. For example, the number of households, construction wages, and median family income were excluded as collinear to softwood plywood price in the Southern pine and "structural species" secondary demand level equation. Similarly, British Columbia lumber production, sawmill wage rate, and sawmill productivity were excluded from the "structural species" primary level supply function because of collinearity with sawmill establishment size.

It is readily admitted that the application of the above three collinearity tests involves considerable judgment, especially the equation test runs. The results showed, however, that a less conservative application of the more objective factor analysis alone would have removed about the same variables removed by the above three step sequence. The results also indicate that either the factor analysis or the test run screening is superior to a simple correlation rejection level alone, especially a high simple correlation level such as the .98 employed by McKillop (1967, p. 35). For example, British Columbia lumber production and Pacific region sawmill establishment size have a simple correlation of only .92. Yet when the British Columbia lumber production is excluded from an equation containing Pacific sawmill establishment size and other basic variables in the Douglas-fir primary supply function, there is sufficient multicollinearity to cause a drop of the establishment size coefficient standard error from 5.4 to 2.7 (50%) while the R^2 dropped less than 0.1%. Whether this indicates sufficient collinearity to warrant exclusion of a variable is certainly a matter of judgment. In this study it was judged sufficient evidence to warrant removal, however, and British Columbia lumber production was excluded.

VARIABLE SIGNIFICANCE

Variables retained through the multicollinearity exclusion process were then subjected to a test of significance. If it could not be shown that there was at least a 70% probability that the estimated coefficient sign was in fact the true sign, as measured by a one tail Student t test, the variable was excluded from the equation. Variables on the supply side removed through this process included work stoppages in sawmills and transportation industries, precipitation level in the Pacific Northwest or its squared transformation, and electricity price. Similarly, cross tie and rail car consumption were excluded on the demand side from the Douglas-fir and "structural species" equations. Since the calculated t value is derived from the ratio of estimated coefficient over the standard error of the coefficient estimate, and since the coefficient is only asymptotically unbiased, any test of significance on the 2SLS estimates are subject to bias. The extent of this bias is undeterminable but since the t test removed those variables which economic logic also judged relatively unimportant, the test provides information which the author felt sufficient to act upon.

MISSPECIFICATION

Anytime variables are not included in an equation, for whatever reason, there is the potential that model misspecification will result. If the excluded variable X_1 has any independent explanatory power not already included in the equation, the relationship of both the excluded variable and some included variable X_2 to the endogenous variable may be partially and erroneously attributed to the included variable alone

(Wonnacott and Wonnacott, 1970, pp. 71-75). Therefore, exclusion may result in biased coefficient estimates and increased standard errors.

Misspecification may have been introduced into this study at three points: original exclusion, multicolinearity exclusion, or exclusion due to non-significance. Some important variables may have been originally excluded due to data unavailability but because of the system representation used in this study their impact should be minimal. Variables excluded due to multicolinearity or non-significance were excluded on the basis that they had no individual importance but multicolinearity and significance are themselves continuums such that any exclusion will remove some explanatory power. Because of the extensive colinearity testing and low significance level utilized for exclusion, however, the amount of misspecification resulting from these should be minimal.

CHAPTER IV

RELATIVE IMPORTANCE OF SUPPLY AND DEMAND SHIFTERS

The method discussed in Chapter III was applied to the industry representation outlined in Chapter II using specific data series found in Appendix A. As noted earlier, two demand functions were developed for each species definition, one using the variables which monitor the consumption level of lumber using markets (primary demand determinants), and one using the supply and demand determinants of these lumber product consumption levels (secondary demand determinants). Similarly, two supply equations were estimated for each species definition. One was estimated from parameters of domestic production, foreign supply, and sawlog competition (primary supply determinants), and a second was estimated from the same as the first with sawlog price replaced by its stumpage sector determinants (primary + secondary determinants). In this chapter results will be presented which pertain to the second study objective, that of judging the relative importance of system parameters as supply and demand function shifters. This will be accomplished by presenting the estimated equations along with associated significance levels and elasticities of particular variables.

ESTIMATED EQUATIONS

Tables 1 through 4 contain the structural coefficient estimates for each equation along with various statistical parameters of the estimates. Each variable is immediately followed by a code identifying the exact data series and description in Appendix A and B. The structural coefficients represent the estimated change in quantity demanded or supplied associated with a one unit change of the variable in question while holding all else constant. This definition is modified to the extent multicollinearity is present, as discussed in Chapter III.

Each coefficient estimate is characterized by three parameters. First, the calculated t value, equal to the coefficient estimate over the standard error of the coefficient estimate, is in the column following the coefficient. Second, the next column shows the probability of certainty that the sign of the estimated coefficient is the true sign as measured by a one-tailed Student's t test. Third, the last column in each table registers the plus-and-minus band corresponding to a 90 percent confidence interval around the estimated coefficient, and is the range within which we can be 90 percent confident that the true value lies.

Similar to the statistical parameters of the coefficient estimate, each equation described in Tables 1-4 is also characterized by its squared multiple correlation coefficient, R^2, the calculated Durbin-Watson serial correlation statistic, and the percentage significance level at which the Basmann phi ratio null hypothesis that the equation is identified can be rejected.

The signs of the estimated coefficients can be classed in three groups. The first group, and by far the largest, contains variables which monitor relatively single natured phenomenon and carry the "correct" or expected sign. Second, there are variables which monitor two or more opposing forces and the sign indicates which force is overriding. Third, there are several estimates that do not seem to exhibit correct signs but were stable in combination with many other variables and had significant t tests.

It is important to remember that these equations were estimated from annual observations from 1947 through 1970. As such, the estimated relationships mirror somewhat of an "average" of the system structure as that structure existed and changed throughout the sample period. To use these results as an exact statement of what existing parameter interrelationships are requires that reality coincide with several very restrictive assumptions concerning such things as data ranges and continuation of sample period multicollinearity. Even these "average" estimates provide some statistical information, however.

Observed lumber consumption, Appendix A series E5, E9, and E27 for the respective species groups, was used to represent both lumber quantity supplied and demanded during equation estimation.

Primary Demand Level Variables

Most of the coefficients estimated for the primary demand determinants, Table 1, were comparable to what economic logic would dictate. The Douglas-fir demand equation shifts to the right as the volume of residential construction increases. However it shifts to the left as more multi-family structures are started and as the volume of maintenance and repair increases. These negative signs perhaps indicate that both provide substitutes for full scale new single family dwellings and thus represent net demand decreases at the same price. The volume of residential construction and the multi-family structure index in the Southern pine function are opposite of what they are in the Douglas-fir equation and opposite of what economic logic dictates. One explanation in the face of the highly significant and stable estimates is that there is greater substitution of Douglas-fir for Southern pine in the lumber market during construction booms. This is somewhat inconsistent with the positive Southern pine housing start coefficient, however. The residential construction signs in the "structural species" are the same as in Douglas-fir demonstrating that the dominate effect upon a larger lumber aggregate which incorporate close species substitutes is as expected.

TABLE 1.--Statistical characteristics of the primary demand level equations for lumber, by species group.

Variable code[a]	Variable	Coefficient	t ratio	% sig.	90% confidence interval
			Douglas-fir[b]		
E38	Douglas-fir price	2.4589	0.2164	--	19.6433
	Constant	8605.1898	6.1547	99	2417.4035
D1	Vol. resid. constr.	0.2188	4.9584	99	0.0762
D3	% starts with 3 or more dwelling units	-10583.0652	-8.6464	99	2116.2591
D4	Vol. maint.+ repair	-0.2733	-1.8394	95	0.2569
			Southern pine[c]		
E39	Southern pine price	33.8991	1.8864	95	31.2683
	Constant	943.3706	0.8007	75	2050.0753
D1	Vol. resid. constr.	-0.1858	-3.2920	99	0.0981
D2	Dwelling starts	3.1170	5.9419	99	0.9128
D3	% starts with 3 or more dwelling units	2249.0318	3.0173	99	1296.9554
D9	No. cross ties	0.0331	1.1064	80	0.0520
D10	No. box cars	42.5179	5.1943	99	14.2427
			Structural species[d]		
E40	Structural species price	-3.1747	-0.1137	--	48.5879
	Constant	19209.9714	5.5922	99	5977.1778
D1	Vol. resid. constr.	0.2973	2.1579	97.5	0.2397
D2	Dwelling starts	2.0102	0.9674	80	3.6157
D3	% starts with 3 or more dwelling units	-13515.7859	-4.1238	99	5702.8028
D4	Vol. maint. + repair	-0.8154	-2.3989	97.5	0.5914
D5	Vol. non-resid. constr.	0.0929	1.0995	85	0.1470

[a]The variable code pertains to the codes in Appendix A and B.

[b]Squared multiple correlation coefficient = .8272; Durbin-Watson statistic = 1.90; Basmann phi ratio = .355.

[c]Squared multiple correlation coefficient = .9670; Durbin-Watson statistic = 2.52; Basmann phi ratio = .937.

[d]Squared multiple correlation coefficient = .7243; Durbin-Watson statistic = 2.35; Basmann phi ratio = .722.

Secondary Demand Level Variables

Of the secondary demand level estimates, a few represent the net effect of opposing forces but most have straightforward correct signs, Table 2. Softwood plywood registers as a strong lumber substitute by the substantial positive shift of demand associated with an increase in plywood price. Likewise, an increase in mortgage rates, as monitored by FHA secondary market yields, curtails demand in all species. The price of building board mirrors two opposing tendencies, one to act as a substitute for lumber in the form of boards and one to act as a complement for lumber dimension stock. Building board is estimated as a net substitute for Douglas-fir lumber and a net complement for Southern pine lumber. Similarly, structural steel is represented as a net lumber substitute in the "structural species" demand equation described in Table 2.

One estimate that may be contrary to expected results is the negative sign of the coefficient of the national population mobility variable in the Southern pine equation. If the coefficient does not merely represent a regional situation it seems to indicate that mobile generally people sell one home before buying another instead of vice versa.

TABLE 2.--Statistical characteristics of the secondary demand level equations for lumber, by species group.

Variable Code[a]	Variable	Coefficient	t ratio	% sig.	90% confidence interval
		Douglas-fir[b]			
E38	Douglas-fir price	-7.1694	-0.3320	--	37.5742
	Constant	-9193.0858	-2.7798	99	5754.3536
D15	No. households	0.1716	2.6457	99	0.1127
D29	Softwood Plywood pr	56.1204	2.6884	99	36.3231
D31	Building board pr	34.5625	1.3916	90	43.2153
D39	Secondary FHA i%	-310.9465	-1.7695	95	305.7667
D55	% families having income $5-10 thou.	115.2325	2.4081	97.5	83.2630
		Southern Pine[c]			
E39	Southern pine price	29.2838	0.9827	80	51.8597
	Constant	14106.4159	3.3266	99	2378.4607
D29	Softwood plywood pr	26.1436	1.7496	95	26.0006
D31	Building board pr	-83.2349	-4.5689	99	31.6984
D39	Secondary FHA i%	-496.2835	-2.2097	97.5	390.7946
D53	% pop. mobility	-220.1648	-1.4300	90	267.8967
D60	% pop. age 0-24 as household heads	332.9874	0.6880	70	842.0465

[a]The variable code pertains to the codes in Appendix A and B.

[b]Squared multiple correlation coefficient = .8219; Durbin-Watson statistic = 2.21; Basmann phi ratio = .213.

[c]Squared multiple correlation coefficient = .9134; Durbin-Watson statistic = 1.99; Basmann phi ratio = .495.

Table 2.--Cont.

Variable Code	Variable	Coefficient	t ratio	% sig.	90% confidence interval
		Structural Species[d]			
E40	Structural species price	31.9760	0.7008	75	79.3875
	Constant	4997.5322	1.2530	85	6939.9249
D29	Softwood plywood price	60.9376	1.9735	95	53.7265
D30	Structural steel price	1446.6995	3.4389	99	731.9953
D39	Secondary FHA i%	-896.1964	-1.8601	95	838.3123
D60	% pop. age 0-24 as household heads	1397.4660	1.5758	90	543.0427
D28	Change mfgt index	39.4566	1.0541	80	65.1316

[d]Squared multiple correlation coefficient = .6496, Durbin-Watson statistic = 2.57; Basmann phi ratio = .269.

Primary Supply Level Variables

The results of the primary supply level equations given in Table 3 present some of the most interesting and most perplexing results. Sawmill establishment size, to which productivity and wage rate variables were previously found to be colinear and therefore were excluded, carries a positive sign. This is expected since an increase in establishment size probably corresponds to more efficient production, more advanced technology, and therefore lower costs. Interestingly, the magnitude of the establishment size coefficient is one-third as large in the Douglas-fir equation as in the Southern pine equation probably resulting from the relatively smaller and more inefficient mills located in the South.

The peeler log price variable in the Douglas-fir equation is intended to monitor the pressure of the plywood industry at the peeler log-sawlog margin. The average peeler log price can change for at least two reasons. First, if there is a relative increase in demand of plywood over lumber, the peeler-sawlog margin of profitability will shift to lower size and quality logs. The average peeler log price may decrease, however, if the lower cost logs added to the peeler log price average outweigh the effect of the price increase for larger size and quality logs. Second, technological advances which allow profitable utilization of smaller peeler logs can increase the input

TABLE 3.--Statistical characteristics of the primary supply level equations for lumber, by species group.

Variable Code[a]	Variable	Coefficient	t ratio	% sig.	90% Confidence interval
			Douglas-fir[b]		
E38	Douglas-fir price	145.9743	6.0918	99	41.8385
	Constant	-17018.3280	-4.6583	99	6378.6972
S6	Average sawmill size	10.8698	4.0083	99	4.7349
S19	Douglas-fir sawlog price	-231.4199	-4.6566	99	86.7714
S26	U.S./Canada money exchange rate	71.2235	3.1451	99	39.5390
S52	Douglas-fir log export	-4.7912	-3.1084	99	2.6912
S55	Douglas-fir peeler log price	27.4736	2.2675	97.5	21.1554
T3	Lumber rail rate	7970.5809	4.0907	99	3402.0088
			Southern Pine[c]		
E39	Southern pine price	97.8272	4.6604	99	36.5245
	Constant	11562.9997	3.2663	99	6159.7432
S7	Average sawmill size	30.8986	1.4643	90	36.7152
S23	Softwood chip residue, South	-0.4541	-1.8827	95	0.4196
S25	Lumber tariff	343.1870	0.8661	80	689.4736
S26	U.S./Canada money exchange rate	-68.3921	-1.9055	95	62.4517
S57	Southern pine pulpwood price	-619.6791	-2.3014	97.5	468.5249

[a]The variable code pertains to the codes in Appendix A and B.

[b]Squared multiple correlation coefficient = .9183; Durbin-Watson statistic = 2.76; Basmann phi ratio = .709.

[c]Squared multiple correlation coefficient = .8982; Durbin-Watson statistic = 2.19; Basmann phi ratio = .120.

Table 3.--Cont.

Variable Code[a]	Variable	Coefficient	t ratio	% sig.	90% Confidence interval
		Structural Species[d]			
E40	Structural species price	237.3802	5.7602	99	71.9538
	Constant	4233.2588	0.5857	--	12618.6894
S20	Softwood sawlog price	-12.4818	-1.8103	95	117.1670
S26	U.S./Canada money exchange rate	144.8248	2.1118	95	119.7373
S28	B.C. lumber prod.	1892.9390	5.4928	99	601.7142
S53	Softwood log export	-0.5138	-1.0737	95	0.8354
S58	Softwood pulpwood price	-243.9394	-2.2197	97.5	91.8798
T3	Lumber rail rate	3863.6176	0.9052	80	7453.3297

[d] Squared multiple correlation coefficient = .7846; Durbin-Watson statistic = 2.61; Basmann phi ratio = .629.

of smaller logs. At the same time the price of high quality peeler logs may even decline if plywood demand is constant. Therefore, it is possible and even probable that a decline in the average peeler log price is associated with increased pressure upon the sawlog market and thus will cause a negative shift of the lumber supply function. The estimated peeler log coefficient is consistent with this logic.

A similar situation occurs in the case of the volume of chip residues from Southern pine sawmills. The sale of chip by-products increases the profitability of lumber production from lower quality and smaller logs, which would exert a positive shift of the supply function. If the sawmills actually chip what was once cut for lumber, however, a negative shift of the supply function would occur. This would occur when mills chip low grade lumber, either because the lumber market is weak or because the mill can use a larger percentage of its operating time producing more profitable high grade lumber. According to the estimated Southern pine supply equation, there is a 95 percent certainty that a net decrease in lumber supply is associated with an increase in chip production.

Three primary supply level variables have signs contrary to those expected by economic theory: U.S./Canadian money exchange rate, lumber tariff rate, and rail transportation cost. The exchange rate and tariff rate should carry opposite signs in the Douglas-fir or "structural species" function than they do in the Southern pine equation. The estimated signs are of the opposite sign in the Southern pine equations but in all three equations the signs are contrary to the expected. Since the variable signs and significance levels were consistent under numerous test runs and transformations, they could not be discarded. Similarly, the railroad cost variable should have a negative rather than a positive sign yet the estimate was positive whether it was included on the supply or demand side of the model.

Primary + Secondary Supply Level Variables

When the sawlog price was removed from the primary supply level equations and replaced by the stumpage sector determinants of sawlog price, the few variables which successfully faced the multicolinearity tests had estimated coefficients with correct signs. As shown in Table 4, increased Forest Service timber sales and money spent on timber access roads both shift the supply functions to the right. An increase in the stumpage price from Forest Service timber sales, a variable which is perhaps less immediate than the stumpage price of the species itself but a more interesting policy variable, causes a shift of the supply function to the left. That is, the coefficient of the stumpage price variable is negative meaning that quantity supplied at the same lumber price is less as stumpage price increases. The individual species stumpage price variables were excluded because they proved

TABLE 4.--Statistical characteristics of the primary + secondary supply level equations, by species group.

Variable Code[a]	Variable	Coefficient	t ratio	% sig.	90% Confidence interval
			Douglas-fir[b]		
E38	Douglas-fir price	87.6556	4.9877	99	30.6850
	Constant	-7450.4051	-2.7456	99	4737.8979
S26	U.S./Canada money exchange rate	46.7869	1.9441	95	42.0194
S52	Douglas-fir log export	-5.7849	-4.0387	99	2.5009
S55	Douglas-fir peeler log price	21.2742	1.4324	90	25.9317
T3	Lumber rail rate	1856.5470	1.0026	80	3233.0605
S38	F.S. stumpage price	-81.7334	-3.3066	99	43.1581
S39	Road cost	6.8788	1.6403	90	7.3218
			Southern Pine[c]		
E39	Southern pine price	103.9045	5.2424	99	34.6058
	Constant	14875.4913	3.8204	99	6798.4551
S7	Average sawmill size	42.5821	1.9896	95	37.3692
S23	Softwood chip residue, South	-0.7560	-2.6346	99	0.5011
S25	Lumber tariff	431.9187	1.1377	85	662.8442
S26	U.S./Canada money exchange rate	-92.8521	-2.5682	97.5	63.1259
S57	Southern pine pulpwood price	-886.8588	-3.0162	99	513.3748
S30	F.S. region 8 timber sales	3.1913	1.9393	95	2.8732

[a]The variable code pertains to the codes in Appendix A and B.

[b]Squared multiple correlation coefficient = .8823; Durbin-Watson statistic = 2.37; Basmann phi ratio = .281.

[c]Squared multiple correlation coefficient = .9134; Durbin-Watson statistic = 1.95; Basmann phi ratio = .849.

Table 4.--Cont.

Variable Code	Variable	Coefficient	t ratio	% sig.	90% Confidence interval
		Structural Species[d]			
E40	Structural species price	247.1900	6.2620	99	68.9230
	Constant	5043.9727	0.9771	80	9013.4028
S26	U.S./Canada money exchange rate	130.5845	2.6561	97.5	85.8391
S28	B.C. lumber prod.	1542.3198	4.0704	99	661.5868
S53	Softwood log export	-1.1580	-2.2230	95	0.9094
S58	Softwood pulpwood price	-287.0258	-3.5637	99	140.6256
S38	F.S. stumpage price	-111.2927	-2.4221	97.5	80.2281
S39	Road cost	16.5977	1.1155	85	25.9782

[d] Squared multiple correlation coefficient = .8207; Durbin-Watson statistic = 2.68; Basmann phi ratio = .296.

non-significant. Lack of structural significance probably lies in the poor quality of the time series data on species stumpage prices.

It seems that, at least for estimated coefficient signs, it can be safely stated that the estimated equations are about what economic logic would dictate. There is little basis on which to judge coefficient magnitudes, however.

ESTIMATED ELASTICITIES OF INDIVIDUAL SHIFT VARIABLES

Even though the significance levels in Tables 1 through 4 give some information relevant to the objective of judging the relative importance of function shifters, coefficient estimates must be presented in some standardized unit of measure before their relative importance can be readily judged. The measurement used for standardization in this study is elasticity. Elasticity is the percent change of the quantity of lumber supplied or demanded associated with a one percentage increase in the exogenous variable of concern, *ceteris paribus*. For example, a demand price elasticity of -0.2 means that quantity demanded decreases 0.2 percent for every 1.0 percent increase in lumber price. See Appendix E for the method used in calculation.

The elasticity estimates were calculated using the arithmetic mean of lumber consumption and the variable in question over the sample observation period on the presumption that they are closest to "normal" levels. As such, the elasticity estimates are somewhat of the average of 1947-70 levels. Although no significance levels are presented in the following elasticity tables, Tables 5 through 10, the probability levels in the above Tables 1 through 4 concerning coefficient signs are applicable to the same null hypothesis concerning the sign of the elasticity estimate. That is, if the coefficient estimate for variable D1 in Table 1 is significantly different from zero at the 99 percent confidence level, so is the corresponding elasticity estimate.

Elasticity provides unit standardization but, because variables exhibit considerably divergent average annual percentage changes, calculated elasticities may not monitor the average relative impact between variables. To demonstrate this aspect of relative importance, the arithmetic mean of absolute annual percentage changes in the level of each exogenous variable over the sample period was determined. The elasticity estimate derived from the 1947-70 sample was then multiplied by this mean absolute annual percentage change to derive the average percentage change in lumber quantity supplied or demanded associated with movements of the variable in question. Thus, in each elasticity table three values are shown for each variable: the elasticity, the average absolute annual percentage change, and the average annual percentage impact on lumber quantity due to the mean sample period changes of the specific variable.

Demand Variable Elasticities

As shown in Tables 5 through 7, the elasticity of all variables included in the final demand equations were inelastic, having a value of less than unity. This is contrary to the results of McKillop's (1967, p. 46) softwood lumber demand equation where over half of the variable elasticities were greater than unity. The secondary demand variables display higher elasticity estimates on the average (elasticity, e = 0.39) than do the primary demand level variables (e = 0.26). This tendency is much more pronounced in the Douglas-fir and Southern pine equations than the "structural species" demand equations but persists throughout. Because of higher absolute average percentage changes, however, the average percentage impact upon quantity demanded of primary demand level variables (average absolute percentage impact, aapi = 3.04) is greater than secondary level variables (aapi = 1.76). Therefore, while there are exceptions, it seems that changes in the consumption level of individual lumber-using products exerts more impact upon lumber demand than do the specific supply and demand factors that determine the consumption level for these lumber-using products.

Multiplication of elasticities by the average percentage change also allows for ready identification of the most important individual variables. The value of residential construction is associated with greater shifts of the lumber demand functions than any other lumber

TABLE 5.--Elasticity and percentage impact estimates for Douglas-fir lumber demand function shifters.

Variable Code[a]	Variable	Elasticity	Average % change	Average % impact
Primary level:				
D1	Volume of residential construction	0.5087	9.85	5.01
D3	% starts with 3 or more dwelling units	-0.2417	16.44	3.97
D4	Volume of maintenance and repair	-0.1874	6.07	1.14
	absolute average[b]	0.3126		3.37
Secondary level:				
D15	Number Households	0.9112	2.09	1.90
D29	Softwood plywood price	0.5328	7.49	3.99
D31	Building board price	0.2857	2.72	0.78
D39	Secondary FHA % yields	-0.1764	5.55	0.98
D55	% families having income of $5-10 thousand	0.4803	3.08	1.48
	absolute average[b]	0.4772		1.83

[a]The variable code pertains to the codes used in Appendix A and B to identify data series.

[b]The arithmetic mean of the absolute elasticity and average annual percentage function shift.

TABLE 6.--Elasticity and percentage impact estimates for Southern pine lumber demand function shifters.

Variable Code[a]	Variable	Elasticity	Average % change	Average % impact
Primary level:				
D1	Volume of residential construction	-0.5843	9.85	5.76
D2	Number of dwelling starts	0.6348	10.68	6.77
D3	% starts with 3 or more dwelling units	0.0694	16.44	1.14
D9	Number of cross ties installed	0.1118	7.84	0.88
D10	Number of box cars installed	0.1282	47.18	6.05
	absolute average[b]	0.3057		4.12
Secondary level:				
D29	Softwood plywood price	0.3394	7.49	2.54
D31	Building board price	-0.9286	2.72	2.52
D39	Secondary FHA % yields	-0.3813	5.55	2.12
D53	Percent population mobility	-0.6000	3.65	2.20
D60	Percent population ages 0-24 as household heads	0.1569	4.93	0.77
	absolute average[b]	0.4817		2.03

[a]The variable code pertains to the codes used in Appendix A and B to identify data series.

[b]The arithmetic mean of the absolute elasticity and average annual percentage function shift.

TABLE 7.--Elasticity and percentage impact estimates for "structural species" lumber demand function shifters.

Variable Code[a]	Variable	Elasticity	Average % change	Average % impact
Primary level:				
D1	Volume of residential construction	0.3081	9.85	3.03
D2	Number of dwelling units	0.1349	10.67	1.44
D3	% starts with 3 or more dwelling units	-0.1376	16.44	2.26
D4	Volume of maintenance and repair	-0.2493	6.07	1.51
D5	Volume of non-residential construction	0.0705	8.21	0.58
	absolute average[b]	0.1800		1.76
Secondary level:				
D29	Softwood plywood price	0.2579	7.49	1.93
D30	Structural steel price	0.3546	3.90	1.38
D39	Secondary FHA % yields	-0.2267	5.55	1.26
D60	Percent population ages 0-24 as household heads	0.2169	4.93	1.07
D28	Change manufacturing activity	0.0082		
	absolute average[b]	0.4817		2.03

[a]The variable code pertains to the codes used in Appendix A and B to identify data series.

[b]The arithmetic mean of the absolute elasticity and average annual percentage function shift.

product demand level variable except for the multi-family building index in the Southern pine equation. The price of softwood plywood (aapi = 2.12) as a substitute for lumber is evidently the most important secondary demand variable affecting lumber demand. Softwood plywood is especially important in the Douglas-fir equation (aapi = 2.54), demonstrating that a sheathing substitute has more impact upon Douglas-fir than it does upon its Southern pine lumber substitute. This difference in plywood elasticities is consistent with the estimation that building board (a sheathing substitute) is a net substitute for Douglas-fir lumber but a net complement for Southern pine lumber. The reason for this may be the nature of residential construction in the regions served by the Douglas-fir and Southern pine lumber industries respectively and the end use differences of the two species, but very little data are available to substantiate this. FHA secondary market yields have only moderate to low impact upon the overall demand level (aapi = 1.45), as does the change in household headship rates in the 0-24 age class (aapi = 0.92). Beyond this, no general groupings are readily apparent.

Supply Variable Elasticities

The estimated elasticity of supply variables shown in Tables 8 through 10 averaged higher (average primary e = 0.58 with four above

TABLE 8.--Elasticity and percentage impact estimates for Douglas-fir supply function shifters.

Variable Code[a]	Variable	Elasticity	Average % change	Average % impact
Primary level:				
S6	Average sawmill size	0.4550	4.90	2.23
S19	Douglas-fir sawlog price	-1.3866	5.49	7.61
S26	U.S./Canada money exchange rate	0.7161	1.64	1.17
S52	Douglas-fir log export volume	-0.0455	56.57	2.57
S55	Douglas-fir peeler log price	0.2782	5.50	1.53
T3	Lumber railroad rate	1.1371	3.50	3.47
	absolute average[b]	0.6697		3.10
Primary + Secondary level:				
S26	U.S./Canada money exchange rate	0.4704	1.64	0.77
S52	Douglas-fir log export volume	-0.0550	56.57	3.11
S55	Douglas-fir peeler log price	0.2154	5.50	1.18
T3	Lumber railroad rate	0.2648	3.05	0.81
S38	F.S. stumpage price	-0.1353	23.17	3.13
S39	Timber access road cost	0.0447	22.08	0.99
	absolute average[b]	0.1976		1.67

[a]The variable code pertains to the codes used in Appendix A and B to identify data series.

[b]The arithmetic mean of the absolute elasticity and average annual percentage function shift.

TABLE 9.--Elasticity and percentage impact estimates for Southern pine lumber supply function shifters.

Variable Code[a]	Variable	Elasticity	Average % change	Average % impact
Primary level:				
S7	Average sawmill size	0.2986	6.28	1.86
S23	Softwood chip residue use, South	-0.1426	45.18	6.45
S25	Lumber import tariff	0.0497	7.72	0.38
S26	U.S./Canada money exchange rate	-0.9303	1.64	1.53
S57	Southern pine pulpwood price	-1.3631	1.82	2.48
	absolute average[b]	0.5568		2.54
Primary + Secondary level:				
S7	Average sawmill size	0.4115	6.28	2.58
S23	Softwood chip residue use, South	-0.2375	45.18	10.73
S25	Lumber import tariff	0.0625	7.72	0.48
S26	U.S./Canada money exchange rate	-1.2630	1.64	2.07
S57	Southern pine pulpwood price	-1.9508	1.82	3.55
S30	F.S. region 8 timber sales	0.3334	11.64	3.88
	absolute average[b]	0.7097		3.88

[a]The variable code pertains to the codes used in Appendix A and B to identify data series.

[b]The arithmetic mean of the absolute elasticity and average annual percentage function shift.

TABLE 10.--Elasticity and percentage impact estimate for "structural species" lumber supply function shifters.

Variable Code[a]	Variable	Elasticity	Average % change	Average % impact
Primary level:				
S20	Softwood sawlog price	-0.5674	4.09	2.32
S26	U.S./Canada money exchange rate	0.6492	1.64	1.06
S28	B.C. lumber production	0.4661	6.38	2.97
S53	Softwood log export volume	-0.0157	36.83	0.58
S58	Softwood pulpwood price	-1.1440	2.13	2.44
T3	Lumber railroad rate	0.2457	3.05	0.75
	absolute average[b]	0.5146		1.69
Primary + Secondary Level:				
S26	U.S./Canada money exchange rate	0.5853	1.64	0.96
S28	B.C. lumber production	0.3739	6.38	2.39
S53	Softwood log export volume	-0.0354	36.83	1.30
S58	Softwood pulpwood price	-1.3460	2.13	2.87
S38	F.S. stumpage price	-0.0821	23.17	1.90
S39	Timber access road cost	0.0465	22.08	1.03
	absolute average[b]	0.4115		1.74

[a]The variable code pertains to the codes used in Appendix A and B to identify data series.

[b]The arithmetic mean of the absolute elasticity and average annual percentage function shift.

unity) and showed more variation in magnitude between variables than found in any of the demand equations. Multiplication by the average percentage change in the variables over the 1947-70 sample period tended to moderate the average impact and variation between variables, however (aapi = 2.44). Average sawmill establishment size, which is correlated to average sawmill labor productivity at .92 in the Pacific region and .97 in the Southern region, showed only moderate to low elasticities (e = 0.38) and average percent impact (aapi = 2.04). To the extent that productivity and establishment size monitor many of the same factors, these results are somewhat contrary to those presented by McKillop (1967, p. 46). McKillop estimated sawmill productivity to have one of the largest elasticities among the supply variables.

The tariff rate on lumber imports into the United States exhibited one of the lowest elasticities (e = 0.05). The U.S./Canadian exchange rate had moderate elasticities (e = 0.77) but low average percentage impacts (aapi = 1.25) because of its generally stable level. Another international factor, log exports, has low elasticities and moderate to low average impacts (aapi = 1.57). Log exports registered higher importance in the Douglas-fir supply equation (aapi = 2.57) than in the "structural species" function (aapi = 0.58), as might be expected. This relatively minor log export impact as measured by the 1947-70 average runs somewhat contrary to the attention awarded log exports by some analysts concerned with lumber price increases during 1968 and 1969. British Columbia lumber production, a proxy for lumber import pressure, has a relatively large elasticity (e = 0.47) and very large average impact (aapi = 2.97) upon the "structural species" supply, the only equation in which it was retained due to multicollinearity in other equations.

Perhaps the most interesting supply elasticity results concern the raw material factors in the lumber market system: sawlog prices, pulpwood price, peeler log price, stumpage price, and chip residue recovery. As a group, they average quite high elasticities (e = 0.64) and even higher relative average annual percentage impacts (aapi = 3.5). Sawlog price is one of the most important shift variables of this raw material group and of all the supply variables. The Douglas-fir supply function is more susceptible to changes in the log price (aapi = 7.61) than the "structural species" supply (aapi = 2.32), a difference possibly due to a relatively more inelastic log supply function for Douglas-fir than "structural species" logs. Similarly, pulpwood factors exhibit high importance (aapi = 2.46) indicating that sawlog availability is receiving substantial pressure at the sawlog-pulpwood margin of log size and quality; more pressure than at the peeler log-sawlog margin (aapi = 1.53).

In summary, results indicate that the consumption levels of lumber using products are relatively more important as lumber demand shifters than are the more indirect supply and demand determinants of those consumption levels. The value of residential construction and the price of softwood plywood showed the greatest importance as demand function shifters. On the supply side average establishment size, log exports, lumber tariffs, and U.S./Canadian exchange rate have an estimated moderate to low impact. Raw material factors, especially sawlog price and pulpwood variables, exhibit relatively greater importance as supply function shifters as does the British Columbia lumber production level.

ESTIMATED PRICE ELASTICITY ESTIMATES

The elasticity of the lumber price variable is interpreted the same as the elasticity of the shifter variables. Price elasticity is the percentage change of the quantity of lumber supplied or demanded associated with a one percent increase in lumber price, *ceterbis paribus*. These are calculated at the arithmetic mean level of lumber consumption and price over the 1947-70 sample period just as they were for the shifter variables. Price elasticities so calculated are recorded in Table 11 along with a 90 percent confidence interval band for each point estimate.

TABLE 11.--Price elasticity estimates for Douglas-fir, Southern pine and "structural species" lumber supply and demand.

Equation level	Douglas-fir		Southern pine		"Structural species"	
	elasticity	90% C.I.	elasticity	90% C.I.	elasticity	90% C.I.
Primary demand	.0271	.2169	.5072	.4679	-.0156	.2395
Secondary demand	-.0791	.4150	.4372	.7737	.1576	.3914
Primary supply	1.6124	.4621	1.4639	.5465	1.1702	.3547
Primary + secondary supply	0.9682	.3389	1.5548	.5178	1.2185	.3397

Demand Price Elasticity Estimates

Except under very unusual conditions economic theory predicts demand price elasticities will be negative, indicating that an increase in price will be associated with a decrease in the quantity demanded. Two of the six estimated demand price elasticities are negative and very close to zero: Douglas-fir secondary level and "structural species" primary level. Two more estimates are slightly positive, Douglas-fir primary level and "structural species" secondary level, but given their confidence intervals, are within the range of expected results.

Both Southern pine demand price elasticity estimates are quite positive. A possible explanation for these estimates is that Southern pine lumber, which is generally considered a less desirable species because of its physical characteristics, is only demanded in relatively larger quantities when other more desirable species such as Douglas-fir and true fir are difficult to obtain. If these other more desirable species are generally less available when lumber prices are up, an estimated positive Southern pine demand price elasticity may result. If this explanation is correct, it indicates the need to include a proxy variable in the model to indicate buyer preference.

Excessive sample variation or the presence of an outlier observation in the sample may also be a reason for the positive Southern pine demand price elasticity estimates. Test runs excluding 1947 data and using the 1948-70 observations alone somewhat substantiated this thought. The price elasticity estimated from 1948-70 data for the Southern pine primary demand level was 0.4085 ± 0.4596 and for the secondary demand level was -0.0383 ± 0.8673.

Given these possible explanations for the Southern pine estimates, the theoretical expectation of negative elasticities, and the exceedingly stable and near zero Douglas-fir and "structural species" estimates, it seems fairly safe to conclude that the lumber demand price elasticity for these species is within the negative inelastic range. On the basis of the confidence intervals given in Table 11, we can also be fairly certain that demand price response is quite inelastic, since there is a 90 percent probability that the true elasticity is no more elastic than -0.50.

McKillop's (1967, p. 40) demand price elasticity estimates provide the only econometric results comparable to those presented here. His softwood lumber estimate was a very elastic -3.2 which, even given the wide 90 percent confidence interval that extends as far inelastic as -0.2, is somewhat at odds with the results of this study. Mead (1966, p. 50) reflects the attitude that economic theory would indicate ". . . demand for lumber with respect to price is well within the inelastic range . . . ," which is consistent with this study's estimates. The U.S. Forest Service (1969) assumption of a -0.1 price elasticity for softwood lumber demand is also consistent with the conclusion here that lumber demand response to price changes is very inelastic.

Supply Price Elasticity Estimates

Economic theory predicts that the price elasticity of supply functions will be positive. Table 11 shows that except in one instance all the estimated supply price elasticities are positive and elastic (greater than unity) implying that a 1 percent price change will be associated with a supply response of greater than 1 percent. The exception in the Douglas-fir primary + secondary supply level estimate, which is positive and very close to unity.

It is assumed that what lies behind the difference in the two Douglas-fir supply price elasticity estimates is the existence of a very inelastic supply function for Douglas-fir stumpage. The primary supply level equation only contains a sawlog price variable so it does not incorporate the stumpage inelasticity within the function (e = 1.61). The primary + secondary supply level equation does include a stumpage price variable (e = 0.97), however, and has a correspondingly lower elasticity estimate. Instead, the primary level equation confronts stumpage inelasticity as an external diseconomy which is signaled by a leftward shift of the lumber supply function due to increased sawlog input price. The supply and demand function shifts analyzed in

Chapter V seem to substantiate this claim. The Douglas-fir lumber supply function containing sawlog price alone shifts to the left whenever lumber demand is strong, and an increased sawlog price is the variable most strongly associated with the leftward supply shift.

Moving onto a comparison between species groups, at least three regional industry and timber characteristics tend to decrease the flexibility which a given species group experiences and thus induces a more inelastic supply response to lumber price changes. More federal and large private holdings managed on a relatively strict sustained yield basis, less viable alternative log uses, and higher barriers to entry all tend to decrease flexibility. The Southern situation is more flexible than the Douglas-fir region on all three of these counts. Extensive federal lands are found in the Douglas-fir region while few federal lands are found in the South and the extent of large private holdings are only slightly more prominent in the South than West. Similarly, the use of Southern pine for pulpwood seems to provide a more viable alternative to sawlog use in the South than does the use of Western species for veneer or pulpwood in the Douglas-fir region. Evidence of this is shown by the relatively larger elasticity estimate for Southern pine pulpwood ($e = -1.36$) than for Douglas-fir peeler logs ($e = 0.28$) in the Tables 8 and 9. Moreover, 60 percent of the 1970 pulpwood output in the Pacific Coast States was residue from lumber and plywood mills rather than roundwood versus only 17 percent in the

South (Hair and Ulrich, 1970, pp. 20-21). Barriers to entry are also relatively greater in the Douglas-fir region due to both the difficulty of acquiring sufficient timber holdings to be assured of adequate timber supply (Mead, 1966, pp. 64-65) and higher capital costs required to handle the larger logs.

While the Douglas-fir industry situation is less flexible on each of these counts, the difference does not surface in the form of a less price elastic lumber supply estimate from the 1947-70 annual observations. The Douglas-fir primary level point estimate (e = 1.61) is slightly more elastic than its Southern pine counterpart (e = 1.46). However, given the confidence intervals of the two estimates and smallness of the difference between the estimates (0.15), it can be rather confidently stated that the supply price elasticity in the one year run for both Douglas-fir and Southern pine lies in the 1.5 to 1.6 area. Whether this closeness means that the estimates are wrong, that there are other counterbalancing factors which should be added to the three named above, or that these flexibility elements simply don't have much effect on elasticity is difficult to access.

Since the "structural species" group is composed predominately of Douglas-fir and Southern pine, with only a minor addition of some Intermountain and Rocky Mountain cutting, we would expect the "structural" supply elasticity estimate to be somewhat similar. However, the "structural species" estimate of 1.2 is somewhat lower than the

Douglas-fir and Southern pine price elasticity estimates. The reason for this difference is uncertain but the narrow confidence intervals for the three suggests that the true price elasticity is actually lower.

Two other econometric studies provide estimates of supply price elasticities. Holland (as reported by Mead, 1966, p. 72) estimated the price elasticity of softwood lumber supply at +1.7. McKillop's (1967, p. 40) estimate of the price elasticity of softwood lumber supply was also +1.7, but his wide confidence interval (± 1.7) suggest that any statement about the magnitude of difference between his results and the estimates presented here would be risky. Essentially all of this econometric evidence is contrary to the conclusion reached by Mead (1966, p. 73), however, that the price elasticity of lumber supply is ". . . in the inelastic range . . . ."

The price elasticity results include contradictions, but allow for the drawing of general conclusions with some confidence. The price elasticity of lumber demand for the species considered here is very inelastic, probably well below -0.5. Lumber supply response with respect to price, however, seems to be elastic and in the neighborhood of 1.2 to 1.6. If the lumber industry that specializes in a particular species faces a very price inelastic stumpage supply function (which is more probable for Douglas-fir than Southern pine or Intermountain species) the lumber supply for that species may exhibit the typical external diseconomy impact of shifting to the left due to increased stumpage input prices such that the effective lumber supply price elasticity may drop as low as 0.9.

ESTIMATES OF LUMBER DEMAND EQUATIONS USING GROSS ECONOMIC INDICATORS

Using the same supply function instrumental variables in the first stage of 2SLS as was used in the above described demand equations, separate demand equations were estimated using Gross National Product (GNP) and per capita disposable income. These variables had to be used separately because of multicolinearity. Total value of construction, wholesale prices, GNP, per capita income, and population all proved to be colinear; no simple correlation between any two was less than .96.

The results of these calculations are presented in Table 12. Several major problems are evident. The squared multiple correlation coefficient or percentage of the variation of lumber quantity accounted for by the exogenous variables (R^2) of these Douglas-fir and Southern pine equations are lower than the R^2 of previous equations by about 0.40 and the "structural species" are lower by about 0.50. The Durbin-Watson test shows significant serial correlation in the Douglas-fir and Southern pine equations and the Basmann phi ratio shows they aren't properly identified as demand equations. The price elasticities of

TABLE 12.--Statistical characteristics of lumber demand equations using gross economic indicators, by species group.

Species	Exogenous Variable	Lumber price		Exogenous variable		R^2[a]	Durbin-Watson[b]	Basmann phi[c]
		coefficient	std. error	coefficient	std. error			
Douglas-fir	GNP	29.30	17.65	-3.03	0.86	.42	.82	.001
	per capita income	31.36	17.30	-1226.57	335.77	.44	.86	.001
Southern pine	GNP	160.30	50.23	-4.18	1.02	.55	.93	.013
	per capita income	170.91	52.51	-1662.19	424.56	.51	.98	.018
"structural species"	GNP	34.45	35.31	-0.48	1.37	.16	1.85	.139
	per capita income	28.07	36.15	-179.46	552.06	.14	1.87	.214

[a] The coefficient of determination (R^2) measures the percentage of variation in lumber quantity demanded accounted for by the lumber price and exogenous variable.

[b] The Durbin-Watson statistic measures the serial correlation among estimated residuals.

[c] Basmann's phi ratio measures the probability that the equation is truly identifiable as a demand function.

the "structural species" estimates are similar to the secondary demand level estimates. The Douglas-fir and Southern pine price elasticity estimates are very positive, however, which is not surprising since they are not properly identified as demand equations. Similarly, all the exogenous variable coefficient estimates are opposite of their expected signs, probably as a result of the gross missepcification signaled by the very low R^2's.

In short, the contents of Table 12 indicate that gross economic indicators alone simply are not adequate for the estimation of demand functions for these lumber species. Hair (1967) was more successful in estimating consumption when he applied gross indicators to quite narrowly defined paper products, as is indicated by his R^2's which were in the .90's. McKillop's (1967, pp. 42-47) elasticity estimates show that gross economic variables only have high importance to the exclusion of any other variables having high importance in the paper demand function. In the demand for any of the other wood products the gross economic variables had lower elasticities. The results of this study in conjunction with McKillop's suggest that paper is the only wood product with which Hair could have been successful in estimating narrowly defined product class consumption levels with gross economic indicators.

CHAPTER V

SHIFTS OF THE SUPPLY AND DEMAND FUNCTIONS

The results presented in Chapter IV give an indication of the relative importance of various shift variables and the supply response in the one year run. Recall the one year run conclusions were drawn from equations estimated from annual observations from 1947-70 and from certain mean values of the 1947-70 variable levels. Some information must be presented to show how supply and demand interact before we can tell how these variables affect the actual market equilibrium, however. For example, even an important supply function shifter has no impact upon consumption if the position of demand dominates the consumption level. This chapter is concerned with the relationship between the supply and demand positions as estimated for 1947-70, their relative impact upon the price and consumption levels, and the nature of supply responses to demand shifts. Once this relationship between supply and demand shifts is identified we will have some indication of the supply response over a longer time span than the one year run implicit in the previously discussed coefficient estimates.

ESTIMATION ACCURACY

Before moving onto estimation of supply and demand shifts, it is appropriate to find how closely the estimated supply and demand functions can predict the observed 1947-70 lumber consumption and price levels. The only information available so far concerning this predictability is the R^2 of supply and demand functions which may not indicate the accuracy with which the two interact.

The 1947-70 coefficient estimates for the secondary demand level and the primary supply level equations for each species were applied to the observed exogenous variable levels in each of the sample years, t_i. This gives the level of supply or demand at a lumber price of zero in t_i. By use of the estimated lumber price coefficient, it was possible to extend the slope of the two functions from the zero price level until they crossed and thus indicated the estimated lumber price and consumption levels in t_i.

The percentage error between actual and estimated consumption and price is shown for each of the three species groups for each year of the sample in Table 13. Evidently the equations are fairly accurate since the average absolute consumption error across all three species groups is only 3.2 percent. The average absolute price error is even lower, 2.4 percent. Only one estimated equilibrium error is in excess of 10 percent, that of Southern pine consumption in 1956 with an error

TABLE 13.--Percentage error of calculated estimates of price and consumption from observed levels of price and concumption for Douglas-fir, Southern pine, and "structural species" lumber.

(In Percent)

Year	Douglas-fir		Southern pine		"Structural species"	
	price	consumption	price	consumption	price	consumption
1947	0.19	-0.34	-5.52	-5.79	1.87	-2.08
1948	-0.64	-0.28	-0.81	1.01	-0.59	0.68
1949	1.41	2.66	-2.31	1.86	5.54	7.85
1950	-0.41	0.72	-1.69	-8.49	-0.43	-2.63
1951	3.08	0.73	5.47	6.29	-0.33	1.41
1952	-3.25	-2.75	6.68	1.89	-4.22	-5.51
1953	1.22	1.98	-0.59	7.60	1.92	2.60
1954	-1.52	-1.39	1.57	5.09	-4.31	-4.36
1955	-1.60	-0.71	-2.50	2.13	-3.16	-0.38
1956	-0.26	-2.25	-5.18	-12.71	0.35	-2.22
1957	2.07	7.15	-3.01	-5.96	3.77	5.46
1958	2.65	-0.77	-1.61	-1.49	-2.31	-1.71
1959	-4.82	-8.86	2.27	-4.09	-0.61	-5.02
1960	-1.00	-0.28	-0.95	2.80	-1.00	1.05
1961	2.66	3.09	-2.07	-1.55	2.77	2.79
1962	3.58	1.19	0.75	7.55	3.71	1.92
1963	2.04	8.87	0.87	3.75	-2.19	4.34
1964	-1.37	-3.03	4.42	2.74	-0.62	-1.12
1965	1.88	-0.42	8.10	0.74	3.94	-0.24
1966	-2.77	-2.63	1.94	2.45	-0.49	-0.93
1967	-2.82	-1.69	4.05	4.53	-0.77	-2.13
1968	0.09	-0.22	1.57	5.29	-1.81	-0.36
1969	2.33	5.32	-6.53	-1.33	3.62	6.25
1970	0.62	-2.81	-1.78	-7.96	-2.51	-4.82
absolute avg.[a]	1.85	2.51	3.01	4.37	2.20	2.74

[a]The arithmetic mean of the absolute annual percentage errors.

of 12.7 percent. There is some tendency for the largest errors to occur at turning points in the trend of demand shifts, especially for Douglas-fir, but there are many exceptions.

Perhaps the most interesting results of this accuracy test is the comparison between percentage error and the R^2 of the supply and demand equations. Southern pine, which has the highest average R^2 of the supply and demand equations used in this test (.90), has the largest average equilibrium estimation errors (3.69). On the other hand, the "structural species" class has a much lower average R^2 (.71) but lower price and consumption errors than Southern pine (2.47). This indicates that the R^2 of individual supply and demand equations may provide little information on the accuracy of equilibrium estimation.

CHARACTERISTICS OF SUPPLY AND DEMAND SHIFTS FOR DOUGLAS-FIR AND SOUTHERN PINE

The relationship between the market equilibrium and shifts of supply and demand functions is derived from a study of changes in the estimated quantity of lumber demanded and supplied during each of the sample years at a constant lumber price. This quantity level is predicted by applying the estimated exogenous variable coefficients to the observed level of these variables in each sample year and applying the estimated lumber price coefficient to an assumed $100 per thousand feet board measure (Mfbm). Note that an increase (decrease) of quantity demanded (supplied) at a constant price is directly related to a rightward (leftward) shift of the demand (supply) function. An increase in the quantity of lumber demanded of X Mfbm as it is measured above is synonymous with a shift of the demand function to the right by X Mfbm since we have held the lumber price constant. Similarly, a decrease in the quantity of lumber supplied at a constant price is synonymous to a leftward shift of the supply function and vice versa. The tabularized estimates of quantities supplied and demanded at $100/Mfbm are presented in Appendix C.

Douglas-fir Supply and Demand Shifts

The estimated quantity of Douglas-fir lumber demanded at $100/Mfbm, Figure 5, increased until 1955 then decreased at the rate of about 2 percent annually until the 1968 increase. Estimated quantity supplied is quite erratic but generally lower than demand at $100/Mfbm through 1956. In 1957 supply shows an increase relative to demand and then decreases similar to demand until 1968.

One of the most important pieces of information available here concerns the response of the supply function position to demand function shifts. The supply of Douglas-fir lumber shows a consistent tendency to shift opposite from demand. Douglas-fir supply shifts to the left

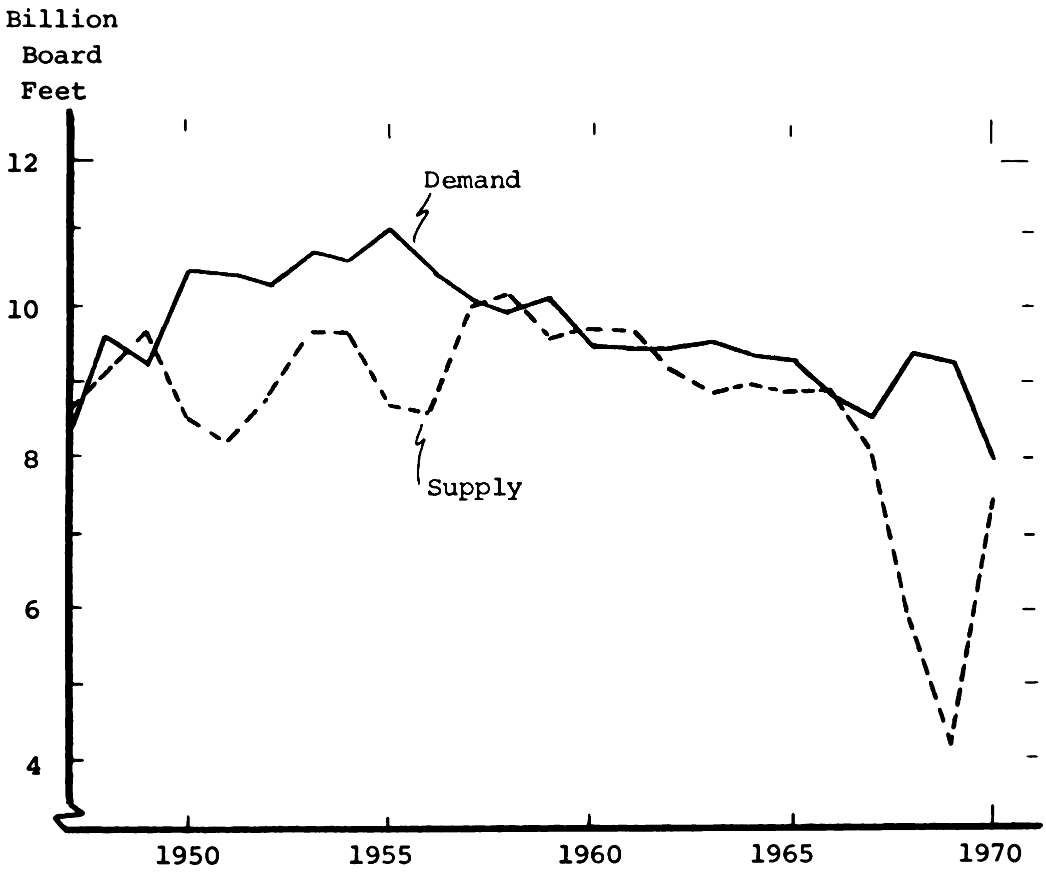

Fig. 5.--Estimated Douglas-fir lumber demand and supply at an assumed price of $100/Mfbm, 1947-70.

when demand shifts to the right and vice versa. This is indicated by the negative correlation of -0.54 between the estimated percentage shifts of the supply and demand functions.

Figure 6 provides a graph of observed year-to-year price and consumption equilibrium in the Douglas-fir lumber market. The graph adequately demonstrates the impact of contrary shifts in supply and demand functions. The connection lines between successive equilibrium have a steeper slope than the estimated slope of the supply function where this slope is equal to the lumber supply price coefficient.

Calculation of the estimated exogenous variable coefficients times the observed variable levels during the sample period shows that changes in the sawlog price variable is very heavily associated with these contrary supply function shifts. Ferguson (1969, pp. 247-248) forwards an argument concerning the longer run supply response in an increasing cost industry, one where a rightward shift of the demand function induces increased input costs which cause the supply function to shift to the left. He concludes that the connection lines between successive equilibrium points traces out the longer run supply response of the industry if the equilibrium change is caused by a demand shift and its induced supply shift. Employing this same logic and given the evidence above, it seems plausible to conclude that the longer run supply response of Douglas-fir lumber is less elastic than the 1.61 estimated in the primary supply level equation. The nature of this

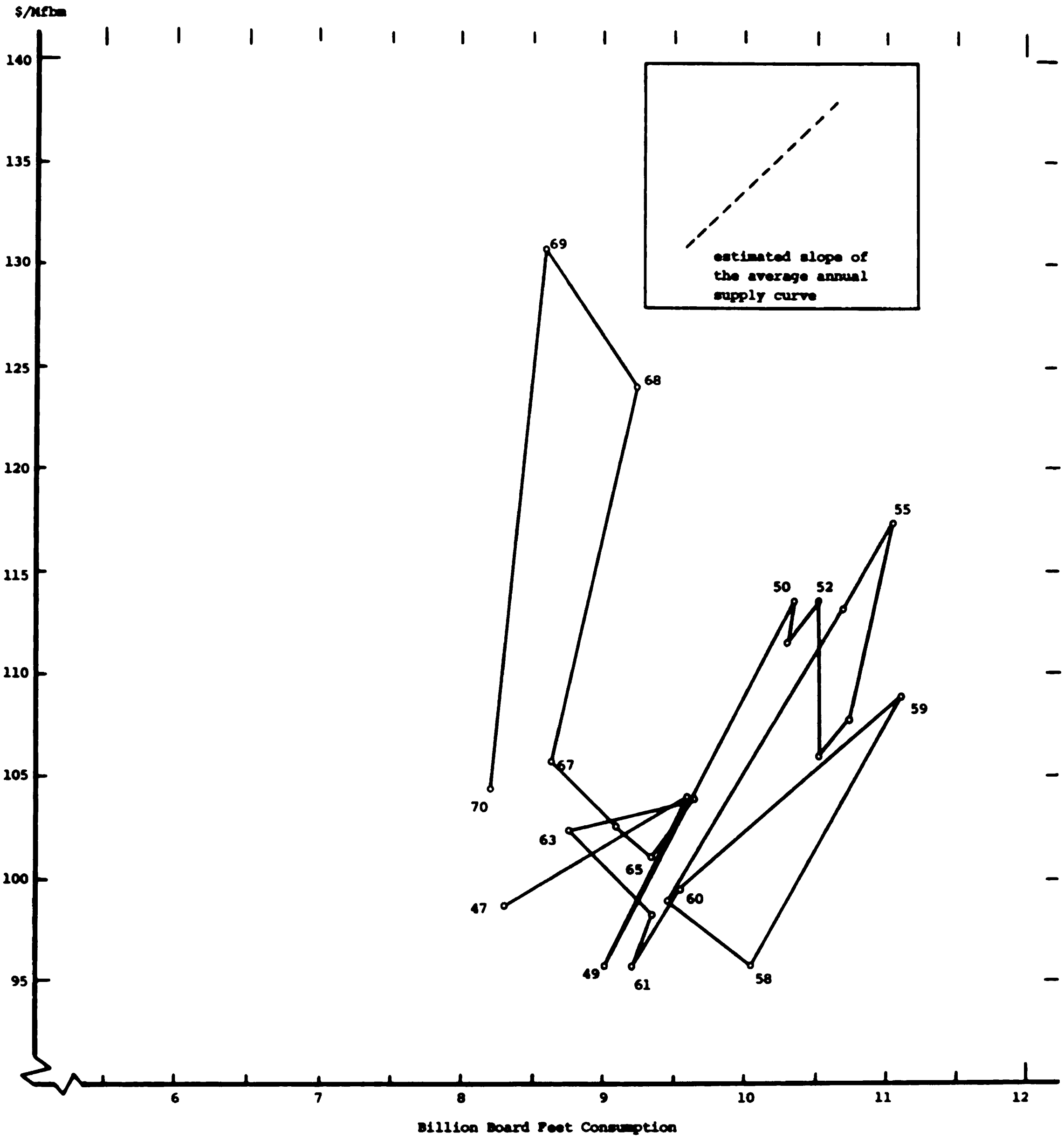

Fig. 6.--Observed market equilibrium points for Douglas-fir lumber, 1947-70.

longer run response is indicated by the slope of lines connecting successive equilibrium points in Figure 6. This is entirely consistent with the lower elasticity estimate of 0.97 from the primary + secondary supply level equation which explicitly contains a stumpage price variable and thus internalizes this external pecuniary diseconomy of industry scale.

Southern Pine Supply and Demand Shifts

The calculated supply and demand positions of Southern pine lumber from 1947-70 at a price of $100/Mfbm are given in Figure 7. The illustrated relationships demonstrate a much different situation than the above discussed Douglas-fir market exhibits. The level of both quantity supplied and demanded gradually decreased, and thus shifted to the left, from 1947 to 1960 at about 3.5 percent annually. Both functions shift to the right during the early 1960's and then decrease more gradually thereafter.

The overall trend of Southern pine supply and demand shifts is probably due to a slower rate of second growth removal than existed before 1947 and the increased importance of the plywood and pulp industries throughout the sample period. Year-to-year supply and demand shift relationships are still apparent, however, and are not too clouded by this overall trend. Generally, the supply and demand functions shift

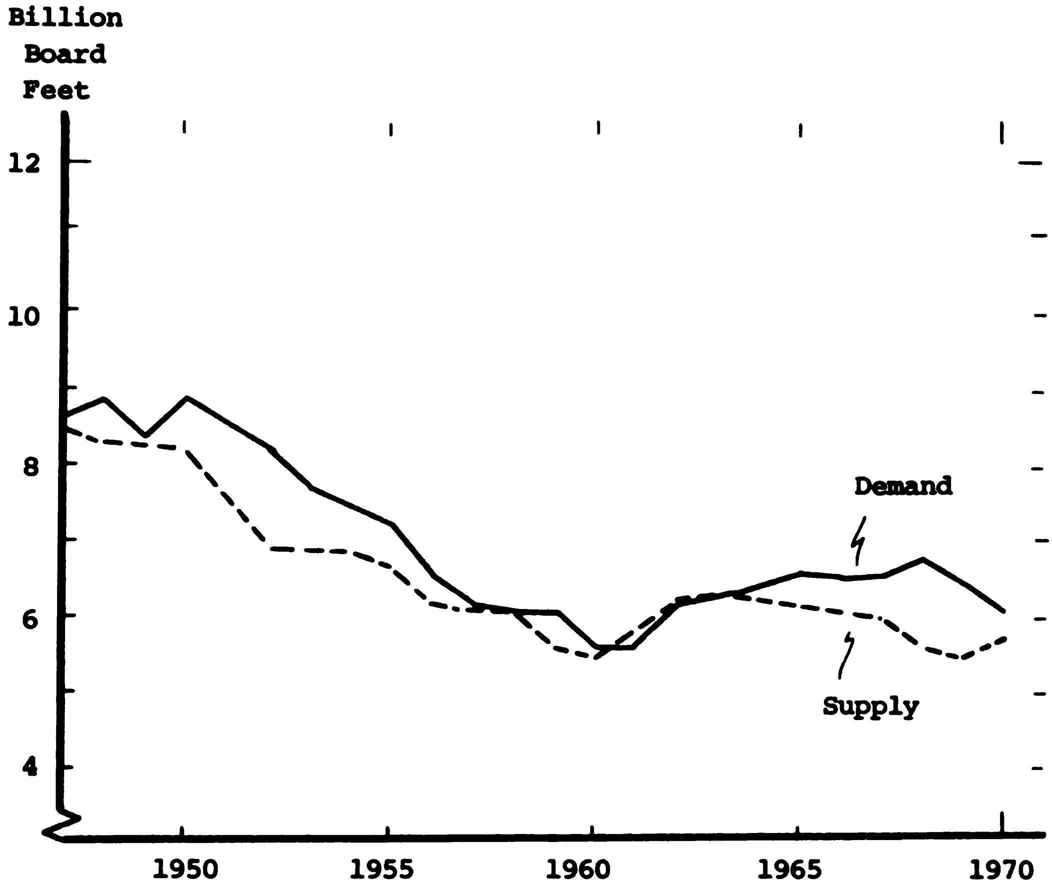

Fig. 7.--Estimated Southern pine lumber demand and supply at an assumed price of $100/Mfbm, 1947-70.

in the same direction. There is a +0.39 correlation between the estimated percentage shifts of the Southern pine supply and demand functions. As demand shifts to the right so does supply and vice versa. Likewise, the equilibrium connection lines in Figure 8 have a flatter slope than the one year supply function slope coefficient from the primary supply level equation. This indicates that the longer run supply response is more elastic than the Southern pine primary level equation estimate of 1.46.

Comparison of Douglas-fir and Southern Pine Longer Run Supply Response

One of the most noticeable contrasts between the Douglas-fir and Southern pine lumber markets is the difference in the stability of the supply function. Southern pine supply only averages a 3.34 percent shift annually from 1947-70 while Douglas-fir shifts an average of 5.45 percent annually from 1947-66 even though the drastic 1967-70 Douglas-fir supply shifts are removed from the average. Their price changes, which are dominated by supply shifts, show the same tendency. The 1947-70 average lumber price for the two species is an almost identical $106/Mfbm yet Douglas-fir price has a standard deviation of 9.0 while that for Southern pine is only 6.3.

Recall now the three aspects of timber and industry flexibility discussed in Chapter IV. Theoretically, the amount of flexibility

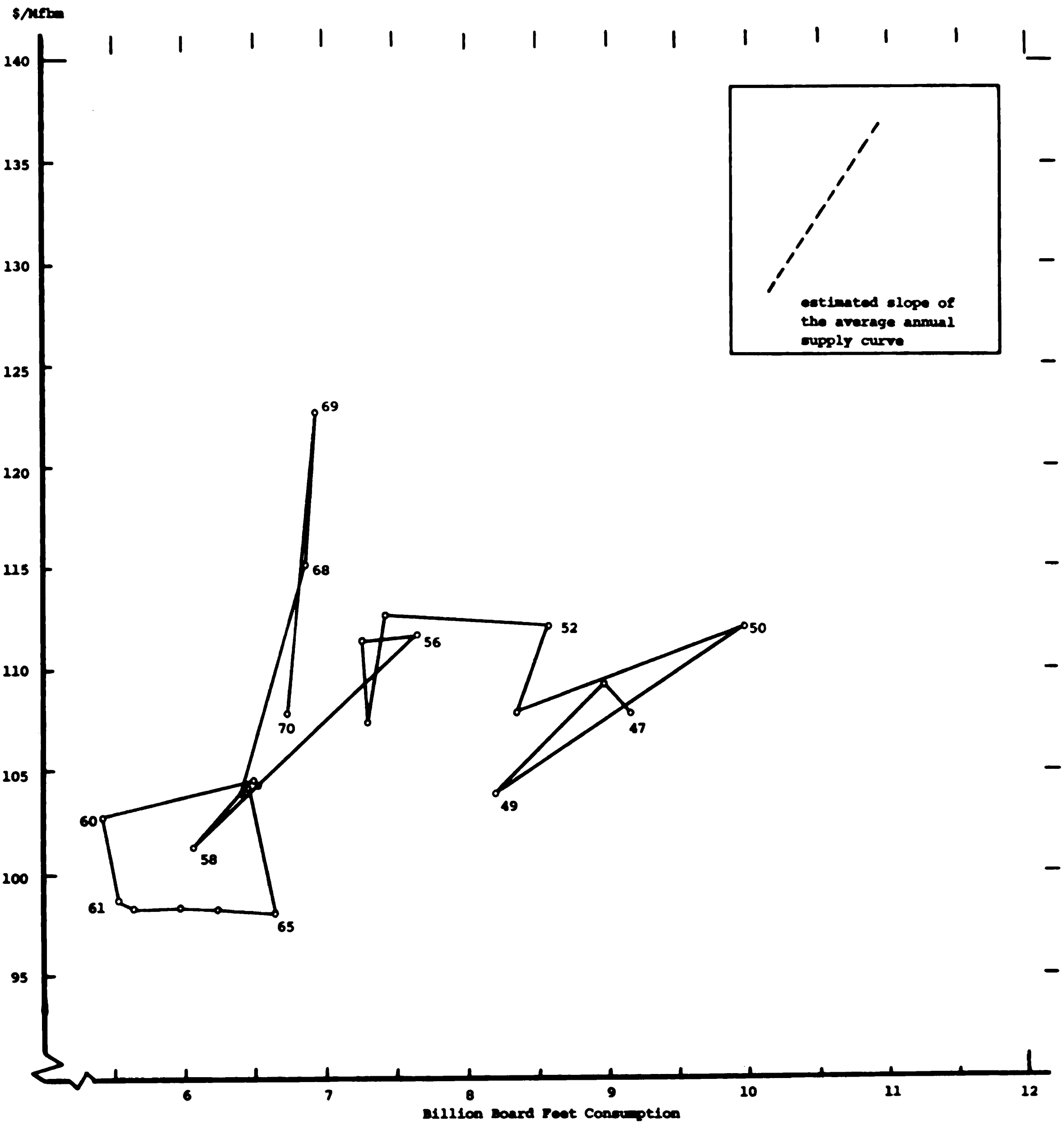

Fig. 8.--Observed market equilibrium points for Southern pine lumber, 1947-70.

should be affected by different ownership distributions, the extent that alternative log markets exist, and by the extent barriers to entry occur. The Southern pine region is more flexible than the Douglas-fir region on all three of these counts, yet there was no apparent effect upon the relative one year run price elasticity estimates for the primary level equations.

These flexibility factors may affect the longer run supply response, however. Given a situation where year-to-year supply shifts occur in response to demand shifts, which is quite logical in a derived demand chain, we have concluded that the connection lines between successive annual equilibrium positions trace out an approximate longer run supply response. Statistical associations alone do not allow deductions of cause and effect, but we do have a situation here where greater flexibility is associated with a more elastic longer run supply response. Similarly, in the Douglas-fir system the contrary supply response is associated with the sawlog price variable and the primary + secondary level Douglas-fir equation containing a stumpage price variable produces a lower price elasticity estimate. Economic logic indicates that at least part of the low flexibility would produce a less price elastic stumpage supply. A relatively inelastic stumpage supply can precipitate external diseconomies of industry scale and thus a less elastic supply price response. Thus, it is difficult to conclude that a cause-effect relationship does not exist between flexibility factors and longer run supply response.

What is difficult to determine is the magnitude of the longer run supply response difference. So far we merely have evidence that the direction of our economic logic concerning the difference between the one year supply elasticity and the longer run response is correctly related to industry and timber flexibility. The problem comes in trying to determine which supply shifts are in response to annual demand shifts alone. Since this determination is quite difficult, perhaps all we can do is use the estimated one year run elasticities as bench marks. The longer run Douglas-fir response is less elastic than the primary level equation estimate of 1.61. It probably falls in the neighborhood of the 0.97 of the primary + secondary estimate since most of the annual supply shift is in response to sawlog price changes. With Southern pine, however, it would appear that the longer run supply response to price is more elastic than the primary level equation estimate of 1.46. The equilibrium line connections indicate that the longer run elasticity may go as high as 2.0.

CHARACTERISTICS OF SUPPLY AND DEMAND SHIFTS FOR THE "STRUCTURAL SPECIES" AGGREGATE

The "structural species" aggregate overcomes some of the detail problems of species comparisons and presents a larger and quite definite product class for analysis. The estimated quantity of "structural species" lumber supplied and demanded at $100/Mfbm from 1947-70 is illustrated in Figure 9. Estimated demand is quite erratic and fluctuates about what seems to be a very gradually declining moving average. The quantity of lumber supplied is also erratic but displays two quite distinct subperiod sections. From 1947-57 quantity supplied is relatively stable and below quantity demanded at $100/Mbfm. During 1956-58, however, the supply function shifts to the right (quantity supplied increases at $100/Mfbm) without a corresponding shift of the demand function. From 1947-57 supply fluctuates with a range similar to that occupied by the quantity demanded.

The impact of this 1956-58 rightward supply function shift relative to the demand curve is readily apparent in the plot of observed price and consumption equilibrium, Figure 10. From 1947 through 1957 consumption varied within a range of approximately 19.6 to 24.0 billion board feet and within a rather narrow price band which has about the same slope as the lumber price coefficient of the primary level supply equation. From 1958 through 1964, after the relative shift of supply to the right occurred, consumption falls within the

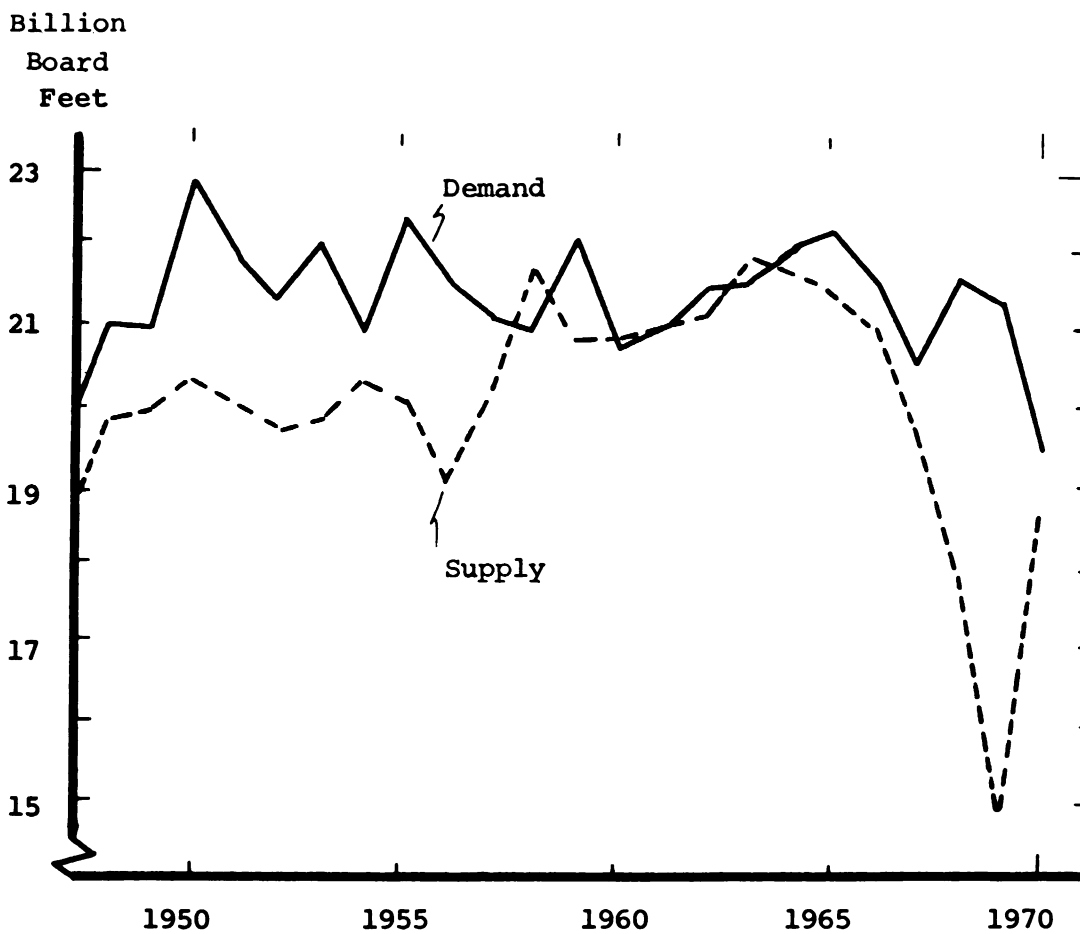

Fig. 9.--Estimated "structural species" lumber demand and supply at an assumed price of $100/Mfbm, 1947-70.

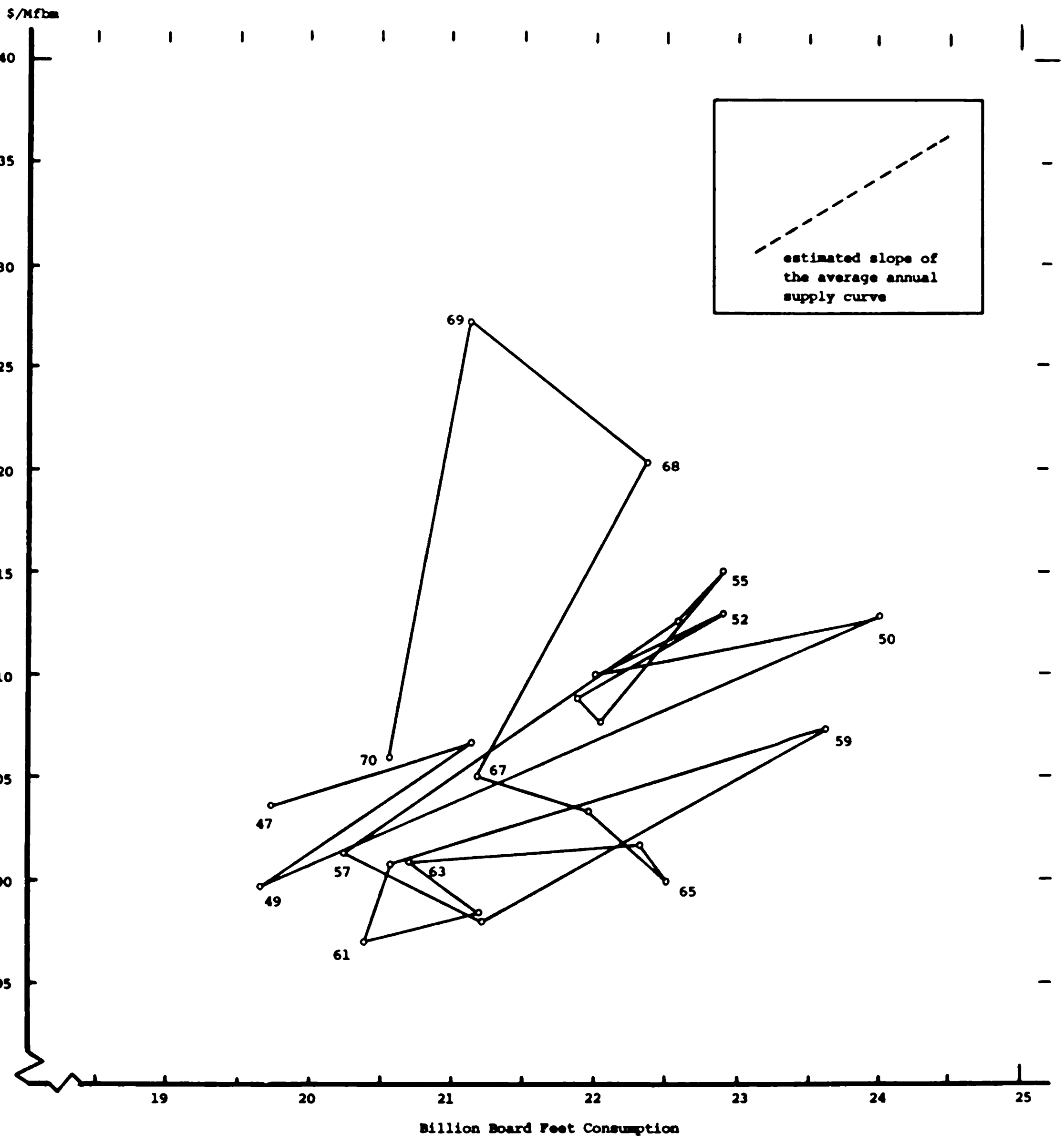

Fig. 10.--Observed market equilibrium points for "structural species" lumber, 1947-70.

same extremes. Lumber price, however, falls in a price band parallel too but lower than the 1947-57 band.

This demonstrates that almost the sole determinant of the "structural species" consumption level is placement of the highly inelastic demand function and that change in consumption levels is dominated by demand function shifts. Similarly, the major determinant of lumber price levels is the supply function. Minor price changes result from demand shifts along a stationary and less than perfectly elastic supply function such as the 1.17 elasticity estimated here. Radical price changes only seem to occur in response to substantial supply shifts, however. This is adequately demonstrated by the drastic supply shifts of 1967-70, Figure 9, and the corresponding movement of observed price during the same period, Figure 10.

A rather disturbing element of the "structural species" aggregate is that the 1965 to 1969 trend is almost diametrically opposed to the 1947 to 1964 trend. The difference is not in the observation that price changes are dominated by supply shifts and consumption changes are dominated by demand shifts. Rather, a substantial difference is evident in the relationship between supply responses to demand shifts. The estimated percentage supply and demand shifts from 1946 through 1964 show a slightly positive simple correlation, r, of +0.16. The correlation between percentages supply and demand shifts from 1965 through 1970 is very negative (r = -0.55).

Since the "structural species" group is the sum of the flexible South, the relatively inflexible Douglas-fir region, and a smattering of the moderately flexible Intermountain and Rocky Mountain regions, we would expect the "structural species" group to exhibit an average between the contrary Douglas-fir supply and demand shifts ($r = -0.52$) and the like shifts of Southern pine ($r = +0.39$). During the period from 1947 through 1964 this is exactly what happens. The correlation between the percentage shifts of "structural species" supply and demand at a lumber price of $100/Mfbm is a moderate +0.16. Therefore, supply shifts to the right slightly as demand does such that from 1947 through 1964 the longer run supply response is only slightly more price elastic than the 1.17 of the primary supply level equation. This conclusion is somewhat substantiated by the more price elastic supply level primary + secondary estimate of 1.22 where the stumpage price variable is explicitly included in the equation.

From 1965 through 1970, however, there is a strong negative correlation between the supply and demand shifts ($r = -0.55$) similar to the response typical of the inflexible Douglas-fir region. Analysis of the estimated coefficients of the primary supply level equation times their respective observed variable levels indicate that decreasing British Columbia lumber production and increased pulpwood prices are the major changes associated with the gradual 1963-67 supply decline. Increased log exports played a minor role. In 1968 and 1969, however, the drastic leftward shift of supply is very heavily associated with an increase in the price of sawlogs. Note in Figure 9 that increased sawlog price dominance did not occur until demand increased in 1968. This sawlog dominance lagged into 1969 even though lumber demand had backed off. This suggests that in the 1965-70 period, and especially the years of 1968 and 1969, the aggregate "structural species" group exhibits the same evidence of external diseconomies characteristic of the Douglas-fir system.

There is little to suggest the reason for this substantial change in the nature of "structural species" supply and demand interactions. Southern pine, which should lend a more flexible factor to the aggregate, represents an even larger percentage of the "structural" aggregate in recent years. In 1960 "structural species" consumption was 26 percent Southern pine and in 1970 it was 33 percent Southern pine. While there is little evidence to suggest a cause of the changes of the relations, change did occur.

CHAPTER VI

CONSUMPTION AND PRICE PROJECTIONS

Using equation estimates presented and discussed in Chapter IV, projections are made annually for the thirty year period from 1971 through 2000. Once structural coefficients are available for the modeled supply and demand relationships, projection of price and consumption levels is a fairly easy process. Ease does not indicate accuracy, however, as there are important assumptions inherent in the model that will most certainly be violated during the projection period. First, the data range implicit in the sample observations is the only range over which there can be any measured confidence concerning the estimated structural relations. These data bands are passed in this study as they are in probably every other study. Second, there is an assumption that colinear variables will maintain their relationship during the projection period. Perhaps the most severe assumption is that the structural relationships observed during the sample period will continue to exist during the projection period even within the same data range let alone an extended range. Another difficulty is obtaining projections of the exogenous variables to which the estimated structural relations are applied. Furthermore, the farther into the future the projection extends, the greater the chance of error from violation of these assumptions.

All projection techniques are subject to the problems noted above or to toher equally serious limitations. Thus the selection of a single projection technique is comparable to trying to select the boat that sinks the slowest. The equation system used in this study has a greater problem by assuming more relations constant by including numerous variables rather than profiting from whatever compensating errors might be covered in an aggregate analysis. The ability to consider changes in specific variables internally and explicitly seems to justify the added risk, however.

EXOGENOUS VARIABLE PROJECTION

Secondary demand level equations and primary supply level equations are used for projections just as they were used in the analysis of past supply and demand shifts in Chapter V. No projected annual series of the variables contained in these equations were known to be available from alternative sources. That which was available was Bureau of Census projections of total households and 0-24 year-old headship rates for five year increments from 1970 through 1990. Estimates available in this form were interpolated between the five-year points and extrapolated beyond. For other variables a linear regression of the variable against time, an approach used by McKillop (1967, pp. 50-51) on some variables, was attempted but discarded as producing unlikely variable levels such as a wholesale price of $3 per thousand square feet for softwood plywood in the year 2000.

Therefore, most projected exogenous series were based upon subjective judgments. Past rates of change in exogenous series were studied along with the changes in factors identified as affecting these rates of change. Probable future changes in the level of these determining parameters were then assumed to have certain effects upon the rate of change of exogenous variables. Projected exogenous series were then derived from these rates of change in determining factors. While this may be a questionable process, it seems to be the best available and is a step any projection technique must become involved with. The exogenous series obtained in this manner are tabularized in Appendix D.

One difficulty with a detailed system approach such as employed here is that the exogenous-endogenous dichotomy maintained through structural estimation and projection is a questionable expediency. For example, chip residues from sawmills and plywood price, considered exogenous in this study, are probably as much determined by the endogenously determined lumber consumption and price variables as by anything else. A lessening of this problem is one of the major advantages of the broader approach employed by McKillop (1967) and Talhelm and

Holland (1971) where numerous wood products are considered simultaneously. Unfortunately there is a trade-off between detail and scope. The detailed approach taken here is more appropriate for identifying supply and demand relations for a well defined relatively homogeneous product class.

DOUGLAS-FIR AND SOUTHERN PINE PROJECTIONS

Supply and demand levels at a lumber price of $100/Mfbm were projected for Douglas-fir and Southern pine. At this price Douglas-fir supply is projected to steadily decrease at the rapid rate of approximately 0.35 billion board feet per year. Southern pine supply is projected to increase at a modest rate of 0.08 billion feet per year until 1985 and decline thereafter at a rate of 0.18, Table 14. The previous analysis of supply and demand shifts concluded that price is dominated by the position of the supply function. The rapid shift of Douglas-fir supply and only moderate shift of Southern pine supply indicate the presence of a large price differential. The projected price of Douglas-fir lumber in the year 2000 is $192/Mbfm while Southern pine is only $118/Mfbm.

The likelihood is low that such a large price differential between two close lumber substitutes would exist in a market system. The model used here would have to be modified to incorporate the regional

TABLE 14.--Projected level of Douglas-fir and Southern pine lumber supply at an assumed price of $100/Mfbm, 1971-2000.

Year	Douglas-fir	Southern pine
1971	7.42	5.25
1972	7.12	6.18
1973	6.66	6.48
1974	6.36	7.25
1975	5.90	7.71
1976	5.49	8.48
1977	4.97	8.94
1978	4.45	9.25
1979	3.94	9.86
1980	3.47	10.17
1981	2.89	10.78
1982	2.30	10.94
1983	1.72	11.24
1984	1.13	11.39
1985	0.55	12.01
1986	0.16	12.30
1987	-0.23	12.27
1988	-0.62	12.72
1989	-1.02	12.85
1990	-1.24	12.98
1991	-1.47	12.81
1992	-1.69	12.63
1993	-1.91	12.45
1994	-2.14	12.28
1995	-2.36	12.10
1996	-2.59	11.93
1997	-2.81	11.75
1998	-3.04	11.57
1999	-3.26	11.40
2000	-3.48	11.22

shift of lumber production which this price differential indicates will occur. Specifically, the lumber price ratio between the species would have to be included in both demand equations. Similarly, supply side changes must incorporate the shift of capital investment or at least the effect of greater investment upon such parameters as sawlog price and pressure at the sawlog-pulpwood margin. In brief, both the system parameters and the model form itself would have to be changed to adequately incorporate the results of the regional shift that the projected price differential indicates will occur.

Even as it now stands, however, the model used here does provide an economic measure of the pressure for regional relocation that has often been measured but in physical terms alone. For example, the U.S. Forest Service (1965) used a physical supply approach to estimate that there would be a 4 percent increase in the sawtimber cut in the Pacific Coast States between 1962 and 2000 but a 235 percent increase of sawtimber cut in the South for the same time period.

"STRUCTURAL SPECIES" PROJECTION

The level of "structural species" demand at an assumed lumber price of $100/Mfbm is projected to increase until 1975 and then decline through 2000, Figure 11. The 1975-2000 projected rate of demand decline

Fig. 11.--Projected "structural species" lumber demand at an assumed price of $100/Mbfm, 1971-2000.

Fig. 12.--Projected "structural species" lumber consumption, 1971-2000.

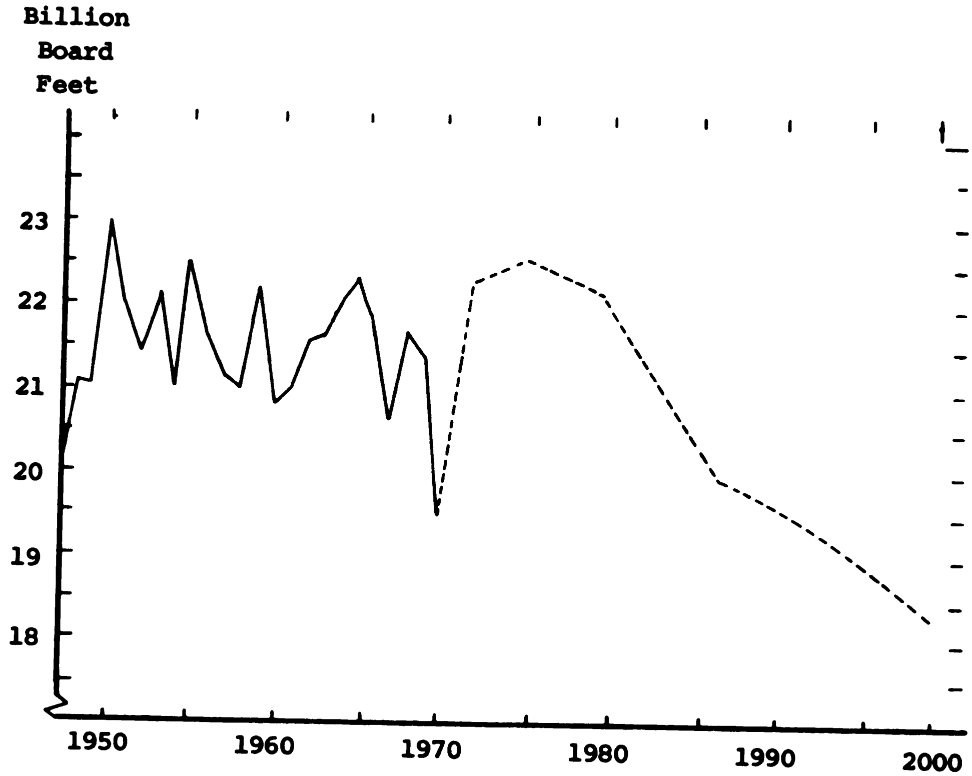

Figure 11.

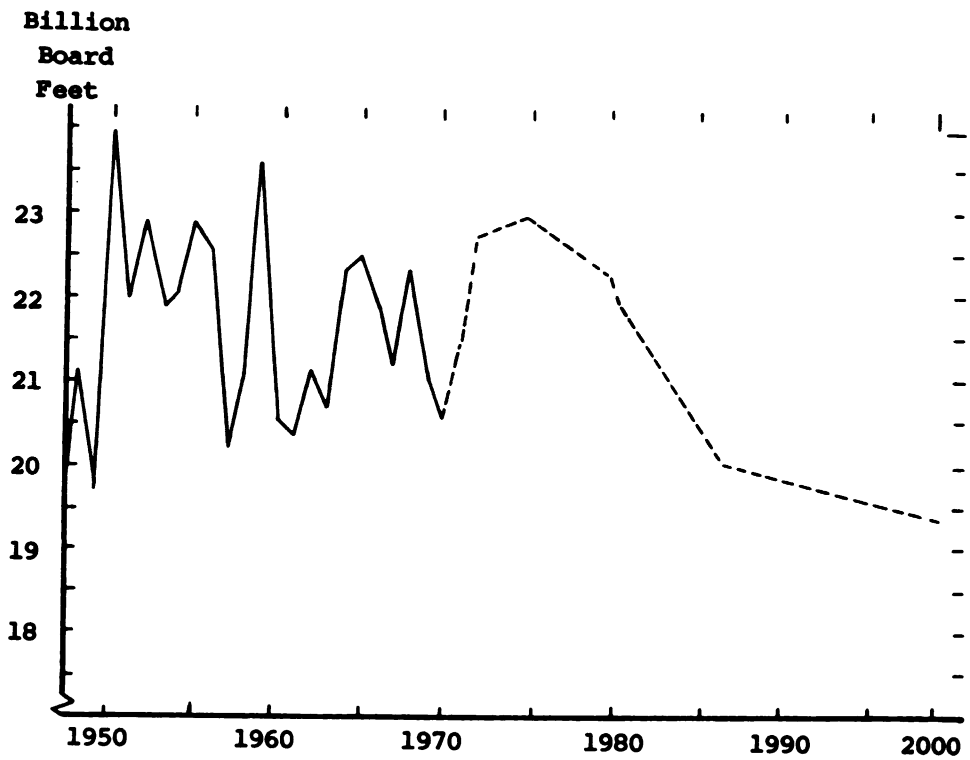

Figure 12.

(0.84 percent annually) is substantially greater than the estimated decline rate for 1947-70 (0.13 percent annually).

Projected supply increases from 1970 through 1981 at 0.9 percent annually compared to the estimated 0.6 percent annual increase for the 1947-65 period, Figure 13. From 1981 through 2000, however, supply is projected to decrease by 3.2 percent annually at the $100/Mbfm price level. The rightward supply shift through 1981, as is indicated by an increase in quantity supplied at a constant price, is associated with the projected high rate of increase in British Columbia lumber production through 1960. Projected British Columbia production rises slowly from 1980 through 1990, however, and then slowly declines to what is considered to be a sustainable level in 2000. After 1981 the shift of the supply function to the left is associated with the projected high rate of softwood sawlog price increase ($2/Mfbm per year through 1985 and $1/Mfbm annually thereafter compared to $1.40/Mfbm from 1947-70) and the projected increase of log exports (205 million board feet increase annually 1970-80, 150 from 1980-90, and 75 from 1990-2000 compared to the average 230 million board feet rate experienced from 1959-70).

Consumption and price projections derived from these supply and demand projections are presented in Figures 12 and 14, respectively. Consumption is projected to maintain a relatively high plateau of about 22.7 billion board feet from 1972 through 1977. Consumption declines

Fig. 13.--Projected "structural species" lumber supply at an assumed price of $100/Mfbm, 1971-2000.

a = expected supply

b = projected supply given a lower log export volume or a slower sawlog price increase

c = projected supply given zero log exports

d = projected supply given a slower sawlog price increase and zero log exports

Fig. 14.--Projected "structural species" lumber price, 1971-2000.

a = expected supply

b = projected supply given a lower log export volume or a slower sawlog price increase

c = projected supply given zero log exports

d = projected supply given a slower sawlog price increase and zero log exports

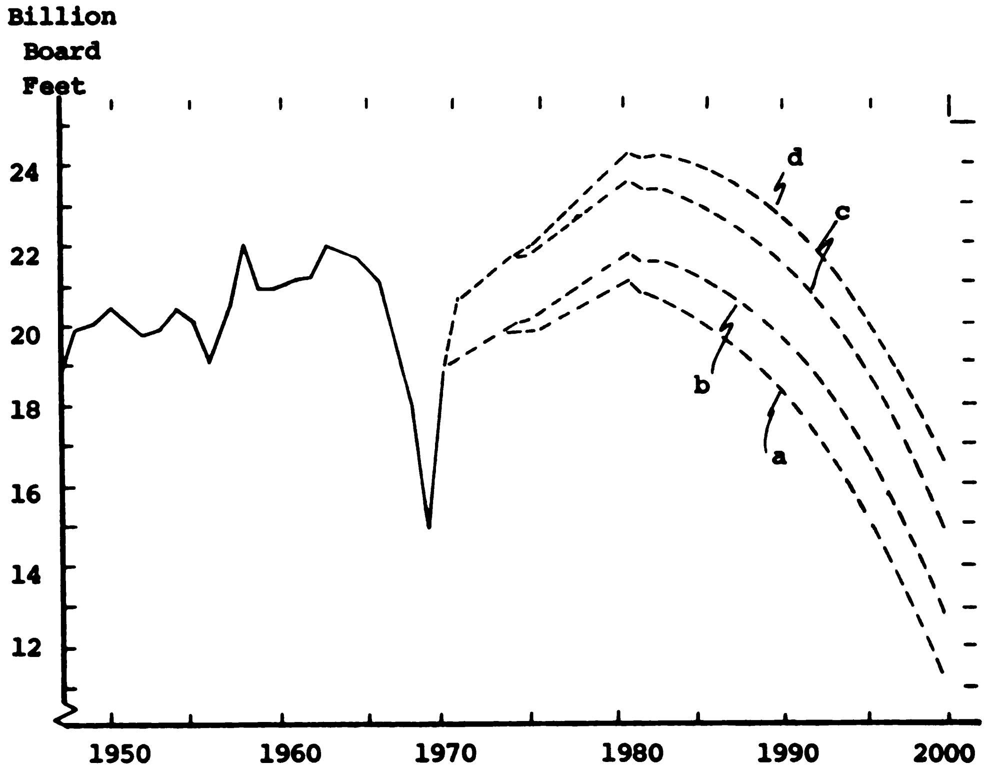

Figure 13.

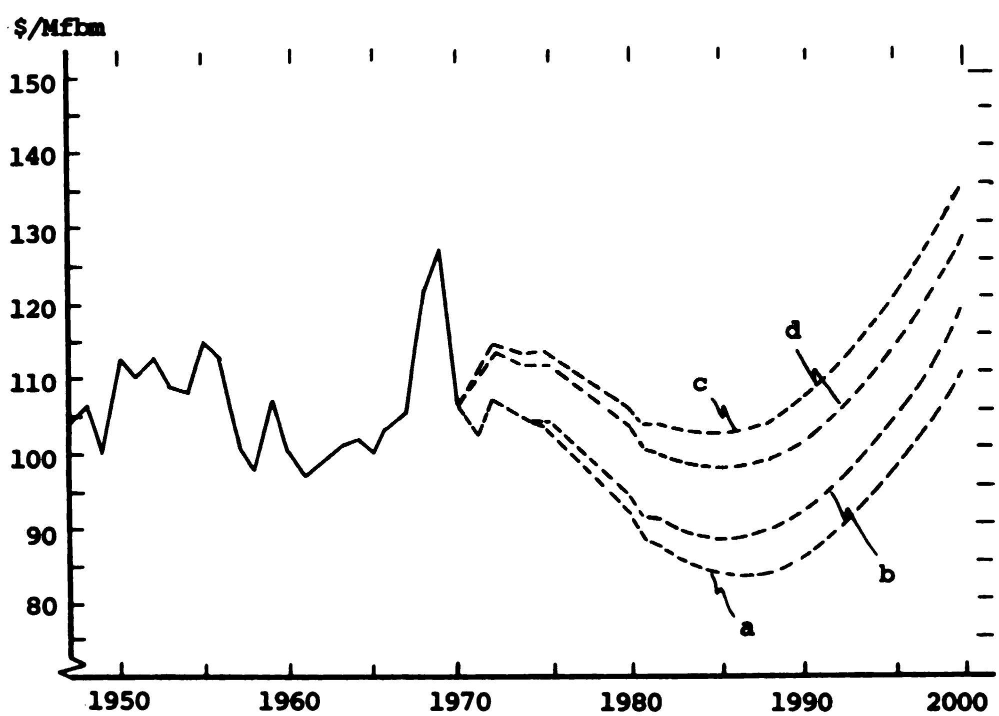

Figure 14.

from 1977 through 1987 at 1.2 percent annually and very gradually declines from 1987 through 2000 at about 0.02 percent annually. The projected 2000 level is 19.5 billion feet or 5 percent below the 1947-70 average of 21.6 billion board feet.

The consumption change projected here is substantially different from projections of "all lumber" available from other major studies. The U.S. Forest Service (1965, p. 41) projected a 35 percent increase in "all lumber" consumption from 1970 to 2000. The medium projection by Landsberg and others (1963, p. 812) for "all lumber" increases 90 percent for the same period. The Forest Service projection for lumber used in residential construction raises even more (45 percent) but the Landsberg *et al.* projection for lumber used in construction increases about the same as their "all lumber" category.

The real price of "structural species" is projected to decline from a 1972 high of $114/Mfbm to a relatively stable 1980-87 plateau of $102/Mfbm. After 1987, however, the projected price rises quite rapidly to $135/Mfbm by the year 2000, Figure 14. The year 2000 projection of $135/Mfbm is 20 percent greater than the $106/Mfbm 1947-70 average. The overall 30-year rate of increase is a very modest 0.65 percent annually. Between 1987 and 2000 price increases at the rather high rate of 2.25 percent annually, due primarily to the rapid shift of the lumber supply function to the left.

Comparison of the "structural species" price projection with McKillop's (1967, p. 62) price projection, the Douglas-fir projection, and the Southern pine price projection provides somewhat of a consistency check. McKillop's prediction of the non-deflated softwood lumber price, which increases $5/Mfbm from 1965 to 1970 and then declines $2/Mfbm from 1970 to 1975, compares quite closely with the above results through 1975. McKillop's projections do not extend beyond 1975, however, and no other major study projected price. Moving onto a species comparison, the "structural species" year 2000 projection of $135/Mfbm lies between the $118/Mfbm Southern pine and $192/Mfbm Douglas-fir projection as it should. Since the Douglas-fir regional industry and timber situation is relatively more inflexible than the Southern pine situation, it seems probable that a regional shift to the South would cause the Douglas-fir price to fall farther than the Southern pine price would rise. This would put the market price somewhere below the $155 midpoint of the $188-192 range: the "structural species" projection of $135/Mfbm is consistent with this expectation.

POLICY SENSITIVITY IN THE "STRUCTURAL SPECIES" SYSTEM

One of the underlying motivations behind this analysis was the contention that a detailed supply and demand model such as the one developed here would be desirable for explicit testing of the effect which changes in policy-sensitive variables have upon future price and consumption levels. This section deals with such sensitivity analysis.

Two major pieces of Federal legislation resulted from the concern over the 1968 and 1969 lumber and plywood price rises, one regarding an export embargo on logs removed from federal land and a second regarding a more intensive level of forest management on Federal lands. Both of these factors have been considered in the model employed in this study. The level of log exports is explicitly included in the "structural species" supply equation. The effect of management intensity can be expressed through its impact upon sawlog prices.

In order to test the possible impact of changes in these variables, the projected exogenous series discussed above were replaced one at a time by the following alternative series:

(1) a slower rate of log export whose rate of increase is only one-sixth that of the expected series,

(2) zero log exports which is comparable to a complete log embargo,

(3) a lower sawlog price projection which raises only two-thirds as fast as the expected series,

(4) a combination of the log embargo and slower sawlog price rise.

Since we concluded in Chapter IV that the demand functions for the three species groups considered here are almost perfectly price inelastic and since these proposed policy changes shift the supply functions, the policy alternatives will be visible in terms of a price change. Projected consumption will be unchanged. Both the lower log price and lower log export alternatives shift the supply curve to the right by about the same amount and therefore have about the same impact upon "structural species" lumber price, Figures 12 and 14. The proposed lowering in either log price or exports will result in a price projection approximately 5 percent lower than the expected trend, reaching a level of $127/Mfbm by the year 2000. A complete log embargo results in a price projection of $118/Mfbm, 13 percent below the expected level in the year 2000. A combined use of both the complete log embargo and lower sawlog price trend results in a price projection 18 percent below the expected trend to a level of $110/Mfbm in 2000. This is only $4 above the $106 average for 1947-70.

These alternatives demonstrate that even though some variables have had a greater average annual impact upon the supply or demand function in the past, a less important variable may be enough more sensitive to policy manipulation to overcome its lower per unit impact. For example, the absolute average annual shift of the "structural species" supply function by sawlog price was an estimated 2.32 percent versus only 0.58 percent for softwood log export but the greater susceptibility of export volume to control may make it a better policy tool.

CHAPTER VII

SUMMARY AND CONCLUSIONS

The impact of future changes in the factors that influence the price and consumption of wood products are typically derived from studies employing rather simplistic analytical techniques. As a result, it is difficult or impossible to reliably estimate the impact of alternative levels of sensitive variables upon the supply and demand of timber products.

The econometric model developed here is designed to overcome this information deficiency. An integrated model of the supply and the demand factors determining the market price and consumption level of Douglas-fir, Southern pine, and "structural species" lumber is developed and exercised. The principal objectives of the study include: 1) discovery of the presence of multi-equation statistical problems, 2) measure the relative importance of supply and demand shifters, 3) analyze the impact of supply and demand movements upon price and consumption levels, and 4) project consumption and price levels and study the sensitivity of these levels to changes in policy-sensitive variables.

Using the derived demand representation as a guide, numerous hypothesized system variables were grouped for analysis. Two totally independent groups of demand variables were collected, one containing monitors of the consumption level in lumber using markets and one containing the supply and demand determinants of these consumption levels. Two partially independent groups of supply variables were also collected, one containing determinants of domestic supply, foreign supply, and log competition, and a second containing the same variables with sawlog price replaced by its stumpage sector determinants. This division allows estimation of two independent demand price elasticities. It also allows partially independent estimates of supply price elasticity and analysis of the difference in price elasticity when sawlog price is replaced by stumpage price.

Data requirements necessary to implement the system representation utilized were substantial. Obtaining consistent annual time series observations for a period as long as the 1947-70 time span used here is always difficult. Data restrictions precluded the study of some parameters and required the use of proxy variables in some cases. On the whole, however, the data collected is of sufficient quality that it does not hamper study results.

Statistically, the system structure was estimated as a number of independent subsystems, each containing a single supply and demand function for a particular species group. Since both price and quantity of lumber supplied or demanded are contained in a single equation and since both are determined endogenously, the ordinary least squares (OLS) statistical model would have produced biased and inconsistent estimates. The two stage least squares (2SLS) model was deemed to be most appropriate for this study since it is unbiased on large samples and relatively insensitive to multicollinearity and misspecification problems.

Since each two equation subsystem has two unknowns (lumber price and lumber quantity) each subsystem is statistically complete. The Durbin-Watson test showed that significant serial correlation among estimated residuals was absent. Similarly, the Basmann phi ratio and economic logic both suggest that the estimated equations contain such variables that they are properly identified as supply and demand functions. System misspecification, the exclusion of important variables, may be present but the completeness of the system representation and the few indications of its presence suggest its effect is minimal.

The only statistical problem having widespread incidence in this study was multicollinearity among variables. Its presence was detected by the sequential use of simple correlation coefficients, factor analysis, and equation test runs. These tests indicated that factor analysis is the best and a simple correlation the worst single test of multicollinearity. When multicollinearity is present, it is obviously impossible to untangle the joint impact of collinear variables to estimate independent impacts. Therefore, to the extent that multicollinearity is present, interpretation of the estimated elasticities used to measure relative variable importance is hampered. Similarly, use of the estimated equations as projection tools is hampered because we only have measured confidence on the structural estimates within the range of variable relations observed in the sample set.

Although the difficulties resulting from multicollinearity are substantial and represent the single most important statistical problem encountered in this study, its importance should not be over-emphasized. This collinearity does not hamper precise estimation of past supply and demand positions and interactions. Projections are not hampered if the collinearity continues or if the structural estimates hold beyond observed ranges of multicollinearity. Finally, it should be noted that multicollinearity is a property of the system itself and not a function of the particular analytical technique applied to that system. Aggregate techniques applied to the same system may ignore or fail to locate multicollinearity but do little or nothing to overcome the difficulties.

Relative importance among various system parameters as supply and demand function shifters was measured by an elasticity estimate and the estimated average percentage change in lumber demanded or supplied associated with the movements of the particular variable. On the demand side, consumption levels in lumber using markets are relatively more important individually than the supply and demand determinants of these consumption levels. Not surprisingly, the volume of residential construction and the price of softwood plywood were the most important single variables in the two groups of demand variables. On the supply side, the volume of log exports proved to have relatively low importance and the average establishment size, which is highly correlated to average productivity, only has an estimated moderate to low importance. British Columbia lumber production was the only variable outside the group of raw material prices which showed high importance; in the structural species aggregate it was the most important supply shifter. The raw material variables (sawlog price, stumpage price, pulpwood price, peeler log price, and chipped residues) proved to be the most important supply shifters. Sawlog price was very important as a supply shifter. Pulpwood price was more important than veneer log price, indicating that sawlog market prices are more affected by conditions in the pulpwood than in the veneer log market.

It must be remembered that these results are derived from 1947-70 annual observations and mean variable levels during that period. As such they implicitly measure the average annual condition and may not adequately mirror the effect of radical trends within the period. For example, the relatively low importance allocated to the log export variable probably is a result of the low export volumes from 1947-59 and the elasticity estimates may understate the impact of export levels like those since 1959.

The following one year run price elasticity conclusions can be drawn from the study. The demand price elasticity is very inelastic and probably well below -0.50. The annual run supply price elasticity lies between 1.2 and 1.6 with little difference between species.

Analysis of supply and demand interactions over the sample period show that Douglas-fir supply will shift to the left in response to a demand increase while Southern pine will shift to the right. Furthermore, the leftward shift of the Douglas-fir supply function is heavily associated with an increased sawlog price and as such indicates the presence of significant external diseconomies embodied in a highly inelastic stumpage supply function. To the extent that the connection lines between successive market equilibrium points represents longer run supply responses, the longer run supply response of Douglas-fir may be as low as 1.0 and of Southern as high as 2.0.

Through 1964 the "structural species" aggregate exhibited an average of the inflexible Douglas-fir and flexible Southern pine influences such that the longer run supply response is only a little more elastic than the 1.17 annual run estimate. From 1965 through 1970, especially 1968-70, however, the whole "structural species" aggregate behaves as the inflexible Douglas-fir class. Sawlog price rises strongly when demand increases. The reason for this character change is unknown.

A clear conclusion of the study is that lumber consumption changes are primarily controlled by demand function shifts. Price changes may result from a demand function shifting over the less than perfectly elastic supply function, but substantial price changes are the result of supply shifts. It may be said that the demand shift is the force which induces the operation of external diseconomies on the supply side, but the especially large changes in lumber price such as those of 1968 and 1969 are directly the result of supply side determinants and most dominately stumpage prices.

Price projections for Douglas-fir and Southern pine lumber provide an indication of the economic pressure for a regional shift of lumber. The extent of the pressure for change from the Douglas-fir region to the South and degree of disequilibrium if change does not occur is indicated by the projected $192 versus $118 price differential in the year 2000.

The "structural species" consumption projection decreases from a 1975 high at a rate of 1.2 percent annually through 1987 then declines at a very slow 0.02 percent annually thereafter. This projection contrasts strongly with the increased consumption levels developed in most other studies. The "structural species" price projection declines from a $114/Mfbm high to $102 in 1985 and then rises sharply to $135 by 2000. The overall increase in projected real prices from 1970 to 2000 is quite low but the 1987 to 2000 rate of increase is a very high 2.25 percent annually.

Modification of the exogenously projected log export and log price variables indicated that projected lumber price can be reduced. For example, a complete log export embargo combined with a slower rate of increased sawlog price decreased the expected price trend by 18 percent resulting in a year 2000 price of only $4/Mfbm above the 1947-70 average. It is quite apprent, however, that the export embargo and the slower increase in log price are only temporary measures. The 1987-2000 rate of lumber price increase is unmitigated by changes in these two policy sensitive variables. The 1987-2000 rise is dominated by the associated exogenously projected decline in British Columbia lumber production. Apparently, then, action must be taken to fill the void currently contained by British Columbia production if the rate of lumber price increase is to be maintained at recent levels beyond the late 1980's. Whether it should be a public goal to maintain lumber prices at or close to their current levels is a question beyond the scope of this analysis. What this analysis does provide is some information concerning how market parameters for the major construction lumber species interact, and some expectation of what will occur if the levels of projected exogenous variables are realized.

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APPENDIX A

ORIGINAL DEFLATED DATA

TABLE A1, DEMAND VARIABLES, ORIGINAL DATA

YEAR	D1 RESID CONSTR V P-I-P (MIL $)	D2 DWELLING STARTS (THOU)	D3 3 OR MORE UNIT STARTS (% TOTAL STARTS)	D4 UPKEEP+REPAIR V P-I-P (MIL $)	D5 NON-RES CONSTR V P-I-P (MIL $)	D6 BUILD CONSTR V P-I-P (MIL $)	D7 INTERCITY FREIGHT VOL (MIL TON-MI)	D8 RR CARS INSTALLED (THOU)
1947	13059	1268	0,09	5399	5805	24264	913,3	90,03
1948	15911	1362	0,13	5688	6819	28419	925,2	107,00
1949	16132	1466	0,19	5974	7568	29473	800,7	42,31
1950	22020	1952	0,14	5539	8262	35820	933,1	73,15
1951	17726	1491	0,14	5413	10040	33179	1025,6	82,94
1952	18215	1504	0,13	5895	10767	34877	986,3	63,94
1953	19168	1438	0,11	5954	11799	36921	1033,8	54,35
1954	20554	1551	0,09	6348	12607	39509	944,9	26,67
1955	24329	1646	0,08	7188	13584	45101	1074,1	52,11
1956	21328	1349	0,09	7478	14291	43598	1129,6	79,50
1957	20252	1224	0,13	7673	15088	43012	1118,9	72,71
1958	21065	1384	0,16	6966	14113	42143	1019,3	31,83
1959	25591	1531	0,16	7672	14153	47417	1074,8	49,06
1960	22763	1274	0,19	7566	15655	45984	1100,6	39,45
1961	22941	1337	0,24	8194	16665	47801	1091,7	25,34
1962	25559	1469	0,30	6543	17367	49468	1148,2	38,47
1963	27019	1615	0,35	6697	18120	51835	1214,0	56,44
1964	27148	1534	0,34	6679	20232	54059	1285,6	67,83
1965	26548	1488	0,33	6542	24010	57200	1342,7	77,05
1966	23595	1173	0,32	6341	26098	56134	1423,4	84,43
1967	23506	1299	0,33	6000	26579	56085	1411,9	65,86
1968	27591	1521	0,39	6790	26883	61765	1444,5	49,26
1969	28425	1492	0,43	6769	29200	64394	1484,0	57,81
1970	26371	1449	0,42	7279	27909	61558	1587,4	57,64

TABLE A1, (CONTINUED)

YEAR	D9 CROSS TIES INSTALLED (THOU)	D10 BOX CARS INSTALLED (THOU)	D11 PI OF LUMBER SUBSTITUTES (1957-59=100)	D12 COST/SQ FT RESID CONSTR ($/SQ FT)	D13 VALUE/DWELLING RESID CONSTR ($/DWELLING)	D14 COST/SQ FT NON-RES CONSTR ($/SQ FT)	D15 NO. OF HOUSEHOLDS (THOU)	D16 PER CAP INC NATIONAL ($)
1947	40206	41,07	85,5	7,96	8313	8,26	39107	1647
1948	40472	29,64	92,3	8,71	8931	9,28	40532	1627
1949	32926	9,54	94,7	9,83	9132	10,56	42182	1657
1950	33091	38,58	97,9	9,59	9994	10,31	43554	1724
1951	32457	31,85	93,6	9,51	9617	10,21	44656	1708
1952	34231	18,46	94,0	9,90	10080	11,20	45504	1844
1953	33462	16,10	98,2	10,16	10734	11,92	46334	1946
1954	25728	15,33	99,4	10,72	11437	12,47	46893	1921
1955	27173	28,53	101,8	10,69	12178	12,85	47788	2013
1956	27323	31,36	99,3	11,04	12708	13,54	48785	2053
1957	25123	20,29	98,8	10,84	13157	13,16	49543	2066
1958	17722	8,41	99,2	10,80	12898	13,24	50402	2060
1959	18267	18,11	102,0	11,21	13345	13,08	51302	2148
1960	16417	11,74	99,2	11,31	13704	13,59	52610	2201
1961	13427	7,37	99,3	11,58	13833	13,65	53291	2258
1962	15206	10,08	96,9	11,65	14240	13,87	54652	2356
1963	15120	16,72	97,4	11,68	14831	14,57	55189	2451
1964	15546	20,15	96,4	11,94	15473	15,08	55996	2577
1965	15982	24,83	94,3	12,12	15854	14,84	57251	2702
1966	17599	22,09	92,7	11,89	15935	14,93	58092	2871
1967	17458	22,19	91,8	12,10	16470	16,28	58845	2987
1968	19306	19,72	96,3	12,17	17165	16,52	60444	3158
1969	20388	24,24	98,0	12,11	17013	16,79	61805	3279
1970	21403	22,05	92,1	11,90	15649	17,98	62874	3348

TABLE A1. (CONTINUED)

YEAR	D17 PER CAP INC NE ($)	D18 PER CAP INC NC ($)	D19 PER CAP INC SOUTH ($)	D20 PER CAP INC WEST ($)	D21 MEDIAN FAMILY INC (1970 $)	D22 CITY POP NATIONAL (THOU)	D23 CITY POP NE (THOU)	D24 CITY POP NC (THOU)
1947	1719	1787	1133	1776	5259	41343	15559	12665
1948	1836	1766	1119	1677	5153	42289	15698	12916
1949	1895	1734	1141	1776	5066	43110	15959	13142
1950	1935	1833	1177	1804	5385	43885	16018	13383
1951	1947	1824	1180	1792	5547	44329	15886	13398
1952	2034	1957	1290	1951	5703	45084	15781	13423
1953	2196	2085	1367	2019	6171	45759	15605	13589
1954	2177	2034	1353	2005	6023	46519	15879	13812
1955	2232	2113	1441	2100	6428	47239	15791	13957
1956	2344	2143	1479	2129	6842	47910	15656	14080
1957	2373	2154	1482	2141	6860	48003	15563	14170
1958	2350	2125	1501	2159	6826	49302	15571	14254
1959	2446	2217	1576	2256	7216	50049	15613	14311
1960	2518	2272	1600	2296	7376	50749	15554	14380
1961	2532	2310	1663	2368	7457	51545	15541	14453
1962	2593	2419	1748	2453	7659	52269	15509	14515
1963	2732	2517	1842	2545	7927	52998	15565	14539
1964	2925	2647	1959	2645	8227	53978	15838	14629
1965	3035	2827	2071	2751	8559	54334	15540	14714
1966	3206	2952	2141	2862	8977	54888	15464	14832
1967	3355	3080	2354	3030	9285	55351	15380	14845
1968	3541	3246	2511	3201	9633	55852	15311	14878
1969	3575	3373	2635	3300	9990	56397	15246	14941
1970	3777	3392	2728	3365	9867	56755	15126	15010

TABLE A1, (CONTINUED)

YEAR	D25 CITY POP SOUTH (THOU)	D26 CITY POP WEST (THOU)	D27 MANUFACTURING ACTIVITY (1957-59=100)	D28 CHANGE MFCT ACTIVITY (1957-59=100)	D29 SOFTWOOD PLYWOOD PR ($/M SQ FT)	D30 STRUCTURAL STEEL PR ($/100 LBS)	D31 BUILDING BOARD PR ($/M SQ FT)	D32 CONCRETE PRODUCTS PI (1957-59=100)
1947	7474	5845	66,2	9,2	100,36	3,14	69,64	92,5
1948	7597	5978	68,9	2,7	119,41	3,54	71,19	89,5
1949	7959	6050	64,9	-4,0	109,00	4,08	75,89	96,4
1950	8311	6173	75,6	10,7	121,22	4,21	75,42	94,9
1951	8588	6357	81,9	6,3	115,80	4,01	71,31	90,8
1952	9048	6832	85,2	3,3	108,53	4,21	74,66	93,5
1953	9313	7052	92,7	7,5	110,42	4,51	79,67	97,2
1954	9595	7233	86,3	-6,4	106,64	4,68	83,64	98,8
1955	10039	7452	97,3	11,0	109,36	4,92	85,43	99,5
1956	10472	7702	100,2	2,9	96,95	5,12	86,58	99,8
1957	10942	7928	100,8	0,6	85,20	5,73	86,96	99,7
1958	11370	8107	93,2	-7,6	84,62	5,88	86,79	99,6
1959	11788	8337	106,0	12,8	89,96	6,00	88,44	100,7
1960	12252	8563	108,9	2,9	79,89	5,99	88,01	101,7
1961	12573	8878	109,6	0,7	77,97	6,02	87,84	102,2
1962	13067	9178	118,7	9,1	75,15	6,00	84,45	102,0
1963	13541	9353	124,9	6,2	77,19	6,06	83,57	101,4
1964	13958	9553	133,1	8,2	74,71	6,19	81,75	100,4
1965	14355	9725	145,0	11,9	73,34	6,06	79,04	99,0
1966	14733	9859	158,6	13,6	71,23	6,10	76,42	97,3
1967	15102	10024	159,7	1,1	67,09	6,09	75,70	99,2
1968	15490	10173	166,9	7,2	84,45	6,05	74,55	99,3
1969	15379	10331	173,9	7,0	87,52	6,18	75,10	99,4
1970	15026	10593	165,6	-8,3	69,00	6,36	69,41	101,0

TABLE A1, (CONTINUED)

YEAR	D33 BUILD CONSTR WAGE, NATIONAL ($/HR)	D34 BUILD CONSTR WAGE, NE ($/HR)	D35 BUILD CONSTR WAGE, NC ($/HR)	D36 BUILD CONSTR WAGE S ($/HR)	D37 BUILD CONSTR WAGE, W ($/HR)	D38 CONSTR MATERIALS PI (1957-59=100)	D39 SECONDARY MKT FHA YIELDS (%)	D40 PRIME LENDING RATE (%)
1947	2,28	2,09	2,25	1,96	2,24	87,7	3,70	1,51
1948	2,37	2,30	2,30	2,04	2,26	89,8	3,95	1,85
1949	2,61	2,83	2,63	2,30	2,49	92,6	4,34	2,00
1950	2,64	2,86	2,66	2,29	2,49	95,6	4,17	2,07
1951	2,50	2,65	2,54	2,20	2,43	93,8	4,21	2,55
1952	2,73	2,86	2,84	2,38	2,62	95,3	4,29	3,00
1953	2,90	3,03	3,01	2,48	2,82	98,1	4,61	3,17
1954	3,01	3,16	3,11	2,63	2,91	98,1	4,62	3,05
1955	3,11	3,28	3,20	2,71	2,99	102,0	4,64	3,16
1956	3,16	3,33	3,23	2,79	3,06	102,9	4,79	3,77
1957	3,23	3,41	3,28	2,85	3,14	100,0	5,42	4,20
1958	3,33	3,55	3,38	2,88	3,26	98,5	5,49	3,83
1959	3,49	3,72	3,53	3,05	3,40	101,5	5,71	4,48
1960	3,63	3,86	3,65	3,19	3,60	99,8	6,18	4,82
1961	3,82	4,05	3,80	3,34	3,80	98,3	5,81	4,50
1962	3,93	4,20	3,84	3,41	3,88	97,7	5,63	4,50
1963	4,09	4,41	3,95	3,50	4,06	98,2	5,47	4,50
1964	4,23	4,52	4,15	3,63	4,31	99,1	5,45	4,50
1965	4,31	4,70	4,31	3,65	4,42	98,3	5,45	4,51
1966	4,33	4,69	4,29	3,66	4,46	98,1	6,34	5,61
1967	4,55	4,89	4,57	3,85	4,65	99,2	6,55	5,59
1968	4,72	5,06	4,84	3,96	4,76	102,1	7,13	6,30
1969	4,90	5,19	5,10	4,08	4,91	103,6	8,19	7,95
1970	5,28	5,57	5,58	4,39	5,16	101,0	9,05	7,92

TABLE A1, (CONTINUED)

YEAR	D41 FREIGHT RATE ($REV/TON-MI)	D42 US POP AGES 0-20 (THOU)	D43 US POP AGES 21-34 (THOU)	D44 US POP AGES 35-44 (THOU)	D45 US POP AGES 45-64 (THOU)	D46 US POP AGES 65-UP (THOU)	D47 US POP AGES 21-44 (THOU)	D48 TOTAL POP NATIONAL (THOU)
1947	1,325	50679	32444	20083	29544	10455	52527	144083
1948	1,423	52021	32672	20398	30082	10940	53070	146730
1949	1,504	53270	32842	20716	30622	11270	53558	149304
1950	1,531	53930	33459	21636	30849	12397	55095	151868
1951	1,382	55285	33514	21914	31362	12803	55428	153982
1952	1,521	56761	33512	22193	31884	13203	55705	156393
1953	1,594	58385	33342	22446	32394	13617	55788	158956
1954	1,530	60207	33140	22661	32942	14076	55801	161884
1955	1,471	62128	32860	22912	33506	14525	55772	165089
1956	1,438	64028	32623	23257	34057	14938	55880	168088
1957	1,460	66084	32325	23596	34591	15388	55921	171187
1958	1,457	68093	32076	23798	35109	15806	55874	174149
1959	1,436	70006	31890	24023	35663	16248	55913	177135
1960	1,393	71848	31746	24223	36208	16659	55969	179975
1961	1,369	73926	31658	24403	36756	17013	56061	182973
1962	1,341	75795	31703	24531	37316	17311	56234	185738
1963	1,306	77386	32003	24594	37869	17565	56597	188438
1964	1,276	78573	32684	24564	38438	17863	57248	191085
1965	1,235	79734	33243	24438	39015	18162	57681	193460
1966	1,187	80727	33879	24249	39601	18464	58128	195501
1967	1,196	81615	34529	23984	40194	18796	58513	197374
1968	1,204	81415	36205	23649	40768	19129	59854	199312
1969	1,195	81413	37626	23314	41393	19470	60940	201306
1970	1,221	81380	39027	23042	41908	19799	62069	203736

TABLE A1, (CONTINUED)

YEAR	D49 TOTAL POP NE (THOU)	D50 TOTAL POP NC (THOU)	D51 TOTAL POP SOUTH (THOU)	D52 TOTAL POP WEST (THOU)	D53 POP MOBILITY (ANNUAL %)	D54 FAMILY INC $0-$4999 (% FAMILIES)	D55 FAMILY INC $5000-$9999 (% FAMILIES)	D56 FAMILY INC $10000-UP (% FAMILIES)
1947	37572	42188	45108	18508	19,6	46,7	39,7	13,5
1948	38532	43053	45542	18959	19,9	48,0	40,3	11,8
1949	39303	43837	46195	19219	18,8	49,2	39,1	11,8
1950	39590	44670	47327	19640	18,7	44,9	42,0	13,2
1951	39825	45050	48211	20305	21,0	45,3	44,0	13,3
1952	40135	45472	48616	21905	19,8	41,6	44,0	14,5
1953	40785	46379	49173	22697	20,1	36,7	45,3	17,9
1954	41591	47497	49457	23369	18,6	38,8	43,8	17,5
1955	41985	48360	50547	24171	19,6	35,3	44,6	20,1
1956	42263	49163	51533	25079	20,5	31,9	44,6	23,6
1957	42673	49860	52657	25918	19,4	28,4	47,2	24,4
1958	43373	50547	53532	26605	19,8	32,0	44,8	23,0
1959	44193	51147	54324	27468	19,2	30,6	42,7	26,9
1950	44774	51725	55188	28297	19,4	29,7	41,4	28,8
1951	45242	52232	56249	29320	20,0	29,4	40,2	30,2
1952	45667	52705	57162	30289	19,1	28,0	40,0	31,9
1953	46365	53043	58390	30858	19,4	24,9	38,9	34,3
1954	47734	53626	59347	31498	19,6	25,8	37,6	36,5
1955	47392	54194	60188	32042	20,1	24,1	36,9	38,9
1956	47723	54893	60929	32473	19,3	22,0	35,7	42,5
1957	48045	55205	61614	32994	18,3	20,7	34,5	44,7
1958	48423	55599	62359	33465	18,8	19,4	33,2	47,4
1959	48677	56107	63086	33974	18,3	18,5	31,5	50,0
1970	49000	56577	62798	34810	18,4	19,3	31,7	49,1

TABLE A1. (CONTINUED)

YEAR	D57 EXPENDITURES ON HOUSING (BIL $)	D58 % ALL EXPEND ON HOUSING (%)	D59 HOUSE HEADS IN ALL POP (%)	D60 HOUSE HEADS 0-24 YR (% CLASS POP)	D61 HOUSE HEADS 25-34 YR (% CLASS POP)	D62 HOUSE HEADS 35-44 YR (% CLASS POP)	D63 HOUSE HEADS 45-64 YR (% CLASS POP)	D64 HOUSE HEADS 65-UP YR (% CLASS POP)
1947	19,3	9,8	27,3	2,6	33,4	45,2	51,4	53,3
1948	19,9	10,1	27,7	2,8	34,5	45,7	51,6	54,2
1949	23,1	10,9	28,1	3,1	36,8	46,1	51,8	54,9
1950	24,5	11,2	28,5	3,3	37,2	45,3	52,5	52,0
1951	24,7	11,6	28,6	3,2	37,9	45,6	52,5	52,9
1952	28,2	12,2	28,8	3,0	38,7	46,0	52,5	53,9
1953	31,6	12,7	29,2	3,2	39,4	45,7	53,3	55,7
1954	34,1	13,4	28,8	2,8	39,4	46,9	52,1	53,7
1955	35,2	13,2	28,8	3,0	38,4	47,9	52,1	54,3
1956	37,4	13,5	28,9	3,1	39,4	46,7	52,8	54,7
1957	38,9	13,7	28,8	3,1	39,6	46,5	53,2	53,9
1958	40,9	14,2	28,8	3,1	40,7	46,4	53,5	54,3
1959	43,4	14,0	28,8	3,2	41,3	47,1	53,2	55,1
1960	45,0	14,2	29,1	3,2	42,3	47,8	53,5	56,4
1961	48,6	14,5	29,0	3,2	42,7	47,3	54,4	55,8
1962	51,7	14,6	29,3	3,4	43,5	48,0	53,4	60,0
1963	55,2	14,8	29,1	3,3	43,4	48,7	53,2	59,7
1964	58,9	14,7	29,1	3,5	43,4	49,4	53,2	59,3
1965	61,7	14,6	29,4	3,8	44,3	49,0	54,0	60,7
1966	63,7	14,5	29,5	3,9	44,3	49,0	54,1	60,7
1967	67,7	14,6	29,6	3,8	44,7	49,7	53,9	60,6
1968	71,1	14,4	30,0	4,1	44,2	50,5	54,7	61,6
1969	74,3	14,5	30,4	4,3	45,7	50,4	54,8	61,7
1970	78,5	14,9	30,6	4,5	46,0	50,8	54,8	61,9

TABLE A2. ENDOGENOUS QUANTITY VARIABLES, EACH MEASURED IN MILLION BOARD FEET, ORIGINAL DATA

YEAR	E1 DOUG-FIR LU PROD	E2 DOUG-FIR LU SHPT	E3 DOUG-FIR LU IMPORTS	E4 DOUG-FIR LU EXPORTS	E5 DOUG-FIR LU CONS	E6 SO PINE LU PROD	E7 SO PINE LU SHPT	E8 SO PINE LU EXPORTS	E9 SO PINE LU CONS
1947	9043	8942	65	707	8300	9473	9359	193	9166
1948	9794	9743	206	324	9625	9110	9084	104	8980
1949	9074	9080	255	329	9006	8259	8311	110	8201
1950	9984	10009	553	214	10348	9939	10094	106	9988
1951	10372	10333	456	494	10295	8495	8505	144	8361
1952	10559	10345	412	233	10524	8572	8683	100	8583
1953	10357	10214	582	279	10517	7581	7507	75	7432
1954	10328	10319	735	326	10728	7332	7384	81	7303
1955	10414	10432	983	371	11044	7360	7353	89	7264
1956	10195	10047	970	324	10693	7740	7738	85	7653
1957	9094	9010	789	350	9449	6568	6614	92	6522
1958	9329	9292	978	238	10032	6110	6134	78	6056
1959	10255	10278	1121	299	11100	6716	6580	79	6501
1960	8832	8889	1022	381	9530	5660	5523	94	5429
1961	8373	8362	1111	273	9200	5622	5603	70	5533
1962	8504	8601	1054	316	9339	5740	5729	76	5653
1963	8353	8359	769	374	8754	6055	6053	77	5976
1964	8853	8822	1175	368	9629	6414	6340	103	6237
1965	8783	8719	1063	445	9337	6628	6739	101	6638
1966	8523	8573	909	401	9081	6609	6567	99	6468
1967	7822	8106	926	398	8634	6511	6511	88	6423
1968	8532	8596	1047	409	9234	6901	6954	91	6863
1969	8057	8018	929	360	8587	7181	7012	76	6936
1970	7727	7691	885	383	8193	6806	6807	78	6729

TABLE A2. (CONTINUED)

YEAR	E10 HEMLOCK LU PROD	E11 HEMLOCK LU SHPT	E12 HEMLOCK LU IMPORTS	E13 HEMLOCK LU EXPORTS	E14 HEMLOCK LU CONS	E15 TRUE FIR LU PROD	E16 TRUE FIR LU SHPT	E17 TRUE FIR LU IMPORTS	E18 TRUE FIR LU CONS
1947	1244	1230	65	14	1281	673	665	16	681
1948	1302	1295	158	5	1448	705	701	57	758
1949	1177	1178	273	15	1436	759	760	18	778
1950	1503	1512	746	15	2243	1114	1117	41	1158
1951	1502	1496	317	94	1719	1285	1280	40	1320
1952	1525	1493	275	30	1738	1667	1632	75	1707
1953	1441	1420	490	21	1689	1557	1534	88	1622
1954	1337	1336	429	40	1725	1804	1802	151	1953
1955	1558	1571	465	26	2010	2059	2063	155	2218
1956	1322	1303	528	22	1809	1954	1927	106	2033
1957	1242	1231	499	31	1699	2013	1994	110	2104
1958	1353	1353	598	41	1910	2475	2465	179	2644
1959	1653	1660	719	25	2354	2838	2842	133	2975
1960	2032	2045	731	39	2737	2224	2238	180	2418
1961	2031	2027	907	68	2866	2216	2212	96	2308
1962	2279	2305	1094	44	3355	2234	2259	99	2358
1963	2485	2488	885	71	3302	2158	2160	67	2227
1964	2493	2477	955	48	3384	2540	2527	81	2608
1965	2575	2557	1098	45	3709	2422	2404	52	2456
1966	2493	2503	1119	44	3610	2321	2333	52	2385
1967	2237	2339	1135	55	3419	2116	2193	53	2246
1968	2185	2202	1256	75	3385	2394	2412	60	2472
1969	1902	1893	1200	77	3016	2135	2125	57	2182
1970	1988	1979	1166	122	3133	2063	2054	61	2115

TABLE A2, (CONTINUED)

YEAR	E19 LARCH LU PROD	E20 LARCH LU SHPT	E21 LARCH LU IMPORTS	E22 LARCH LU CONS	E23 STRUCT SP LU PROD	E24 STRUCT SP LU SHPT	E25 STRUCT SP LU IMPORTS	E26 STRUCT SP LU EXPORTS	E27 STRUCT SP LU CONS
1947	292	289	9	297	20725	20485	155	914	19726
1948	305	303	6	309	21217	21126	427	433	21120
1949	224	224	3	227	19493	19553	549	454	19648
1950	245	247	13	260	22791	22979	1353	335	23997
1951	295	294	9	303	21949	21908	822	732	21998
1952	343	341	8	349	22681	22494	770	363	22901
1953	403	397	8	405	21349	21072	1168	375	21865
1954	321	321	12	333	21122	21162	1327	447	22042
1955	345	347	14	361	21747	21766	1617	486	22897
1956	393	387	7	394	21604	21402	1611	431	22582
1957	455	452	4	456	19373	19301	1402	473	20230
1958	541	539	14	553	19813	19783	1769	357	21195
1959	672	673	14	687	22149	22033	1987	403	23617
1960	418	421	17	438	19166	19116	1950	514	20552
1961	441	440	21	461	18688	18644	2135	411	20368
1962	443	448	24	472	19200	19342	2271	436	21177
1963	393	390	28	418	19442	19450	1749	522	20677
1964	431	429	32	461	20743	20595	2243	519	22319
1965	441	438	23	461	20850	20857	2236	591	22502
1966	421	423	24	447	20369	20399	2104	544	21959
1967	405	420	21	441	19111	19569	2135	541	21163
1968	403	403	23	426	20413	20567	2386	575	22378
1969	353	363	28	391	19638	19411	2214	513	21112
1970	355	353	24	377	18939	18884	2136	583	20547

TABLE A2, (CONTINUED)

YEAR	E28 SOFTWOOD LU PROD	E29 SOFTWOOD LU SHPT	E30 SOFTWOOD LU IMPORTS	E31 SOFTWOOD LU EXPORTS	E32 SOFTWOOD LU CONS	E33 TOTAL LU PROD	E34 TOTAL LU SHPT	E35 TOTAL LU IMPORTS	E36 TOTAL LU EXPORTS	E37 TOTAL LU CONS
1947	27937	27461	1092	972	27581	35404	34711	1306	1158	34859
1948	29600	28387	1652	462	29577	37000	35541	1869	550	36860
1949	26472	26428	1425	534	27319	32176	32127	1563	667	33023
1950	30533	31089	3140	407	33822	38007	38410	3424	518	41316
1951	29493	29128	2250	876	30502	37204	36618	2512	998	38132
1952	30234	30176	2267	566	31877	37462	37557	2482	727	39312
1953	29552	29105	2527	513	31119	36742	36208	2759	643	38324
1954	29232	29392	2855	585	31662	36356	36664	3063	718	39009
1955	29815	29848	3327	652	32523	37380	37501	3593	841	40253
1956	30231	29615	3131	571	32175	38199	37443	3405	761	40087
1957	27100	27973	2712	623	30062	32901	33777	2958	811	35924
1958	27379	27449	3155	550	30054	33385	33471	3390	727	36134
1959	30509	30234	3742	608	33368	37166	36911	4064	787	40188
1960	26572	26672	3639	694	29617	32926	32885	3931	861	35955
1961	26056	26209	4013	618	29604	32019	32274	4258	773	35759
1962	26819	26905	4584	629	30800	33178	33188	4893	760	37321
1963	27552	27557	5032	743	31846	34706	34801	5335	875	39261
1964	29234	29058	4918	812	33164	36559	36365	5223	956	40632
1965	29295	29284	4898	779	33403	36762	36773	5233	919	41087
1966	28847	28878	4779	869	32789	36584	36599	5200	1023	40776
1967	27311	27518	4798	965	31351	34741	34948	5141	1130	38959
1968	29236	29709	5809	1048	34470	36473	36896	6154	1162	41888
1969	28342	27702	5854	1024	32532	35824	35266	6301	1142	40425
1970	27297	27088	5778	1161	31705	34417	34056	6114	1289	38881

TABLE A3. ENDOGENOUS PRICE VARIABLES, ORIGINAL DATA

YEAR	E38 DOUGLAS-FIR LU PR ($/MFBM)	E39 SO PINE LU PR ($/MFBM)	E40 STRUCT SP LU PR ($/MFBM)	E41 SOFTWOOD LU PI (BLS) (1957-59=100)	E42 SOFTWOOD LU PI (AUTHOR) (1957-59=100)	E43 ALL LU PI (1957-59=100)
1947	98,71	107,96	103,56	95,00	93,92	95,4
1948	104,07	109.39	106,63	100,23	99,36	100,1
1949	95,75	104,00	99,68	96,59	96,29	96,4
1950	113,56	112,20	112,89	108,23	103,92	108,2
1951	111,56	107,99	109,96	105,20	104,96	105,1
1952	113,59	112,20	112,97	107,76	107,20	105,3
1953	106,01	112,77	108,81	106,97	106,85	105,8
1954	107,74	107,51	107,64	105,15	105,35	103,8
1955	117,38	111,49	115,04	111,53	111,57	109,9
1956	113,19	111,79	112,61	108,94	108,93	108,7
1957	98,95	104,44	101,19	99,53	99,79	99,5
1958	95,76	101,43	97,96	96,23	96,28	96,6
1959	108,95	104,63	107,36	104,39	104,02	103,9
1960	99,49	102,88	100,71	97,94	97,81	99,1
1961	95,75	98,85	96,92	93,25	92,68	94,4
1962	98,28	98,46	98,35	95,30	94,91	95,9
1963	102,41	98,44	100,81	97,70	97,32	98,6
1964	103,92	98,35	101,73	98,78	98,55	100,2
1965	101,10	98,15	99,87	96,64	96,30	99,4
1966	102,54	104,38	103,31	98,16	97,31	102,5
1967	105,78	103,99	105,01	100,28	99,33	102,2
1968	123,99	115,29	120,28	118,03	116,68	116,9
1969	130,75	122,82	127,19	126,65	125,00	126,2
1970	104,35	107,92	105,96	103,04	101,79	105,3

TABLE A4, SUPPLY VARIABLES, ORIGINAL DATA

YEAR	S1 SAW WAGES PAC REG ($/HR)	S2 SAW WAGES SO REG ($/HR)	S3 SAW WAGES PAC+SO REGS ($/HR)	S4 SAW WAGES NATION ($/HR)	S5 SAW STRIKES (MAN-DAYS IDLE/ PROD WORKER)	S6 SAW EST SIZE PAC REG ($THOU VA/EST)	S7 SAW EST SIZE SO REG ($THOU VA/EST)	S8 SAW EST SIZE PAC+SO REGS ($THOU VA/EST)
1947	1,356	0,8202	1,4138	1,2167	1,1570	258,3	32,9	167,5
1948	1,395	0,8203	1,4061	1,1843	0,3120	259,3	35,4	168,2
1949	2,087	0,9305	1,5892	1,3102	0,1830	260,2	37,9	168,9
1950	2,098	0,9597	1,5714	1,3203	0,2170	261,2	40,4	169,6
1951	2,100	0,9297	1,5915	1,3123	0,2640	262,1	42,9	170,3
1952	2,283	0,9862	1,7426	1,4447	1,7130	263,1	45,4	171,0
1953	2,352	1,0766	1,8479	1,5318	0,5020	264,1	47,9	171,7
1954	2,334	1,0344	1,7750	1,5070	7,4790	265,0	50,5	172,8
1955	2,430	1,0547	1,8391	1,5408	0,3810	275,5	50,6	180,9
1956	2,389	1,1247	1,8264	1,5842	0,1270	286,0	50,7	189,2
1957	2,318	1,1172	1,8222	1,5525	0,2570	296,5	50,8	197,5
1958	2,342	1,1026	1,8536	1,6046	0,6970	307,0	50,9	206,0
1959	2,389	1,1402	1,8897	1,6590	0,4910	336,9	56,8	225,2
1960	2,417	1,1579	1,9325	1,6485	0,1670	366,8	62,7	244,4
1961	2,474	1,2144	1,9840	1,7109	0,4120	396,7	68,6	263,7
1962	2,551	1,2753	2,0527	1,7545	1,5360	426,6	74,5	282,9
1963	2,736	1,3679	2,1825	1,9202	2,3620	456,8	80,7	302,1
1964	2,843	1,4159	2,2786	2,0517	0,2000	501,0	88,1	330,9
1965	2,845	1,4176	2,2654	1,9951	0,2710	545,2	95,5	359,6
1966	2,949	1,4221	2,3163	2,0236	0,1990	589,4	102,9	388,4
1967	2,996	1,6381	2,4336	2,1979	0,1370	633,6	110,6	417,1
1968	3,070	1,7096	2,5064	2,3428	0,2720	677,8	117,8	445,8
1969	3,168	1,7204	2,5336	2,3938	0,5050	722,0	125,0	474,6
1970	3,341	1,7199	2,6405	2,4697	0,2770	764,2	132,2	503,4

TABLE A4. (CONTINUED)

YEAR	S9 SAW EST SIZE NATION ($THOU VA/EST)	S10 $NEW SAW CAP ($NEW CAP/ MAN-HR)	S11 PRODUCTIVITY PAC SAW ($VA/MAN-HR)	S12 PRODUCTIVITY SO SAW ($VA/MAN-HR)	S13 PRODUCTIVITY PAC+SO SAW ($VA/MAN-HR)	S14 PRODUCTIVITY NATIONAL SAW ($VA/MAN-HR)	S15 ELECTRIC PR PAC REG ($/KIL-HR)	S16 ELECTR PR ALABAMA ($/KIL-HR)
1947	140.3	0.183	3.7383	1.3561	2.0338	2.1887	0.0129	0.0128
1948	142.5	0.170	3.5088	1.3583	2.0400	2.1191	0.0121	0.0118
1949	144.6	0.177	3.3069	1.3605	2.0462	2.0538	0.0132	0.0131
1950	145.8	0.189	4.0290	1.6265	2.3929	2.4366	0.0126	0.0123
1951	143.9	0.206	4.2571	1.7114	2.5853	2.6330	0.0112	0.0110
1952	151.1	0.152	4.2571	1.6661	2.5887	2.6247	0.0118	0.0114
1953	153.2	0.174	4.2283	1.7876	2.7473	2.6674	0.0123	0.0115
1954	155.4	0.223	4.3898	1.7584	2.6709	2.7181	0.0121	0.0118
1955	152.5	0.296	4.6577	1.8560	2.8257	2.9129	0.0117	0.0116
1956	159.6	0.288	4.6275	2.0400	2.9586	3.0120	0.0111	0.0113
1957	175.8	0.209	4.1597	2.0092	2.8843	2.6667	0.0108	0.0109
1958	183.9	0.317	4.2409	1.9885	2.9317	2.9351	0.0108	0.0110
1959	201.6	0.316	4.5537	2.1468	3.1437	3.4060	0.0105	0.0108
1960	217.4	0.352	3.9432	2.1839	3.0021	3.0779	0.0111	0.0108
1961	233.1	0.281	4.6773	2.3121	3.3467	3.2352	0.0108	0.0111
1962	243.9	0.340	4.6296	2.4925	3.4686	3.5162	0.0107	0.0110
1963	252.6	0.473	5.2854	2.7300	3.8329	3.7779	0.0108	0.0110
1964	290.0	0.428	5.8038	2.9343	4.1859	4.2827	0.0105	0.0107
1965	317.4	0.450	5.5928	2.8835	4.0486	3.9526	0.0101	0.0101
1966	344.8	0.446	5.9844	3.2563	4.4425	4.4883	0.0095	0.0098
1967	372.2	0.376	6.1996	3.6697	4.8239	4.8100	0.0095	0.0097
1968	399.6	0.525	8.0386	4.2918	5.9032	5.9242	0.0096	0.0093
1969	427.0	0.588	8.7032	4.6468	6.2854	6.4144	0.0088	0.0094
1970	454.4	0.441	10.2564	5.4171	7.2939	7.4850	0.0084	0.0090

TABLE A4, (CONTINUED)

YEAR	S17 ELECTRICITY PR NATION ($/KILWHR)	S18 FUEL AND POWER PI (1957-59=100)	S19 DOUGLAS-FIR SAWLOG PR ($/MFBM)	S20 SOFTWOOD SAWLOG PI (1957-59=100)	S21 ALL SAWLOG PI (1957-59=100)	S22 PRECIPITATION PAC REG (INCHES)	S23 SAW CHIP VOL SO PINE (THOU CORDS)	S24 TOTAL CHIP PROD (THOU CORDS)
1947	0,0183	98,2	41,50	82,4	85,3	31,53	5,3	750
1948	0,0174	106,7	44,71	83,2	85,2	46,51	8,7	925
1949	0,0192	106,9	46,71	88,1	89,6	34,93	12,1	1075
1950	0.0177	103.9	51,50	90,1	90,3	39,23	15,5	1250
1951	0.0155	96,7	49,53	88,9	88,8	33.14	18,9	1410
1952	0.0162	99,3	53,83	94,7	95,5	22.20	23,3	1570
1953	0.0164	103,5	51,78	96,3	97,4	38,08	25,7	1535
1954	0.0166	101,8	51,78	96,6	97,2	31,04	80,5	1500
1955	0,0156	101,4	56,01	102,9	102,8	35,62	284,3	2350
1956	0,0149	101,2	57,28	104,8	104,7	39,37	488,0	3050
1957	0,0147	103,7	53,33	100,4	100,2	36,46	1047,7	3885
1958	0,0150	98,3	52,89	97,4	97,4	40.72	1581,1	5150
1959	0,0147	98,1	57,36	102,3	102,4	38,00	2177,9	6135
1960	0,0148	98,9	57,99	104,6	105,3	38,78	2575,0	6545
1961	0,0149	100,4	57,33	101,6	101,5	41,66	2823,7	8155
1962	0,0147	99,6	57,06	98,5	98,9	37,82	3219,1	9440
1963	0,0146	99,5	58,33	99,3	99,8	35,34	3534,5	10045
1964	0,0141	96,6	59,20	102,9	103,1	42,94	3921,1	11150
1965	0,0137	96,5	61,46	106,2	106,2	32,49	4247,2	12030
1966	0,0129	95,7	61,38	105,0	106,3	36,44	4544,1	14230
1967	0,0129	97,6	65,22	106,5	108,0	36,23	4846,9	15640
1968	0,0125	94,1	75,37	118,0	116,8	44,12	5792,4	17420
1969	0,0120	92,5	87,35	133,8	129,6	34,63	6206,4	19840
1970	0,0116	0,0	76,26	117,8	115,9	39,92	6219,6	19300

TABLE A4. (CONTINUED)

YEAR	S25 US LU TARIFFS ($/MFBM)	S26 US-CANADA MONEY EXCHANGE RATE ($ US/$ CANADA)	S27 CANADIAN LU PROD (BIL FBM)	S28 BC LU PROD (BIL FBM)	S29 FS VOL SOLD REG 6 (MIL FBM)	S30 FS VOL SOLD REG 8 (MIL FBM)	S31 FS VOL SOLD REGS 6+8+5+10 (MIL FBM)	S32 FS VOL SOLD NATION (MIL FBM)
1947	2.46	91.999	5.9	2.7	1508	433	2410	3785
1948	1.14	91.691	5.9	2.9	1415	465	2716	3676
1949	1.20	92.881	5.9	3.0	1156	387	1875	2616
1950	1.15	91.474	6.5	3.5	1384	510	2294	3434
1951	1.03	94.939	6.9	3.7	1795	423	2867	4913
1952	1.06	102.149	6.8	3.7	1896	629	3078	4587
1953	1.08	101.550	7.3	4.1	2016	497	3244	4801
1954	1.08	102.724	7.2	4.4	2301	557	3644	5368
1955	1.07	101.401	7.9	5.0	2392	652	4238	6590
1956	1.04	101.600	7.8	4.8	2446	824	4564	6837
1957	1.01	104.291	7.1	4.4	2997	754	4672	6533
1958	1.00	103.025	7.2	4.9	3919	865	5880	8034
1959	0.99	104.267	7.6	4.9	4379	850	6577	9357
1960	0.99	103.122	8.0	5.3	3825	843	6492	12166
1961	1.00	98.760	8.2	5.6	3813	843	5846	8958
1962	0.99	93.561	8.8	6.0	4800	845	7688	10327
1963	1.00	92.699	9.9	6.7	5510	800	8682	12176
1964	1.00	92.589	10.3	7.1	4703	833	8389	11682
1965	0.98	92.743	10.8	7.4	4603	869	8307	11511
1966	0.94	92.811	10.6	7.3	4636	957	8211	11384
1967	0.94	92.689	10.3	7.1	4485	971	8117	11654
1968	0.74	92.801	11.4	7.8	4610	948	8399	11651
1969	0.53	92.855	11.5	7.7	4201	1023	7972	10907
1970	0.34	95.802	11.2	7.7	5357	1056	8966	13382

TABLE A4, (CONTINUED)

YEAR	S33 FS MGT+PRO APPROP (MIL $)	S34 FS S+PF APPROP (MIL $)	S35 FS ROAD APPROP (MIL $)	S36 DOUGLAS-FIR STUMPAGE PR ($/MFBM)	S37 SO PINE STUMPAGE PR ($/MFBM)	S38 AVG FS STUMPAGE PR ($/MFBM)	S39 TIMBER ROAD COST (THOU $)
1947	25.83	12.03	32.28	12.19	13.42	7.14	8895
1948	27.32	11.16	18.54	22.64	18.66	9.36	8217
1949	30.18	12.08	27.01	13.29	23.59	13.33	8650
1950	35.99	11.68	11.76	18.89	30.76	11.06	8321
1951	34.69	11.12	11.70	26.27	35.78	12.73	7469
1952	39.87	11.50	16.64	27.45	40.96	15.44	17701
1953	39.33	11.58	11.65	21.79	36.89	12.79	20680
1954	43.95	11.50	21.80	17.44	31.97	12.11	31272
1955	39.97	11.45	23.94	31.01	34.33	23.81	35886
1956	57.27	11.82	24.42	39.19	38.88	19.66	41057
1957	61.90	12.30	24.51	26.46	31.82	17.18	48882
1958	74.58	13.15	43.53	21.71	30.98	12.80	59542
1959	87.18	12.07	43.89	36.58	34.99	14.13	56761
1960	102.04	12.45	40.19	31.78	34.26	13.95	68903
1961	129.22	12.27	45.57	27.52	26.72	14.09	68301
1962	134.50	15.04	43.24	24.65	25.84	12.86	72335
1963	154.53	15.94	50.26	27.82	25.02	12.57	69155
1964	157.69	15.77	71.95	37.91	27.66	14.65	96529
1965	154.13	16.37	92.30	41.56	30.93	16.80	136813
1966	155.28	15.36	111.73	47.21	36.45	18.74	98440
1967	192.74	17.42	111.70	39.30	36.10	16.87	91439
1968	203.65	18.23	113.58	56.25	38.79	21.64	118903
1969	183.13	17.16	102.22	72.74	45.75	38.76	113238
1970	197.39	19.20	112.73	35.75	37.64	20.25	145510

TABLE A4. (CONTINUED)

YEAR	S40 FS SI SOUTH (BIL FBM)	S41 PRIVATE SI SOUTH (BIL FBM)	S42 ALL SI SOUTH (BIL FBM)	S43 FS SI PNW (BIL FBM)	S44 PRIVATE SI PNW (BIL FBM)	S45 ALL SI PNW (BIL FBM)	S46 FS SI SOUTH+PNW (BIL FBM)	S47 PRIVATE SI SOUTH+PNW (BIL FBM)
1947	16,18	318,54	342,76	286,15	252,39	662,39	302,33	570,93
1948	17,35	319,19	345,15	289,94	262,00	678,14	307,29	581,19
1949	18,52	319,85	347,53	293,74	271,60	693,89	312,26	591,45
1950	19,70	320,51	349,92	297,53	281,21	709,64	317,23	601,72
1951	20,87	321,17	352,30	301,32	290,82	725,38	322,19	611,99
1952	22,05	321,83	354,69	305,12	300,42	741,13	327,17	622,25
1953	23,22	322,48	357,07	308,91	310,03	748,88	332,13	632,51
1954	24,52	326,53	362,57	324,51	307,23	764,93	349,02	633,76
1955	25,81	330,58	368,07	340,11	304,43	780,98	365,91	635,01
1956	27,11	334,63	373,57	355,71	301,63	797,03	382,80	636,26
1957	28,40	338,68	379,07	371,31	298,83	813,08	399,69	637,51
1958	29,70	342,73	384,57	386,91	296,03	829,13	416,58	638,76
1959	30,99	346,78	390,07	402,51	293,23	845,18	433,47	640,01
1960	32,29	350,83	395,57	418,11	290,43	861,23	450,36	641,26
1961	33,58	354,88	401,07	433,71	287,63	877,28	467,25	642,51
1962	34,88	358,93	406,57	449,31	284,83	893,33	484,14	643,76
1963	36,17	362,94	412,07	464,90	282,02	909,37	501,07	644,96
1964	36,92	371,57	422,32	454,65	276,72	891,30	491,57	648,29
1965	37,67	380,20	432,57	444,40	271,42	873,23	482,07	651,62
1966	38,42	388,83	442,82	434,15	266,12	855,16	472,57	654,95
1967	39,17	397,46	453,07	423,90	260,82	837,09	463,07	658,28
1968	39,92	406,09	463,32	413,65	255,52	819,02	453,57	661,61
1969	40,67	414,72	473,57	403,40	250,22	800,95	444,07	664,94
1970	41,41	423,38	483,85	393,17	244,92	782,86	434,58	668,30

TABLE A4, (CONTINUED)

YEAR	S48 ALL SI SOUTH+PNW (BIL FBM)	S49 FS SI NATION (BIL FBM)	S50 PRIVATE SI NATION (BIL FBM)	S51 ALL SI NATION (BIL FBM)	S52 DOUGLAS-FIR LOG EXPORTS (MIL FBM)	S53 SOFTWOOD LOG EXPORTS (MIL FBM)	S54 ALL SPECIES LOG EXPORTS (MIL FBM)	S55 DOUGLAS-FIR PEELER LOG PR ($/MFBM)
1947	1005,15	508,16	955,77	1714,95	9,4	21,7	44,6	89,46
1948	1023,29	611,03	976,52	1771,94	1,7	25,0	55,0	90,67
1949	1041,42	641,90	997,27	1828,93	1,4	41,6	68,0	89,70
1950	1059,55	672,77	1018,02	1885,92	1,0	28,9	48,6	103,00
1951	1077,68	703,64	1038,77	1942,91	2,4	57,9	79,4	99,79
1952	1095,82	734,51	1059,52	1999,90	4,2	44,4	63,7	102,13
1953	1105,95	765,38	1080,30	2056,85	12,4	86,0	115,1	103,88
1954	1127,50	804,35	1083,82	2104,85	12,8	106,4	139,5	102,05
1955	1149,05	843,32	1087,34	2152,85	9,8	144,2	166,2	103,33
1956	1170,60	882,29	1090,86	2200,85	15,8	154,9	187,7	103,01
1957	1192,15	921,26	1094,38	2248,85	8,1	107,3	139,3	99,70
1958	1231,70	960,23	1097,90	2296,85	12,4	127,3	169,8	95,32
1959	1235,25	999,20	1101,42	2344,85	20,8	167,6	204,6	96,52
1960	1255,80	1038,17	1104,94	2392,85	27,5	210,3	266,3	99,40
1961	1273,35	1077,14	1108,46	2440,85	66,8	432,2	481,8	94,62
1962	1299,90	1116,11	1111,98	2488,85	48,1	452,7	522,2	94,43
1963	1321,44	1155,11	1115,51	2536,80	71,6	879,6	951,3	84,95
1964	1313,63	1136,03	1118,60	2520,41	94,6	1022,6	1086,3	85,37
1965	1305,82	1116,95	1121,69	2504,02	111,3	1111,4	1192,8	91,61
1966	1298,01	1097,87	1124,78	2487,63	130,5	1317,5	1393,1	92,07
1967	1290,20	1078,79	1127,87	2471,24	272,0	1873,6	1970,7	99,81
1968	1282,39	1059,71	1130,96	2454,85	396,5	2473,2	2568,1	102,02
1969	1274,58	1040,63	1134,05	2438,46	380,6	2316,8	2397,0	121,86
1970	1255,71	1021,58	1137,14	2422,10	487,7	2684,1	2753,0	116,65

TABLE A4, (CONTINUED)

YEAR	S56 ALL SPECIES PEELER LOG PR (1957-59=100)	S57 SO PINE PULPWOOD PR ($/CORD)	S58 SOFTWOOD PULPWOOD PR (1957-59=100)	S59 ALL SPECIES PULPWOOD PR (1957-59=100)
1947	76,2	13,67	92,0	94,3
1948	83,0	13,42	88,7	89,9
1949	84,1	13,51	89,1	89,7
1950	96,4	13,86	88,7	89,4
1951	94,9	14,51	92,5	94,1
1952	100,4	15,00	97,4	98,5
1953	103,6	15,19	99,5	100,5
1954	101,5	15,23	100,1	100,6
1955	102,8	15,56	101,7	102,3
1956	105,6	16,14	104,0	104,4
1957	100,8	15,56	100,5	100,6
1958	98,7	15,34	98,6	98,6
1959	99,6	15,76	100,9	100,7
1960	102,5	16,14	102,1	101,5
1961	97,2	16,15	102,4	101,5
1962	98,6	16,08	102,4	104,8
1963	90,8	16,10	102,9	102,6
1964	91,3	16,37	104,1	103,5
1965	97,8	16,57	105,4	105,1
1966	97,5	16,84	105,9	105,9
1967	105,2	17,15	108,2	108,1
1968	106,7	17,28	113,7	112,3
1969	123,5	17,46	118,4	115,8
1970	119,3	17,04	112,8	111,5

TABLE A5, TRANSPORTATION VARIABLES, ORIGINAL DATA

YEAR	T1 RAIL + MOTOR TRANS STRIKES (THOU MAN-DAY)	T2 RAIL+MOTOR+WATER TRANS STRIKES (THOU MAN-DAY)	T3 LU RAIL RATES WEST COAST-NY ($/100LBS)	T4 FREIGHT RATE ($REV/TON-MI)
1947	641	765	1,16	1.325
1948	417	2687	1,26	1.423
1949	1361	1416	1,38	1.604
1950	1540	1594	1,34	1.531
1951	591	1074	1,22	1.382
1952	654	1154	1,35	1.521
1953	438	691	1,40	1.594
1954	248	928	1,40	1.530
1955	2250	2477	1,39	1.471
1956	185	613	1,40	1.438
1957	557	1039	1,43	1.460
1958	835	963	1,46	1.457
1959	265	1142	1,46	1.436
1960	936	1006	1,46	1.393
1961	322	681	1,48	1.369
1962	657	1303	1,40	1.341
1963	563	1683	1,41	1.306
1964	797	1037	1,40	1.279
1965	722	2352	1,38	1.235
1966	477	2417	1,33	1.187
1967	1967	2132	1,34	1.196
1968	947	1510	1,34	1.204
1969	257	2194	1,35	1.195
1970	937	2063	1,44	1.221

TABLE A6, GROSS ECONOMIC INDICATORS, ORIGINAL DATA

YEAR	B1 WHOLESALE PI (1957-59=100)	B2 UNITED STATES POP (THOU)	B3 GROSS NA PRODUCT (BIL $)	B4 DISPOSABLE PERSONAL INC (MIL $)	B5 TIME TREND
1947	81.2	144083	284.9	208.0	1
1948	87.9	146730	293.1	215.1	2
1949	83.5	149304	307.2	225.9	3
1950	86.8	151868	328.1	238.4	4
1951	96.7	153982	339.6	234.3	5
1952	94.0	156393	367.6	253.5	6
1953	92.7	158956	393.3	272.5	7
1954	92.9	161884	392.7	277.1	8
1955	93.2	165089	427.0	295.4	9
1956	96.2	168088	435.8	304.8	10
1957	99.0	171187	445.6	311.6	11
1958	100.4	174149	445.5	317.5	12
1959	100.6	177135	480.8	335.3	13
1960	100.7	179975	500.2	347.6	14
1961	100.3	182973	518.5	363.3	15
1962	100.6	185728	557.0	383.0	16
1963	100.3	188438	588.7	403.4	17
1964	100.5	191085	629.3	435.9	18
1965	102.5	193460	667.2	461.7	19
1966	105.9	195501	701.9	483.4	20
1967	106.1	197374	748.3	514.9	21
1968	108.8	199312	794.3	543.4	22
1969	113.0	201306	822.2	558.9	23
1970	117.1	203736	831.9	584.7	24

APPENDIX B

SOURCE NOTES AND DESCRIPTION OF ORIGINAL DATA

APPENDIX B

SOURCE NOTES AND DESCRIPTION OF ORIGINAL DATA

D1: Value Put in Place of Residential Construction

source:

- 1947-63 "Value of Construction Put in Place: 1946-63 Revised," Construction Reports series C-30-61 supplement, Dept. of Commerce, Oct. 1964, pp. 6-7.
- 1964-70 "Value of Construction Put in Place," Construction Reports series C-30-71-2, Dept. of Commerce, Feb. 1971, pp. 6-7.

description: Units in million dollars. Value of construction put in place during the period of concern regardless of period construction began. Series includes summation of:

(1) new dwellings, private
(2) additions and alterations, private
(3) non-housekeeping, private
(4) farm dwellings, private
(5) residential building, public

Because farm dwellings were not separately reported after 1967, their level was estimated by linking to non-dwelling farm construction at the average 1962-67 ratio of .60.

D2: Number of Dwelling Units Started

source:

- 1947-58 "18th Annual Report," Housing and Home Financing Agency, 1964, p. 376.
- 1959-69 "Statistical Yearbook 1969," Dept. of Housing and Urban Development, p. 364.
- 1970 "Housing Starts," Construction Reports series C-20-71-3, Dept. of Commerce, April 1971, p. 3.

description: Units in thousands of non-farm housing units started. Utilized non-farm starts because total starts are not available before 1959. This restriction is relatively unimportant, however, since farm starts were only 1.4 and 1.8 percent of total starts in 1959 and 1969 respectively.

D3: Percent Non-farm Dwelling Starts in Structures Containing Three or More Dwelling Units

source: Components from same as D2.

description: Division of (no. of structures containing three or more unit starts/total unit starts) times 100%.

D4: Value Put in Place of Residential Upkeep and Repairs

source:

1947-56	"Construction Volume and Costs, 1915-1956," supplement to Construction Review, Depts. of Commerce and Labor, Dec. 1954, p. 26.
1957-59	"Construction Review," Depts. of Commerce and Labor, vol. 6, no. 12, Dec. 1960, p. 5.
1960-61	"Residential Alterations and Repairs," Construction Reports series C-50-6, July 1962, p. 3.
1962-63,65	ibid., C-50-10 part 1, Jan. 1967, p. 3.
1966-69	ibid., C-50-69A, Aug. 1970, p. 4.
1970	ibid., C-50-70-Q4, April 1971, p. 2.

description: Units in million dollars. Value put in place on all maintenance, repair, and improvements in farm or non-farm, private or public residential buildings. 1964 estimated by interpolation because no survey was conducted.

D5: Value Put in Place of Non-Residential Construction

source;

1947-67	Same as D1.
1968-70	Correspondence with Bureau of Census, Wash., D.C.

description: Units in million dollars. Value put in place during period of concern regardless of construction commencement data on summartion of:

(1) private; industrial, commercial, religious, educational, hospital and institutional,

social and recreational, and non-residential farm.

(2) public; industrial, educational, hospital and institutional, and administrative and service.

Note exclusion of public utilities, highways, public sewer and water, public conservation and development, and military facilities.

D6: Value Put in Place of All Building Construction

source: Components from D1, D4, and D5.

description: Units in million dollars. Equals summation of residential, non-residential, and upkeep and repairs.

D7: Intercity Freight Volume

source: 1947-57 "Historical Statistics, Colonial Times to 1957," supplement to Statistical Abstract, Bureau of Census, Dept. of Commerce, 1960, p. 427.

1958-69 "Statistical Abstract 1971," Bureau of Census, Dept. of Commerce, p. 525.

description: Units in billions of ton-miles of intercity domestic freight carried by rail, motor vehicle, and inland waterway transport. 1970 not yet published so estimated by linkage of freight volume to index of freight revenue found in "Transport Economics," Bureau of Economics, I.C.C., June 1971, p. 7.

D8: Number of Rail Cars Installed

source: 1947-69 "Annual Report" (various issues), I.C.C.

description: Units in thousands of cars installed. Source reports in fiscal year but series D8 uses fiscal year "x" as calendar year "x-1." 1970 not yet published so estimated at 1967-69 average.

D9: Number of Cross Ties Installed

source: 1947-57 "Historical Statistics of the United States, Colonial Times to 1957," supplement to Statistical Abstract, Bureau of Census, Dept. of Commerce, series Q132, 1960, p. 436.

1958-62	"Historical Statistics of the United States; Continuation to 1962 and Revisions," Bureau of Census, Dept. of Commerce, series 132, Feb. 1965, p. 62.
1963	"Transport Statistics in the United States for year ending Dec. 31, 1963," I.C.C., part 1, release 2, p. 21.
1964	ibid., "1964," p. 34.
1965-66	"Statistical Abstract 1970," Bureau of Census, Dept. of Commerce, p. 555.
1967-69	ibid., "1971," p. 547.

description: Units in thousands of cross ties utilized in both replacements and new track construction. 1970 data not yet published so estimated at average of 1967-69 trend.

D10: Number of Box Cars Installed

source: Same as D8.

description: Same as D8 except contains only box cars.

D11: Price Index of Major Lumber Substitutes

source: Component parts from D29 through D32.

description: Units in 1957-59 = 100. Simple average of wholesale prices on softwood plywood, structural steel, building board, and concrete products.

D12: Cost Per Square Foot of Residential Construction

source:

1947-68	"Trends in Valuation Per Square Foot of Building Floor Area, 1956-68," John C. Musgrave, Construction Review, vol. 15, no. 11, Nov. 1969, pp. 4-12.
1969-70	"Statistical Abstract 1971," Bureau of Census, Dept. of Commerce, p. 665.

description: Units in dollar value per square foot of contracted floor area in residential construction. 1947-56 based upon linkage of series by Kaplan (Construction Review, May 1958) to Dodge Corp. information at 1950 ratio between the two series. 1969-70 developed from Dodge Corp. information listed in above source.

D13: Value Per Dwelling Start

source:	1947-57	"Construction Review," Dept. of Commerce, vol. 5, no. 1, Jan. 1959, p. 23.
	1958-60	ibid., vol. 19, no. 2, Feb. 1963, p. 14.
	1961-63	ibid., vol. 10, no. 12, Dec. 1964, p. 18.
	1964-66	ibid., vol. 13, no. 7, July 1967, p. 22.
	1967-68	ibid., vol. 15, no. 12, Dec. 1969, p. 22.
	1969-70	ibid., vol. 17, no. 8, Aug. 1971, p. 21.

description: Units in dollars of average value per single family home started.

D14: Cost Per Square Foot of Non-Residential Construction

source: Same as D12.

description: Units in dollar value per square foot of contracted floor area in non-residential construction.

D15: Number of Households

source:	1947-64	"18th Annual Report," Housing and Home Financing Agency, 1964, p. 395.
	1965-68	"Statistical Yearbook 1968," Dept. of Housing and Urban Development, p. 17.
	1969	ibid., "1969," p. 327.
	1970	"Household and Family Characteristics: March 1970," Population Characteristics, Bureau of Census, Current Pop Reports, series P-20, no. 218, March 1971, p. 76.

description: Units in thousands of total households.

D16: National Per Capita Income

source:	1947	"Survey of Current Business," Office of Business Economics, Dept. of Commerce, Aug. 1952, pp. 16-17.
	1948-70	ibid., Aug. 1971, pp. 30-31.

description: Units in dollars of disposable income per capita. 1947 adjusted by 1948 ratio of new/old data series.

D17-D20: Regional Per Capita Income

source: Derived from sources for D16.

description: Units in dollars of disposable income per capita for the following regional aggregations of source regions:
(1) Northeast = New England and Middle East
(2) Northcentral = Great Lakes and Plains
(3) South = Southeast
(4) West = Rocky Mountains and Far West (excluding Alaska and Hawaii)
Subregion per capita income aggregated by population wgts where population was derived as (total subregion income/per capita subregion income). 1947 adjusted by 1948 ratio of new/old series.

D21: Median Family Income

source:

1947, 50, 58-59	"Income in 1969 of Families and Persons in the United States," Consumer Income, Bureau of Census, Current Population Reports, series P-60, no. 75, Dec. 1970, p. 31.
1948-49, 51-56	Correspondence with Population Division, Bureau of Census, Wash., D.C.
1970	"Income in 1970 of Families and Persons in the United States," Consumer Income, Current Population Reports, series P-60, no. 80, Oct. 1971, p. 21.

description: Units in median dollars of income for families and unrelated individuals.

D22-D26: Population in Cities Larger than 100 Thousand

source: (1) population by city size,

1940, 50, 60	"Number of Inhabitants," United States Summary, United States Census of Population 1960, Bureau of Census, Dept. of Commerce, pp. 1-66, 1-67.
1970	"Statistical Abstract, 1971," Bureau of Census, Dept. of Commerce, p. 21.

(2) population by region,

1940, 50 60, 70	Same as D49 through D52.

description:	Units in thousands of regional or national population in cities larger than 100 thousand population. The percent of a particular region's population in cities above 100 thousand was calculated for dicennial census years, interpolated between census years, and applied to regional population estimates equaling the estimated population in cities above 100 thousand. The national estimate equals the sum of derived regional estimates.

D27: Index of Manufacturing Production

source:	1947-50	"Federal Reserve Bulletin," Federal Reserve Board, Jan. 1961, p. 86.
	1951-69	ibid., Dec. 1970, p. A-62.
	1970	ibid., Aug. 1971, p. A-64.

description:	Units in 1957-59 = 100 for physical volume of individual commodities weighted by their respective value-added. The earlier 1947-49 and the later 1967 index were adjusted to the 1957-59 index at their average link ratios of 1951-57 and 1969 respectively.

D28: Change in Manufacturing Production

source:	Derived from D27.
description:	Units in 1957-59 = 100. Calculated as index of production in year "x" minus index in year "x-1."

D29: Wholesale Price of Softwood Plywood

source:	1947-66	"Statistical Yearbook 1966," Dept. of Housing and Urban Development, pp. 41-42.
	1967-68	ibid., "1968," p. 75.
	1969	ibid., "1969," p. 389.
	1970	"Wholesale Prices and Price Indexes" (monthly issues), Bureau of Labor Statistics, Dept. of Labor.

description:	Units in dollars per thousand square feet fob mill (BLS 08-31). The annual index series was converted to dollars by the ratio of (1970 price/1970 index). The 1970 price equals an average of western plywood prices weighted by BLS weights. Southern pine price

quotes were not available and western species accounted for 87% of the 1970 softwood plywood component weights. 1970 index equals average of monthly quotes.

D30: **Wholesale** Price of Structural Steel

source: Same as D29.

description: Units in dollars per 100 lbs. fob mill (BLS 10-13-02-48). Series defined as "structural shapes, carbon steel, 6"x4"x1/2" angles 30 ft. long." Price index converted to price per unit at 1970 (price/index) ratio.

D31: **Wholesale** Price of Building Board

source: Same as D29.

description: Units in dollars per thousand sq. ft. fob mill (BLS 09-2). The price index series was converted to price per unit using the 1970 ratio based upon the insulation board and hardboard but excluding partical board which lacked price per unit quotes.

D32: **Wholesale** Price of Concrete Products

source: Same as D29.

description: Units in 1957-59 = 100 index (BLS 133). This series was not converted to price per unit because of its diverse content of concrete blocks, concrete tile, and ready-mix cement.

D33-D37: **Wages in Building** Construction

source: 1947-70 "Union Wages and Hours: Building Trades, July 1 (year)," an annual bulletin in the Bureau of Labor Statistics bulletin series, Dept. of Labor.

description: Units in dollars per hour, excluding fringe benefits, as specified in union contracts from representative cities larger than 100 thousand population. Average over all building trades for journeymen, helpers, and laborers. The nine subregions were aggregated into the same four regions as in D17-D20 through

weighting wages by subregion population. 1947-48 and 1962-63 subregion estimates made from linkage to representative cities within the region due to lack of reported data.

D38: Wholesale Price Index of All Construction Materials

source: Same as D29.

description: Units in 1957-59 = 100. A BLS composed special index including a large number of construction materials.

D39: Secondary Market Yield Rates on FHA Loans

source: 1949-70 Correspondence with Federal Housing Administration, Wash., D.C.

description: Units in percent yield on FHA home mortgages in the secondary market measured as the simple average of monthly quotes. 1947-48 estimated by extrapolating a moving average due to lack of data. This series moves very similar to the shorter FHA series on estimated interest rates on conventional home mortgages.

D40: Prime Lending Rate Charged by Banks

source: 1947-70 "Federal Reserve Bulletin," Federal Reserve Board, Dec. 1970, p. A-33.

description: Units in percent per annum calculated by weighting rates within a year by the number of days it was in affect to obtain the annual rate series.

D41: Rail Freight Revenue Per Ton-Mile

source: 1947-68 "Business Statistics," a supplement to Survey of Current Business, Office of Business Economics, Dept. of Commerce, 1969, p. 122.

1969-70 "Survey of Current Business," Office of Business Economics, Dept. of Commerce, Sept. 1971, p. S-24.

description: Units in dollars revenue per ton-mile on class I line haul railroads.

D42-D47: Population by Age Distribution

source:	1947-49	"Provisional Estimates of the Population of the Contential U.S.," Population Characteristics, Bureau of Census, Current Population Reports, series P-20, no. 38, Feb. 1950, pp. 5-6.
	1950-69	"Estimates of the Population of the United States, by Age, Race, and Sex; July 1, 1967 to July 1, 1969," Population Estimates and Projections, Bureau of Census, Current Population Reports, series P-25, no. 441, March 1970, p. 22.
	1970	"Projections of the Population of the United States, by Age and Sex (Interim Revisions): 1970-2020," Population Estimates and Projections, Bureau of Census, Current Population Reports, series P-25, no. 448, Aug. 1970, p. 10.

description: Units in thousands of individuals in respective age classes in United States, including armed forces overseas.

D48: National Population

source:	1947-70	"Statistical Abstract, 1971," Bureau of Census, Dept. of Commerce, p. 5.

description: Units in thousands of individuals in United States, excluding armed forces overseas.

D49-D52: Regional Population

source:	1947-51	"Statistical Abstract, 1953," Bureau of Census, Dept. of Commerce, p. 14.
	1952-62	ibid., "1963," p. 9.
	1963-68	ibid., "1970," p. 12.
	1969-70	ibid., "1971," p. 14.

description: Units in thousands of individuals in the four regions as developed from aggregation of subregions from source as shown,

(1) Northeast = New England and Mid-Atlantic
(2) Northcentral = East Northcentral and West Northcentral

(3) South = South Atlantic and East Southcentral
and West Southcentral
(4) West = Mountain and Pacific

D53: Population Mobility

source:	1948-70	"Mobility of the Population of the United States: March 1969 to March 1970," Population Characteristics, Bureau of Census, Current Pop. Reports, series P-20, no. 210, pp. 7-8.

description: Units in percent of the population which live in a different house than they did one year ago, including armed forces living off post or on post with their families. 1947 data unavailable individually so estimated at the average 1948-51 mobility rate.

D54-D56: Distribution of Families by Total Income

source:	1947, 50 58-70	"Income in 1970 of Families and Persons in the United States," Consumer Income, Bureau of Census, Current Population Reports, series P-60, no. 80, Oct. 1971, p. 23.
	1948-49, 51-57	Correspondence with the Bureau of Census, Wash., D.C.

description: Units in percent of the total families and unrelated persons found in the respective income classes where the income classes are measured in 1970 constant dollars.

D57-D58: Total Expenditures on Housing

source:	1947-65	"The National Income and Product Accounts of the United States, 1929-65," a supplement to the Survey of Current Business, Office of Business Economics, Dept. of Commerce, Aug. 1966, pp. 40-41.
	1966-69	"Survey of Current Business," Office of Business Economics, Dept. of Commerce, July 1970, p. 27.
	1970	ibid., June 1971, p. 11.

description: Units in billions of dollars of personal consumption expenditures spent on housing services, and said expenditures as a % of total personal consumption expenditures, respectively. Expenditures on housing equal to rental value or rental equivalent value of owner occupied homes.

D59-D64: Household Headship Rates by Age Distribution

source:

1947-70 Number of household heads, total and by age class, found in annual issues of Current Population Reports, series P-20, Bureau of Census, entitled "Household and Family Characteristics."

1947-70 Population by age classes taken from source as D42-D47.

description: Units in percent of the population in a given age class listed as household heads. Calculated by division of number of household heads of a given age by total population in that group.

Lumber Production

source:

1947, 49-70 "Lumber Production and Mill Stocks," Current Industrial Reports, series MA-24T, Bureau of Census, Dept. of Commerce, annual issues.

1948 From following sources for given species;

(1) Douglas-fir; "Historical Statistics of the United States; Colonial Times to 1957," a supplement to Statistical Abstract, Bureau of Census, 1960, p. 314.

(2) softwood and all species; ibid., p. 312.

(3) Southern pine; "Business Statistics," Office of Business Economics, Dept. of Commerce, 1969, p. 150.

(4) hemlock, fir, and larch; estimated by linkage to Southern pine plus Douglas-fir because of lack of data.

description: Units in million board feet. Estimates the domestic mill production based upon a sample survey. Structural species equals the sum of Douglas-fir, Southern pine, hemlock, fir, and larch.

Lumber Shipments from Sawmills

source: Components came from same source as listed in lumber production source above.

description: Units in million board foot. Shipments for industrial species is estimated by applying a (regional lumber shipment/regional lumber production) ratio to the species lumber production value. The regional production and shipment values which were applied to individual species is as follows:

(1) Douglas-fir, hemlock, larch, and fir;

1947-51	Northern Pacific lumber shipment/production ratio
1952-64	Douglas-fir region lumber shipment/production ratio
1965-70	Northern Pacific lumber shipment/production ratio
1948,57-59	ratio estimated by interpolation

(2) Southern pine;

1947-51, 65-70	Southern region lumber shipment/production ratio
1952-64	Actual mill stock levels were available for Southern pine from which stock changes were directly calculated.

Actual mill stock levels were available for softwood and all species aggregates so stock changes were directly calculated. Structural species equals sum of Douglas-fir, Southern pine, hemlock, fir, and larch.

Lumber Imports

source: (1) Individual species;

1947-63 "U.S. Imports for Consumption of Merchandise: Commodity by Country of Origin," Bureau of Census, Dept. of Commerce, Foreign Trade Report, no. FT110.

1964-70	"U.S. Imports of Merchandise for Consumption," Bureau of Census, Dept. of Commerce, Foreign Trade Report, no. FT125.

(2) softwood and all species aggregate;

1947-63	"The Demand and Price Situation for Forest Products, 1964," U.S.D.A. misc. pub. no. 983, Forest Service, U.S.D.A., Nov. 1964, p. 39.
1964-70	ibid., "1970-71," U.S.D.A. Misc. pub. no. 1195, May 1971, p. 59.

description: Units in million board feet. Douglas-fir, Southern pine, softwood, and all species aggregate reported in source individually. Larch reported separately except for 1960-63 when data was interpolated. 1947-63 hemlock and fir estimated by what was reported separately plus the ratio (hemlock (or fir)/fir-hem) times (hemlock (or fir)). 1964-70 data was reported separately for the two species. Structural species equals sum of Douglas-fir, Southern pine, larch, fir, and hemlock.

Lumber Exports

source: (1) Individual species;

1947-70	"United States Exports of Domestic and Foreign Merchandise: Commodity by Country of Destination (year)," Bureau of Census, Dept. of Commerce, Foreign Trade Report no. FT410.

(2) Softwood and all species aggregate;

same sources as for lumber imports except following page numbers;

1947-63	p. 39.
1964-70	p. 59.

description: Units in million board feet. Structural species equals the sum of Douglas-fir, Southern pine, fir, larch, and hemlock.

Apparent Lumber Consumption

source: Components from the above.

description: Units in million board feet. Calculated as (shipments + imports - exports). Structural species equals the sum of Douglas-fir, Southern pine, larch, hemlock, and fir.

E38: Wholesale Price of Douglas-fir Lumber

source:

1947-66	"Statistical Yearbook, 1966," Department of Housing and Urban Development, pp. 41-42.
1967-68	ibid., "1968," p. 75.
1969	ibid., "1969," p. 389.
1970	"Wholesale Prices and Price Indexes" (monthly issues), Bureau of Labor Statistics, Dept. of Labor.

BLS wholesale price indexes is the original source for all the above.

description: Units in dollars per thousand board feet (BLS 08-11-01). BLS procedure includes collecting price quotes of various types and grades of lumber and weighting these various products together into an index by value of output weights derived from census of manufacturers data, i.e. the weights are often held constant for a number of years. Specific product definitions change slightly but always represent prices fob mill at point of first commercial transaction. The BLS 1957-59 = 100 index series was converted to \$/Mfbm by the ratio of 1970;

(Douglas-fir lumber prices weighted by BLS weight/1957-59 = 100 index for Douglas-fir)

E39: Wholesale Price of Southern Pine Lumber

source: Same as E38.

description: Units in dollars per thousand board feet (BLS 08-11-02). Procedure essentially similar to that followed in E38.

E40: Wholesale Price of Structural Species Lumber

source: Components from E38, E39, and lumber consumption series.

description: Units in dollars per thousand board feet. Derived through weighting Douglas-fir and Southern pine lumber prices together by their respective consumption levels rather than the value weights utilized by BLS aggregation.

E41: Wholesale Price of Softwood Lumber, BLS Estimate

source: Correspondence with BLS, Wash., D.C.

description: Units in 1957-59 = 100 index. Calculated by weighting BLS Douglas-fir, Southern pine, and other softwood (BLS 08-11-03) series together by relative value of production weights.

E42: Wholesale Price of Softwood Lumber, Author Estimate

source: Components of price and consumption as described above.

description: Units in 1957-59 = 100 derived through weighting the three individual species groups together by their relative consumption levels rather than BLS value of product weights.

E43: Wholesale Price of All Lumber

source: Same as E38.

description: Units in 1957-59 = 100 (BLS 08-11). Derived by BLS essentially as described in E38 only for all species.

S1: Pacific Region Sawmill Wage Rates

source: Components for calculation from:

1947, 54, 58,63,67	"Census of Manufacturers (respective years)," Bureau of Census, Dept. of Commerce.
1950-53, 55-57, 59-62, 64-66	"Annual Survey of Manufacturers (respective years)," Bureau of Census, Dept. of Commerce.
1963-69	"The Demand and Price Situation for Forest Products, 1970-71," U.S.D.A. Misc. pub. no. 1195, Forest Service, U.S.D.A., May 1971, p. 49.

description: Units in dollars per hour derived through the division of total production worker wages by production worker man-hours. Specific years were derived in the following manner:

(1) 1948-49	estimated by interpolation
(2) 1947,50-57	Pacific region, SIC code 24
(3) 1958-67	Pacific region, SIC code 242
(4) 1968-69	Washington state, SIC code 242
(5) 1970	estimated by the 1966-69 trend because of data unavailability

S2: Southern Region Sawmill Wage Rates

source: Same as S1.

description: Units in dollars per hour as calculated in S1 above with specific years taken as the following:

(1) 1948-49	estimated by interpolation of Southern region, SIC 24
(2) 1947-57	Southern region, SIC 24 linked to Southern region, SIC 242 at average 1954, 58-60 ratio of 0.9581.
(3) 1958-67	Southern region, SIC 242
(4) 1968-69	Arkansas, SIC 24 linked to Southern region SIC 242 at average 1963-67 ratio of 0.9302.
(5) 1970	estimated at 1963-67 trend because of lack of data.

S3: Pacific and Southern Region Sawmill Wage Rates

source: Components from S1, S2, and lumber consumption.

description: Units in dollars per hour derived through the weighting of Pacific and Southern region wages (S1 and S2 respectively) by their respective regional lumber production ratios.

S4: Sawmill Work Stoppages

source: Components from an annual issue in the BLS bulletin series. The annual issue is entitled, "Work stoppages caused by Labor-Management Disputes in (years)," Bureau of Labor Statistics, Dept. of Labor.

description: Units in number of man-day idle per production worker as calculated by the division of respective totals. Idle days are measured for all disputes that entail stoppages of more than one 8 hr. shift and involving six or more men. Includes those idle in other departments due to the stoppage (SIC 242).

S6-S9: Average Sawmill Size

source: Components for calculation from:

1947,54, 58,63,67 "Census of Manufacturers (respective years)," Bureau of Census, Dept. of Commerce.

description: Units in thousands of dollars value-added per establishment, SIC 2421 calculated by division of total value-added by no. of establishments. The ratio resulting from this division is interpolated and extrapolated respectively to estimate between census years and 1968-70. Regional series calculated as:

(1) Pacific region; ratio for entire Pacific region.

(2) Southern region; the individual ratio for the three Southern subregions weighted by respective lumber production.

(3) Pacific and Southern region; Pacific and Southern region ratio series weighted by respective lumber production.

(4) U.S.; each region's ratio weighted by respective lumber production.

S10: New Capital Expenditure Per Man-Hour in Sawmills

source: 1947-57 "Census of Manufacturers, 1958," Bureau of Census, Dept. of Commerce.

1958-67 ibid., "1967."

1968-69 "Annual Survey of Manufacturers (respective year)," Bureau of Census, Dept. of Commerce.

description: Units in dollars of new capital per man-hour derived by the division of respective totals.

(1) 1947-53 SIC 24 linked to SIC 2421 at average 1954-58 link ratio.

(2) 1954-69	SIC 2421
(3) 1970	estimated by extrapolation due to lack of data.

S11: Pacific Region Sawmill Productivity

source:

1947,54 58,63,67	"Census of Manufacturing (respective years)," Bureau of Census, Dept. of Commerce.
1950-53, 55-57, 59-62, 64-66, 68-69	"Annual Survey of Manufacturers (respective years)," Bureau of Census, Dept. of Commerce.

description: Units in dollars of value-added per man-hour derived through division of the total value-added by total production worker man-hours with the following specifications:

(1) 1948	estimated by interpolation of Pacific region SIC 24
(2) 1947,49-57	Pacific region SIC 24
(3) 1958-67	Pacific region SIC 242
(4) 1968-69	National SIC 2421 linked to Pacific region 242 at 1963-67 average ratio
(5) 1970	estimated at 1966-69 trend due to lack of data.

S12: Southern Region Sawmill Productivity

source: Same as S11.

description: Units in dollars value-added per man-hour derived by division of respective totals for following specifications:

(1) 1947-57	Southern region SIC 24 linked to Southern region SIC 242 at average 1958-60, 63, and 67 link ratios.
(2) 1948	By interpolation.
(3) 1958-67	Southern region SIC 242
(4) 1968-69	National SIC 2421 linked to Southern region SIC 242 at average 1963-67 link ratios.
(5) 1970	estimated at 1966-69 trend due to lack of data.

S13: Pacific and Southern Region Sawmill Productivity

source: Components from S11 and S12.

description: Units in dollars value-added per production man-hour derived by weighting the Pacific region and Southern region series by respective regional lumber production.

S14: National Sawmill Productivity

source:

1947-57	"Census of Manufacturers, 1958," Bureau of Census, Dept. of Commerce.
1958-67	ibid., "1967."
1968-69	"Annual Survey of Manufacturers (respective years)," Bureau of Census, Dept. of Commerce.

description: Units in dollars of value-added per production worker man-hour derived by division of respective totals for SIC 2421. 1948 was estimated by interpolation and 1970 estimated at 1966-69 trend due to lack of data.

S15-S16: Regional Electricity Price

source:

1947-69	"Statistics of Privately Owned Electric Utilities in the United States (respective years)," Federal Power Commission, sections IV on "electric operating revenues, customers, and sales."

description: Units in dollars per kilowatt-hour derived as in S17 where the Pacific region is calculated by all A and B class private operators in Washington and Oregon.

S17: National Electricity Price

source:

1947-57	"Statistics of Privately Owned Electric Utilities in the United States, 1957," Federal Power Commission, p. XXXIII.
1958-64	ibid., "1964,", p. XXX.
1965-69	ibid., "1969,", p. XXIX.

description: Units in dollars per kilowatt-hour derived by division of total revenue from sale of electricity to commercial and industrial consumers by the respective total kilowatt-hours sold. Data is restricted to private A and B class producers.

S18: Wholesale Price of Power and Fuels

source:	1947-68	"Business Statistics, 1969," Office of Business Economics, Dept. of Commerce, Sept. 1969, p. 45.
	1969-70	"Wholesale Prices and Price Indexes," Bureau of Labor Statistics, Dept. of Labor, Jan. 1970.

description: Units in 1957-59 = 100 (BLS 05) on an aggregate series composed of items such as coal, gas, petroleum, crude petroleum, coke, and electricity.

S19: Douglas-fir Sawlog Price

source:	1947-49	"Price Trends and Relationships for Forest Products," 85th Congress, 1st session, House Document no. 195, 1957, p. 53.
	1950-69	"The Demand and Price Situation for Forest Products, 1970-71," U.S.D.A., Misc. Pub. no. 1195, Forest Service, U.S.D.A., May 1971, p. 45.
	1970	Correspondence with the Forest Service, Wash., D.C.

description: Units in dollars per thousand board feet for log transactions that occur at a number of points along the distribution process.

S20: Softwood Sawlog Price

source:	1947-70	Work conducted by Daniel Talhelm and Irving Holland concerning supply and demand functions for forest products, not yet completed.

description: Units in 1957-59 = 100 index derived by a weighted average of Douglas-fir, Southern pine, ponderosa pine, white fir, eastern white and red pine, cypress, cedar, and eastern hemlock. Weights used were 1959 value of production levels. The S20 annual series is a simple average of the above sourced monthly observations.

S21: All Species Sawlog Price

source: 1947-70 Hardwood and softwood price index series from same source as S20 and lumber production weights from previously described source.

description: Units in 1957-59 = 100 derived by weighting the S20 softwood price index and a similar hardwood price index series (composed of oak, gum, maple, poplar, cottonwood and aspen, basswood, birch, beech, cherry, and ash weighted by their respective 1958-59 value of production) weighted together by their respective lumber production.

S22: Pacific Region Precipitation Level

source: 1947-70 "Climatological Data" (annual summaries), Environmental Data Service, National Oceanic and Atmospheric Administration, Dept. of Commerce.

description: Units in inches of annual precipitation. 1947-56 is a simple average of Washington and Oregon precipitation and 1957-70 is a simple average of nine and ten substate areas respectively with the resulting state totals averaged.

S23: Southern Softwood Chip Production Residues Used in Pulping

source: Annual U.S. Forest Survey releases from the Southern and Southeastern Forest Experiment Stations entitled,

1947	"Pulpwood Production in Southern Forest Survey Territory (year)."
1953-57	"(year), Pulpwood Production in the South"
1958-70	"Southern Pulpwood Production (year)"

description: Units in thousands of softwood chips from sawmills utilized in pulping. However, especially in recent years it contains an unknown amount of roundwood chipped away from the pulp mill site. Excludes other residues.

S24: Chipped Residues used in All U.S. Pulp Mills

source:	1947-49	"The Demand and Price Situation for Forest Products, 1964," U.S.D.A. misc. pub. no. 984, Forest Service, U.S.D.A., Nov. 1964, p. 41.
	1950-70	"The Demand and Price Situation for Forest Products, 1970-71," U.S.D.A. misc. pub. no. 1195, Forest Service, U.S.D.A., May 1971, p. 66.

description: Units in thousands of cords of chipped residues used in pulping from sawmills, veneer mills, and other wood-using industries. However, especially in the South, the past few years contains some roundwood chipped away from the pulpmill site.

S25: U.S. Lumber Import Tariff

source:	1947-61	"Softwood Lumber," U.S. Tariff Commission, T.C. pub. no. 79, Feb. 1963, p. 78.
	1962-70	"Tariff Schedules of the United States Annotated (year)," U.S. Tariff Commission.

description: Units in dollars per thousand board feet tariff charged on the following species and corresponding codes;

(1) Douglas-fir	202.15
(2) fir	202.18
(3) hemlock	202.21
(4) larch	202.24

S26: U.S.-Canada Money Exchange Rate

source:	1947-48	"Federal Reserve Bulletin," Federal Reserve Board, Dec. 1949, p. 1529.
	1949-53	ibid., Feb. 1954, p. 229.
	1954-58	ibid., Oct. 1959, p. 1337.
	1959-63	ibid., Jan. 1964, p. 132.
	1964-65	ibid., June 1966, p. 926.
	1966-70	ibid., June 1971, p. A89.

description: Units in U.S. cents per Canadian dollar.

S27: Canadian Lumber Production

source:	1947	"The Canada Yearbook, 1951," Dominion Bureau of Statistics, Dept. of Trade and Commerce, p. 456.
	1948-49	ibid., "1952-53," p. 465.
	1950-69	"The Demand and Price Situation for Forest Products, 1970-71," U.S.D.A. misc. pub. no. 1195, Forest Service, U.S.D.A., May 1971, p. 61.
	1970	Estimated by linking Canadian production to British Columbia production at the average 1965-69 ratio of 1.46.

description: Units in billion board feet of lumber production.

S28: British Columbia Lumber Production

source:	1947-69	Same as for S27.
	1970	"Production, Shipments, and Stocks on Hand of Sawmills in British Columbia," Dominion Bureau of Statistics, vol. 24, no. 12, p. 3.

description: Units in billion board feet lumber production.

S29-S32: Volume of Timber Sold from National Forests

source: Correspondence with the U.S. Forest Service, Wash., D.C.

description: Units in million board feet of timber sold from National Forests. To better estimate immediate impact upon lumber markets, four large sales in Alaska (region 10) were excluded (1952, 55, 58, and 59) and data was interpolated in its place.

S33-S35: U.S. Forest Service Congressional Appropriations

source:	1947-70	"The Budget of the United States" (annual issues), U.S. Government Printing Office.

description: Units in million dollars of appropriations.

S36: Douglas-fir Stumpage Price

source:	1947-49	"The Demand and Price Situation for Forest Products, 1964," U.S.D.A. misc. pub. no. 984, Forest Service, U.S.D.A., Nov. 1964, p. 33.
	1950-69	"The Demand and Price Situation for Forest Products, 1970-71," U.S.D.A. misc. pub. no. 1195, Forest Service, U.S.D.A., May 1971, p. 41.
	1970	Correspondence with U.S. Forest Service, Wash., D.C.

description: Units in dollars per thousand board feet. 1947-56 data entails Forest Service and Bureau of Land Management sales of Douglas-fir in Western Washington and Western Oregon. 1957-70 entails only Forest Service sales from the same area.

S37: Southern Pine Stumpage Price

source: Same as for S38.

description: Units in dollars per thousand board feet. 1947-49 data entails Forest Service sales of all species in the Southern region. 1950-70 entails Forest Service sales of pine alone in Southern region.

S38: Average Forest Service Stumpage Price

source: Components from correspondence with the U.S. Forest Service, Wash., D.C.

description: Units in dollars per thousand board feet as calculated by the division of total dollar sales by volume of the sales made on National Forests. Alaskan sales in 1952, 55, 58, and 69 were excluded and data interpolated in their place due to the very long term nature of the sales and their relative low price.

S39: Timber Access Road Construction Expenditures

source: Correspondence with U.S. Forest Service, Wash., D.C.

description: Units in thousands of dollars of government and purchase costs for construction and reconstruction of timber access roads. 1947-51 observations set equal the annual average 1940-51 rate due to lack of anything except a total figure for 1940-51. Source recorded fiscal year data for year "x," recorded on enclosed table as calendar year "x."

S40-S51: Sawtimber Inventory Volume by Region and Ownership

source:

1945	"Gaging the Timber Resources of the United States," report no. 1 from "A Reappraisal of the Forest Situation," Forest Service, U.S.D.A., 1946, p. 54.
1953	"Timber Resources for America's Future," Forest Resource Report no. 14, Forest Service, U.S.D.A., Jan. 1958, pp. 554-555.
1963	"Timber Trends in the United States," Forest Resource Report no. 17, Forest Service, U.S.D.A., Feb. 1965, pp. 156-157.
1970	Preliminary results from correspondence with the U.S. Forest Service, Wash., D.C.

description: Units in billion board feet with years between the above sourced years estimated by straight line interpolation.

S52-S54: Volume of Log Exports

source:

1947-49	Same source as for lumber exports.
1950-70	"The Demand and Price Situation for Forest Products, 1970-71," U.S.D.A. misc. pub. no. 1195, Forest Service, U.S.D.A., May 1971, p. 50.

description: Units in million board feet.

S55: Douglas-fir Peeler Log Price

source: Same as S19 except 1950-69 from p. 75 of same source.

description: Units in dollars per thousand board feet, average over all grades.

S56: All Species Peeler Log Price

source: (1) Peeler log price components of the aggregate from:
(a) Douglas-fir in S35 converted to a 1957-59 = 100 index used as a softwood series.
(b) Hardwood peeler log price series from the study by Talhelm and Holland cited for S20. A simple annual average of monthly observations by Talhelm and Holland of a hardwood series composed of maple, walnut, birch, gum, and oak weighted by 1957-59 value of output.
(2) Veneer log production used to weight the hard and soft price series found in:

1947	"The Demand and Price Situation for Forest Products, 1964," U.S.D.A. misc. pub. no. 983, Forest Service, U.S.D.A., Nov. 1964, p. 44.
1951-70	"The Demand and Price Situation for Forest Products, 1970-71," U.S.D.A. misc. pub. no. 1195, Forest Service, U.S.D.A., May 1971, p. 75.

description: Units in 1957-59 = 100 as calculated by weighting the hard and softwood price indexes by their respective veneer production. 1948-50 veneer production estimated by interpolation.

S57: Southern Pine Pulpwood Price

source:

1947-62	"The Demand and Price Situation for Forest Products, 1964," U.S.D.A. misc. pub. no. 983, Forest Service, U.S.D.A,, Nov. 1964, p. 43.
1963-69	"The Demand and Price Situation for Forest Products, 1970-71," U.S.D.A., misc. pub. no. 1195, Forest Service, U.S.D.A., May 1971, p. 68.
1970	Correspondence with U.S. Forest Service, Wash., D.C.

description: Units in dollars per standard cord calculated as the simple average of Mid-South and Southeast price series where each series represents price quotas at a number of different delivery points.

S58: Softwood Pulpwood Price

source: The study by Talhelm and Holland cited for S20.

description: Units in 1957-59 = 100 derived by taking a simple average of monthly quotes from source for aggregate series calculated from Southern softwood pulp series (Southern pine) from a no. of subregions, Northern species (spruce-fir, hemlock, pine, and tamarack) from a no. of states, and western species (fir and hemlock) all weighted together by 1957-59 value of output.

S59: All Species Pulpwood Price

source: (1) Pulpwood price components from:
- (a) Softwood price from S58.
- (b) Hardwood price from Talhelm and Holland study cited in S20. Average monthly price of a series composed of Southern and Northern price quotes on hardwood pulpwood prices weighted by 1957-59 value of output weights.

(2) Pulpwood production used to weight the hardwood and softwood series from:
- 1947-49 Same as S24 except p. 42.
- 1950-70 Same as S24 except p. 66.

description: Units in 1957-59 = 100 calculated by weighting the hardwood and softwood price series by respective pulpwood production.

T1-T2: Transportation Work Stoppages

source: Same source as S4.

description: Units in thousand man-days of work stoppages in the respective transportation industries. Entails data as described in S4.

T3: Lumber Freight Rates from West Coast to New York

source: The Talhelm and Holland study cited for S20.

description: Units in dollars per hundred pounds for sending lumber by rail from the West Coast to New York.

T4: Rail Revenue Per Ton-Mile

source:	1947-68	"Business Statistics, 1969," a supplement to Survey of Current Business, Office of Business Economics, Dept. of Commerce, p. 122.
	1969-70	"Survey of Current Business," Office of Business Economics, Dept. of Commerce, Sept. 1971, p. S-24.

description: Units in revenue per ton-mile on class I line haul railroads.

B1: All Commodity Wholesale Price Index

source:	1947-69	"Handbook of Labor Statistics, 1970," Bulletin no. 1666, Bureau of Labor Statistics, Dept. of Labor.
	1970	"Wholesale Prices and Price Indexes, Jan. 1971," Bureau of Labor Statistics, Dept. of Labor, p. 29.

description: Units in 1957-59 = 100.

B2: United States Population

source: Identical series to D48.

description: Units in thousands. Description as D48.

B3: Gross National Product

source:	1947-66	"Business Statistics, 1967," Office of Business Economics, Dept. of Commerce, p. 3.
	1967-70	"Survey of Current Business," Office of Business Economics, Dept. of Commerce, July 1971, p. 14.

description: Units in billion dollars.

B4: Disposable Personal Income

source:	1947-70	"Economic Report of the President," Government Printing Office, Feb. 1971, p. 25.

description: Units in billion dollars.

APPENDIX C

ESTIMATED SUPPLY AND DEMAND POSITION AT AN ASSUMED PRICE OF $100/Mfbm, 1947-70

TABLE C1. ESTIMATED SUPPLY AND DEMAND FOR DOUGLAS-FIR LUMBER AT $100/MFBM, 1947-70

YEAR	DEMAND	% CHANGE DEMAND	% DIF FROM MEAN DEMAND	SUPPLY	% CHANGE SUPPLY	% DIF FROM MEAN SUPPLY
1947	8.26		-14.63	8.44		-2.92
1948	9.62	16.44	-0.59	9.11	7.85	4.70
1949	9.22	-4.14	-4.71	9.67	6.18	11.17
1950	10.52	14.01	8.64	8.52	-11.89	-2.04
1951	10.48	-0.37	8.24	8.18	-3.98	-5.94
1952	10.31	-1.64	6.46	8.80	7.59	1.20
1953	10.78	4.58	11.34	9.66	9.74	11.06
1954	10.62	-1.44	9.74	9.69	0.35	11.45
1955	11.08	4.27	14.43	8.71	-10.20	0.08
1956	10.54	-4.81	8.93	8.58	-1.42	-1.34
1957	10.13	-3.91	4.67	9.99	16.37	14.81
1958	9.94	-1.87	2.71	10.21	2.24	17.39
1959	10.14	2.02	4.79	9.58	-6.15	10.16
1960	9.49	-6.42	-1.94	9.73	1.51	11.83
1961	9.47	-0.21	-2.15	9.73	0.07	11.90
1962	9.46	-0.09	-2.24	9.20	-5.51	5.74
1963	9.56	1.05	-1.22	8.88	-3.48	2.06
1964	9.36	-2.17	-3.36	8.98	1.13	3.21
1965	9.32	-0.38	-3.73	8.87	-1.19	1.98
1966	8.84	-5.15	-8.68	8.90	0.29	2.28
1967	8.51	-3.75	-12.11	8.09	-9.02	-6.95
1968	9.39	10.33	-3.03	5.70	-29.61	-34.49
1969	9.29	-1.07	-4.07	4.11	-27.86	-52.74
1970	7.99	-13.97	-17.47	7.43	80.71	-14.60
ABSOLUTE AVERAGE	9.68	4.53		8.70	10.62	

TABLE C2. ESTIMATED SUPPLY AND DEMAND FOR SOUTHERN PINE LUMBER AT $100/MFBM, 1947-70

YEAR	DEMAND	% CHANGE DEMAND	% DIF FROM MEAN DEMAND	SUPPLY	% CHANGE SUPPLY	% DIF FROM MEAN SUPPLY
1947	8.58		23.78	8.44		30.28
1948	8.82	2.86	27.32	8.24	-2.38	27.17
1949	8.31	-5.84	19.89	8.20	-0.50	26.54
1950	8.84	6.40	27.57	8.14	-0.76	25.58
1951	8.48	-4.06	22.38	7.53	-7.44	16.24
1952	8.17	-3.67	17.89	6.82	-9.44	5.26
1953	7.64	-6.44	10.30	6.82	-0.01	5.25
1954	7.41	-3.10	6.88	6.78	-0.63	4.59
1955	7.16	-3.26	3.40	6.57	-3.05	1.40
1956	6.50	-9.21	-6.12	6.10	-7.20	-5.90
1957	6.10	-6.29	-12.03	6.01	-1.41	-7.22
1958	5.97	-2.03	-13.81	5.99	-0.33	-7.53
1959	6.03	0.98	-12.97	5.55	-7.30	-14.28
1960	5.53	-8.37	-20.26	5.40	-2.79	-16.67
1961	5.54	0.28	-20.03	5.76	6.76	-11.04
1962	6.10	10.15	-11.91	6.16	6.91	-4.89
1963	6.21	1.75	-10.37	6.26	1.60	-3.37
1964	6.33	1.92	-8.65	6.15	-1.81	-5.13
1965	6.51	2.84	-6.06	6.09	-0.88	-5.96
1966	6.44	-1.07	-7.06	6.00	-1.51	-7.38
1967	6.47	0.53	-6.57	5.92	-1.39	-8.66
1968	6.73	3.89	-2.94	5.55	-6.15	-14.28
1969	6.41	-4.68	-7.48	5.40	-2.75	-16.64
1970	6.02	-6.13	-13.15	5.61	3.89	-13.39
ABSOLUTE AVERAGE	6.93	4.16		6.48	3.34	

TABLE C3. ESTIMATED SUPPLY AND DEMAND FOR STRUCTURAL SPECIES LUMBER AT $100/MFBM, 1947-70

YEAR	DEMAND	% CHANGE DEMAND	% DIF FROM MEAN DEMAND	SUPPLY	% CHANGE SUPPLY	% DIF FROM MEAN SUPPLY
1947	19,53		-8,71	18,42		-8,15
1948	21,07	7,88	-1,52	19,85	7,74	-1,04
1949	21,02	-0,23	-1,75	19,97	0,62	-0,43
1950	22,97	9,25	7,34	20,42	2,25	1,81
1951	22,00	-4,22	2,81	20,04	-1,86	-0,08
1952	21,38	-2,83	-0,10	19,70	-1,73	-1,80
1953	22,08	3,31	3,21	19,85	0,76	-1,06
1954	20,98	-4,98	-1,94	20,38	2,67	1,59
1955	22,45	6,96	4,89	20,11	-1,32	0,24
1956	21,66	-3,48	1,24	19,00	-5,51	-5,28
1957	21,18	-2,26	-1,05	20,16	6,11	0,51
1958	20,97	-0,97	-2,00	21,86	8,42	8,96
1959	22,22	5,94	3,82	20,86	-4,56	3,99
1960	20,78	-6,48	-2,91	20,86	-0,01	3,98
1961	20,95	0,82	-2,11	21,05	0,91	4,93
1962	21,52	2,73	0,57	21,11	0,29	5,24
1963	21,62	0,47	1,03	21,91	3,79	9,23
1964	22,03	1,91	2,97	21,82	-0,39	8,79
1965	22,33	1,35	4,34	21,56	-1,22	7,47
1966	21,67	-2,96	1,25	21,10	-2,11	5,21
1967	20,56	-5,02	-3,84	19,72	-6,57	-1,71
1968	21,72	5,54	1,49	18,01	-8,65	-10,21
1969	21,41	-1,40	0,07	14,88	-17,37	-25,80
1970	19,45	-9,17	-9,10	18,78	26,17	-6,38
ABSOLUTE AVERAGE	21,40	3,92		20,06	4,83	

APPENDIX D

PROJECTED EXOGENOUS VARIABLES

TABLE D1. PROJECTED EXOGENOUS VARIABLES

YEAR	P1 NO. OF HOUSEHOLDS (THOU)	P2 SOFTWOOD PLYWOOD PR ($/M SQ FT)	P3 STRUCTURAL STEEL ($/100 LBS)	P4 BUILDING BOARD PR ($/M SQ FT)	P5 SECONDARY MKT FHA YIELDS (%)	P6 POP MOBILITY (ANNUAL %)	P7 FAMILY INC $5000-$9999 (% FAMILIES)	P8 HOUSE HEAD 0-24 YR (% POP CLASS)	P9 CHANGE MFCT ACTIVITY (1957-59=100)
1971	64315	68.70	6.40	68.79	8.20	18.30	29.0	4.7	4.5
1972	65756	68.40	6.45	68.17	7.15	18.40	28.0	4.9	4.5
1973	67197	68.10	6.49	67.55	7.37	18.40	27.0	5.0	4.5
1974	68638	67.80	6.53	66.93	7.59	18.50	26.0	5.2	4.5
1975	70079	67.50	6.57	66.31	7.81	18.60	25.0	5.4	4.5
1976	71523	67.20	6.62	65.69	8.03	18.70	24.0	5.4	4.5
1977	72957	66.90	6.66	65.07	8.25	18.70	23.0	5.5	4.5
1978	74411	66.60	6.70	64.45	8.47	18.80	22.0	5.5	4.5
1979	75855	66.30	6.74	63.83	8.69	18.80	21.0	5.6	4.5
1980	77299	66.00	6.79	63.21	8.91	18.90	20.0	5.6	4.5
1981	78532	65.70	6.83	62.59	9.13	18.90	19.0	5.5	4.5
1982	80055	65.40	6.87	61.97	9.35	19.00	18.0	5.4	4.5
1983	81448	65.10	6.91	61.35	9.57	19.00	17.0	5.3	4.5
1984	82831	64.80	6.96	60.73	9.79	19.00	16.0	5.2	4.5
1985	84214	64.50	7.00	60.11	10.01	19.00	15.0	5.1	4.5
1986	85333	65.50	7.06	60.73	10.23	18.90	14.0	4.9	4.5
1987	86552	66.50	7.13	61.35	10.50	18.90	13.0	4.8	4.5
1988	87721	67.50	7.20	61.97	10.50	18.80	12.0	4.6	4.5
1989	88890	68.50	7.26	62.59	10.50	18.80	11.0	4.4	4.5
1990	90059	69.50	7.33	63.21	10.50	18.70	10.0	4.2	4.5
1991	90817	70.50	7.40	63.83	10.50	18.70	9.0	4.0	4.5
1992	91575	71.50	7.46	64.45	10.50	18.60	8.0	3.8	4.5
1993	92333	72.50	7.53	65.07	10.50	18.60	7.0	3.6	4.5
1994	93091	73.50	7.60	65.69	10.50	18.50	6.0	3.4	4.5
1995	93849	74.50	7.66	66.31	10.50	18.50	5.0	3.2	4.5
1996	94840	75.50	7.73	66.93	10.50	18.50	4.0	3.0	4.5
1997	95831	76.50	7.80	67.55	10.50	18.50	3.0	2.8	4.5
1998	96822	77.50	7.86	68.17	10.50	18.60	2.0	2.5	4.5
1999	97813	78.50	7.93	68.79	10.50	18.60	1.0	2.3	4.5
2000	98804	79.50	8.00	69.41	10.50	18.60	0.0	2.1	4.5

TABLE D1. (CONTINUED)

YEAR	P10 SAW EST SIZE PAC REG ($THOU VA/EST)	P11 SAW EST SIZE SO REG ($THOU VA/EST)	P12 DOUGLAS-FIR SAWLOG PR ($/MFBM)	P13 SOFTWOOD SAWLOG PR (1957,59=100)	P14 SAW CHIP VOL SO PINE (THOU CORDS)	P15 US LU TARIFFS ($/MFBM)	P16 US-CANADA MONEY EXCHANGE RATE (CENTS US/$ CANADA)
1971	800.0	150.0	78.21	118.0	6348.1	0.0	100.0
1972	835.0	185.0	80.16	120.0	6476.6	0.0	100.0
1973	855.0	200.0	82.11	122.0	6605.1	0.0	100.0
1974	890.0	230.0	84.06	124.0	6733.6	0.0	100.0
1975	910.0	250.0	86.01	126.0	6862.1	0.0	100.0
1976	935.0	280.0	87.96	128.0	6990.6	0.0	100.0
1977	950.0	300.0	89.91	130.0	7119.1	0.0	100.0
1978	965.0	315.0	91.86	132.0	7247.6	0.0	100.0
1979	980.0	340.0	93.81	134.0	7376.1	0.0	100.0
1980	1000.0	355.0	95.76	136.0	7504.6	0.0	100.0
1981	1000.0	380.0	97.71	138.0	7633.1	0.0	100.0
1982	1000.0	390.0	99.66	140.0	7761.6	0.0	100.0
1983	1000.0	405.0	101.61	142.0	7890.1	0.0	100.0
1984	1000.0	415.0	103.56	144.0	8018.6	0.0	100.0
1985	1000.0	440.0	105.51	146.0	8147.1	0.0	100.0
1986	1000.0	455.0	106.50	147.0	8275.6	0.0	100.0
1987	1000.0	460.0	107.50	148.0	8404.1	0.0	100.0
1988	1000.0	480.0	108.50	149.0	8532.6	0.0	100.0
1989	1000.0	490.0	109.50	150.0	8661.1	0.0	100.0
1990	1000.0	500.0	110.50	151.0	8789.6	0.0	100.0
1991	1000.0	500.0	111.50	152.0	8918.1	0.0	100.0
1992	1000.0	500.0	112.50	153.0	9046.6	0.0	100.0
1993	1000.0	500.0	113.50	154.0	9175.1	0.0	100.0
1994	1000.0	500.0	114.50	155.0	9303.6	0.0	100.0
1995	1000.0	500.0	115.50	156.0	9432.1	0.0	100.0
1996	1000.0	500.0	116.50	157.0	9560.6	0.0	100.0
1997	1000.0	500.0	117.50	158.0	9689.1	0.0	100.0
1998	1000.0	500.0	118.50	159.0	9817.6	0.0	100.0
1999	1000.0	500.0	119.50	160.0	9946.1	0.0	100.0
2000	1000.0	500.0	120.50	161.0	10074.6	0.0	100.0

TABLE D1. (CONTINUED)

YEAR	P17 SCI LU PROD (BIL FBM)	P18 DOUGLAS-FIR LOG EXPORTS (MIL FBM)	P19 SOFTWOOD LOG EXPORTS (MIL FBM)	P20 DOUGLAS-FIR PEELER LOG PR ($/MFBM)	P21 SO PINE PULPWOOD PR ($/CORD)	P22 SOFTWOOD PULPWOOD PR (1957-59=100)	P23 LU RAIL RATES WEST COAST-NY ($/100 LBS)
1971	8.1	552.7	2889.0	117.00	17.76	117.00	1.45
1972	8.6	617.7	3094.0	120.00	17.92	118.00	1.45
1973	9.0	682.7	3299.0	123.00	18.08	119.00	1.45
1974	9.4	747.7	3504.0	126.00	18.24	120.00	1.45
1975	9.9	812.7	3709.0	129.00	18.40	122.00	1.45
1976	10.3	877.7	3914.0	132.00	18.56	123.00	1.45
1977	10.7	942.7	4119.0	135.00	18.72	124.00	1.45
1978	11.1	1007.7	4324.0	138.00	18.88	125.00	1.45
1979	11.6	1072.7	4529.0	141.00	19.04	126.00	1.45
1980	12.0	1138.0	4734.0	144.00	19.20	127.00	1.45
1981	12.4	1183.0	4884.0	147.00	19.36	128.00	1.45
1982	12.6	1228.0	5034.0	150.00	19.52	129.00	1.45
1983	12.8	1273.0	5184.0	153.00	19.68	130.00	1.45
1984	13.0	1318.0	5334.0	156.00	19.84	131.00	1.45
1985	13.1	1363.0	5484.0	159.00	20.00	132.00	1.45
1986	13.2	1408.0	5634.0	161.00	20.19	133.00	1.45
1987	13.4	1453.0	5784.0	163.00	20.38	135.00	1.45
1988	13.4	1498.0	5934.0	165.00	20.57	136.00	1.45
1989	13.5	1543.0	6084.0	167.00	20.76	137.00	1.45
1990	13.5	1553.0	6234.0	169.00	20.95	138.00	1.45
1991	13.5	1563.0	6309.0	171.00	21.14	139.20	1.45
1992	13.4	1573.0	6384.0	173.00	21.33	140.40	1.45
1993	13.4	1583.0	6459.0	175.00	21.52	141.60	1.45
1994	13.2	1593.0	6534.0	177.00	21.71	142.80	1.45
1995	13.1	1603.0	6609.0	179.00	21.90	144.00	1.45
1996	13.0	1613.0	6684.0	181.00	22.09	145.20	1.45
1997	12.8	1623.0	6759.0	183.00	22.28	146.40	1.45
1998	12.6	1633.0	6834.0	185.00	22.47	147.60	1.45
1999	12.4	1643.0	6909.0	187.00	22.66	148.80	1.45
2000	12.0	1653.0	6984.0	189.00	22.85	150.00	1.45

TABLE D1. (CONTINUED)

YEAR	P24 FHA YIELD ALTER 1 (%)	P25 FHA YIELD ALTER 2 (%)	P26 DOUG LOG PR ALTER 1 ($/MFBM)	P27 SOFT LOG PR ALTER 1 (1957-59=100)	P28 DOUG LOG EXP ALTER 1 (MIL FBM)	P29 DOUG LOG EXP ALTER 2 (MIL FBM)	P30 SOFT LOG EXP ALTER 1 (MIL FBM)	P31 SOFT LOG EXP ALTER 2 (MIL FBM)
1971	8.20	8.20	77.5	118.0	504.5	0.0	2744.0	0.0
1972	7.15	7.15	78.7	120.0	521.0	0.0	2804.0	0.0
1973	7.00	6.15	79.9	122.0	537.5	0.0	2864.0	0.0
1974	7.00	5.07	81.2	123.3	554.0	0.0	2924.0	0.0
1975	7.00	4.00	82.4	124.7	570.5	0.0	2984.0	0.0
1976	7.00	3.00	83.6	126.0	587.0	0.0	3044.0	0.0
1977	7.00	3.00	84.9	127.3	603.5	0.0	3104.0	0.0
1978	7.00	3.00	86.1	128.6	620.0	0.0	3164.0	0.0
1979	7.00	3.00	87.3	130.0	636.5	0.0	3224.0	0.0
1980	7.00	3.00	88.6	131.3	653.0	0.0	3284.0	0.0
1981	7.00	3.00	89.8	132.6	669.5	0.0	3309.0	0.0
1982	7.00	3.00	91.0	134.0	686.0	0.0	3334.0	0.0
1983	7.00	3.00	92.3	135.3	702.5	0.0	3359.0	0.0
1984	7.00	3.00	93.5	136.6	719.0	0.0	3384.0	0.0
1985	7.00	3.00	94.7	137.9	735.5	0.0	3409.0	0.0
1986	7.00	3.00	95.4	138.6	750.0	0.0	3434.0	0.0
1987	7.00	3.00	96.0	139.3	750.0	0.0	3459.0	0.0
1988	7.00	3.00	96.7	139.9	750.0	0.0	3484.0	0.0
1989	7.00	3.00	97.3	140.6	750.0	0.0	3509.0	0.0
1990	7.00	3.00	98.0	141.3	750.0	0.0	3534.0	0.0
1991	7.00	3.00	98.7	141.9	750.0	0.0	3547.0	0.0
1992	7.00	3.00	99.3	142.6	750.0	0.0	3559.0	0.0
1993	7.00	3.00	100.0	143.2	750.0	0.0	3572.0	0.0
1994	7.00	3.00	100.7	143.8	750.0	0.0	3584.0	0.0
1995	7.00	3.00	101.3	144.5	750.0	0.0	3597.0	0.0
1996	7.00	3.00	102.0	145.1	750.0	0.0	3609.0	0.0
1997	7.00	3.00	102.6	145.8	750.0	0.0	3622.0	0.0
1998	7.00	3.00	103.3	146.5	750.0	0.0	3634.0	0.0
1999	7.00	3.00	103.9	147.1	750.0	0.0	3647.0	0.0
2000	7.00	3.00	104.6	147.8	750.0	0.0	3659.0	0.0

APPENDIX E

METHOD OF CALCULATING THE ARC ELASTICITIES AND THEIR CONFIDENCE INTERVAL

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METHOD OF CALCULATING THE ARC ELASTICITIES AND THEIR CONFIDENCE INTERVAL

The arc elasticity estimates were calculated using the standard elasticity formula:

$$\text{elasticity} = \frac{\Delta \text{ lumber quantity/lumber quantity}}{\Delta \text{ variable level/variable level}}$$

where (1) lumber quantity and variable level were represented by the mean 1947-70 level of lumber consumption and the variable in question.

(2) Δ lumber quantity is the estimated coefficient of the particular variable.

(3) Δ variable level is 1.0 to correspond with the use of the variable coefficient as the Δ lumber quantity.

The width of a plus-and-minus confidence band around this elasticity estimate can be derived by replacing the variable coefficient used for Δ lumber quantity by the standard error of the coefficient estimate times an appropriate tabulated student's t ratio.