AN ABSTRACT OF THE THESIS OF

Stefan Stanislaw Bandrowski for the Doctor of Philosophy
(Name of student) (Degree)
in Resource Economics presented on July 10, 1973
(Major) (Date)

Title: An Economic Analysis with Emphasis on Stochastic Evaluation of the Structural and Marketing Changes of the Oregon Millwork Industry

Abstract approved: ______________________
(Charles F. Sutherland)

Recently, the millwork industry in Oregon, an important consumer of pine lumber produced in this region, has undergone a series of changes which have seemingly affected its structure and marketing organization. The principal purpose of this study is to explain these changes in terms of economic analysis and to find out whether they can be supported by the results of stochastic tests.

In the analytical part of the study a very close look is given to the competitive characteristic of the industry and although some trend towards integration and concentration has been detected the industry could still be regarded largely as competitive and labour intensive. Further analytical investigation is concerned with the industrial efficiency in utilization of scarce resources, labour in particular. The results show that labour productivity for the aggregate industry

did not register any gains during the period under observation. However, when arranged in size-groups, firms revealed different performance: medium-size plants noted substantial increases in productivity, while the large and the small plants did not do as well.

In the part concerned with stochastic evaluation the functional interrelationship among various factors influencing the product market is tested with two models; a single multiple regression equation and the four simultaneous equations. Both models are fairly accurate in respect of their predictive capacity but reveal a weakness in the linkage between the sales of millwork products and construction activities.

Another central topic in stochastic evaluation is the application of the Markov principle to the process of the evolution of firm sizes over a certain time period. It has provided an insight into the transitional movements of firms and spotlighted the long term shift within the industry's structure towards the medium and large size units.

The study raises a question of the adequacy of any single method of analysis, in providing a solution to some specific problems. It attempts to demonstrate the importance of stochastic techniques in strengthening the traditional economic analysis and points out the pitfalls of relying solely on one method in explaining even relatively simple economic phenomena.

An Economic Analysis with Emphasis on Stochastic Evaluation of the Structural and Marketing Changes of the Oregon Millwork Industry

by

Stefan Stanislaw Bandrowski

A THESIS
submitted to
Oregon State University

in partial fulfillment of
the requirements for the
degree of

Doctor of Philosophy

June 1974

TABLE OF CONTENTS

An Economic Analysis With Emphasis on Stochastic Evaluation of the Structural and Marketing Changes of the Oregon Millwork Industry

CHAPTER 1. INTRODUCTION

1.1 The Purpose and Objectives

The principal purpose of this study is to subject a regional forest industry to economic analysis in order to determine how efficiently it utilizes scarce resources consumed during the manufacturing process and to establish a concourse between analytical conclusions and quantitative evaluation. In addition to purely academic interest that might be aroused by the stochastic treatment of certain structural and functional developments the study should be of benefit to the representatives of the industry in particular. The economic evaluation of the industry's aggregate performance suggested that the labor input was not used in the optimum proportion with other productive resources. The practical implication for the industry would be to reduce the average plant size to the point of maximum real output per unit of labor.

The millwork industry in Oregon is an important consumer of pine lumber produced in the region. At the same time it is also an important source of inputs into the construction sector of the national economy. The study takes a close look at the intricate pattern of input-output flows and how the functional relationships among the important factors which affect this pattern are determined. Since these interrelationships take place within and without the institution of industry, it has been necessary to sketch the structural framework of the industry and to make a note of significant changes that have occurred throughout time. Attention has been paid also to the operational characteristics of the industry in order to determine their efficiency and impact upon regional economy.

The following hypotheses have been formulated during the course of writing this study and wherever possible subjected to analytical and stochastic testing:

(a) In spite of the inroads made by the integration and concentration processes, the Oregon millwork industry can still be regarded as a competitive and labour-intensive industry;

(b) The industry depends on the construction activity in major market areas and this dependence can be expressed in a linear functional form;

(c) A 'westward' shift has occurred, but is more noticeable in the structural rather than marketing characteristics of the industry;

(d) The Pacific region offers good expansion opportunities for the output of millwork firms.

Analytical discussion concerned with the first hypothesis is included in Sections 5.2 and 5.4. No rigorous analytical tests could be carried out to verify in a precise manner the degree of the competitiveness and labour-intensiveness of the industry. It is rather a qualitative judgement arrived at after having observed behaviour of prices and trends in capital and labour shares in output. The quantitative test of this hypothesis is presented in Chapter 9 through consideration of a size-dependent stochastic process.

The second hypothesis is discussed in Chapter 8. Empirical considerations on the nature of the dependence of the industry's output on construction activity (derived demand) are presented in Section 8.1. This dependence is tested stochastically in Sections 8.2 and 8.3 through application of the uniequation and the simultaneous equation models. The results of the tests are discussed in the last section of the Chapter.

The last two hypothesis are of a broader and more general character than the preceding ones. The way they have been developed is presented in Sections 6.3 and 10.2, respectively.

1.2 Outline of Methodology and Procedure

The phrase 'millwork industry' used in the study is to be understood as a conglomeration of plants engaged primarily in the manufacture of fabricated millwork made from wood, non-upholstered wood furniture and wood partitions, shelving, lockers and office and store fixtures. These plants are grouped in the three four-digit SIC industries: 2431, 2511 and 2541. The meaning of these codes is described in detail in the Standard Industrial Classification Manual.

The term 'pine-using millwork industry' or simply, 'pine users' will refer to those millwork firms whose raw material inputs consist wholly or in part of ponderosa pine lumber.

Delineation of the 'universe' of millwork firms in Oregon conceived as described above was based on the Dun and Bradstreet listing, official Oregon State list of business firms, Oregon telephone directories and information obtained from private sources. The principal identification characteristics for this process were: the SIC code number in the case of the first two sources and the 'Millwork' heading in the case of telephone directories. Admittedly, this is not the best way of defining a statistical universe. However, millwork industry is an ambiguous enough term and difficult to define even in common language. In any case, it is hoped that the margin of error (i.e., including non-millwork firms and excluding millwork firms) was not significant.

All the listed firms were approached initially by mail; a brief letter explaining the purpose of the study and a self-addressed postcard containing two simple questions concerning usage of pine lumber and millwork activity were sent to each of them. The response (after two telephone follow-ups) was over 90 per cent. The non-respondents were mostly out of business or could not be reached either by mail or telephone. Based on the postcard replies, the original population of millwork firms in Oregon was stratified into two groups: a) pine users and b) others.

The first group of respondents, i.e., the pine lumber users, was approached a second time and each firm was interviewed personally. Altogether 41 such interviews were carried out. Details concerning the response and size of strata are included in Table 1.1 below.

TABLE 1.1 INITIAL POPULATION AND SIZE OF SAMPLE

Millwork firms listed	263	Firms approached for personal interview	66
No answer	19	No answer	4
Did not use pine	154	Did not use pine	7
Not manufacturers	3	Out of business (small shops)	7
Not in millwork	21	Not in millwork	7
Pine lumber users	66	Firms in sample	41

Out of the total population of 263 firms, 140 (53%) were found to be in Millwork Industry (SIC 2431), 80 (32%) in Furniture Industry (SIC 2511) and 23 (8%) in Wood Partitions Industry (SIC 2541). The remaining 20 (7%) firms were classified in other SIC industries; this number roughly corresponds to 21 firms which answered negatively the question on the postcard referring to millwork activity.

From the methodological point of view the procedure employed here can be regarded as purposive stratified sampling with complete enumeration of the secondary sampling unit. The simple dichotomy of the population of interest (i.e., pine users and non-pine users) was a logical outcome of the objectives of the study. The manageable size of the second stratum justified complete enumeration notwithstanding the fact of a rather lengthly questionnaire used in personal interviews. The advantages thus secured were of two kinds: biases that could have occurred due to an inefficient sampling plan were avoided and more freedom was achieved in estimation of change in time, an important factor in trend projection.

The bias of non-response (7% in initial screening and 6% in personal interviews) is not considered as significant; it was ascertained from other sources that the non-responsive firms were small. Considering 19 firms that did not answer the initial screening (postcard), it could be assumed that six of them were pine-users, mostly small shops employing one to two workers. It was judged that the omission of these firms from complete enumeration did not affect findings to any appreciable degree.

Although 66 firms were approached for personal interview, only 41 were interviewed fully as indicated in Table 1.1. Four were reluctant to get involved in the long process of questioning; seven were not currently using any pine lumber, in spite of answering affirmatively the postcard question referring to pine usage; seven (small 'backyard' shops) were closed; and seven were found to be manufacturing other products than millwork (crates, boxes, etc.). The 41 fully interviewed firms were distributed as follows: 68 per cent were in millwork industry proper (2431), 20 per cent in furniture business and 12 per cent were manufacturing wood partitions, shelving and similar products.

1.3 Emphasis of the Study

The first four chapters of the study (2, 3, 4 and 5) provide a look at the development of the industry structure from a historical perspective and also present the supply situation on the input markets. In Chapter 6 attention is switched to the production process and the more interesting features of the demand for output. It is, however, in Chapters 7, 8 and 9 where the emphasis of the study is concentrated.

Generally speaking, an increasing trend in corporate income and net return on invested capital is recognized as an indication of sound management. These measures are thought to reflect the final success of various operations such as research and development, production planning, purchasing and marketing practices, wage and financial policies and other managerial aspects. However, they do not tell the whole story of efficient resource utilization. A very important element is missing. This element, which reflects the successful conduct of business, is the rate of technological progress usually expressed by a declining trend in real costs per unit of output (input/output ratios). In Chapter 7 the necessary inputs are evaluated in real terms and then investigation is carried out whether the millwork industry has made any progress in technology as measured by physical output/input ratios. The material covered in that chapter provides some modest insight into the industry's performance with respect to productivity.

The principal features on the supply and demand sides identified in the early chapters through economic analysis have been cast into component parts of a deterministic model of the output market which is explored in Chapter 8. The purpose of this exercise is to test the viability of analytical statements about the behaviour of market forces with a series of statistical inferences obtained as a result of interpretation of the classical econometric model of that market. A point of interest here is a predictive characteristic of the model, which, although subject to certain limitations, provides a practical and fairly accurate way of foretelling the response of the market for a specified millwork product to changes in demand.

A similar quantitative inquiry into the process of the evolution of firm sizes provides a topic of main interest in Chapter 9. The economic analysis of the structural changes within the millwork industry led to certain conclusions noted in the earlier part of the study. These conclusions have been subjected to a mathematical treatment based on the idea that the growth pattern of firms in an industry can be considered as a size-dependent stochastic process. Such a process describes the evolution of firms through size classes based on the probability that a firm in a certain size class will move to another size class. Using these 'transition probabilities' the structure of the industry can be predicted for some future point of time, subject to certain assumptions about the nature of the stochastic process.

The advantage of this quantitative inquiry is that it provides a method through which the pattern of structural changes within a given industry can be described fairly accurately without taking into consideration all factors that have initiated these changes. Once the transition probabilities have been determined it is relatively easy to calculate the expected size distribution of the industry at future time points.

1.4 Overview of the Study

The description and economic analysis of the Oregon millwork industry constitutes the subject matter discussed in the first five chapters of this study (Chapters 2, 3, 4, 5 and 6).

The origin and historical development of millwork provides a background for the description of the current industry structure in Chapter 2. Included there also are the geographical distribution of plants and their tendency to cluster around larger urban areas. The phenomenon of concentration of output, and connected with it the problem of market control exercised by large firms as well as factors determining the optimal plant size, are treated in the concluding part of Chapter 2.

Chapter 3 contains an analytical description of the operational and structural characteristics of the pine-using millwork plants. Furthermore, certain processes, including the trend towards integration, development of optimal size of plant and the phenomenon of survival of small plants, are analyzed in greater detail. Also, in the same chapter, an important relationship between the length of ownership and the size of business is tested for possible correlation.

Discussion of input markets is carried out in the next two chapters. It seemed sensible to consider pine lumber separately from the other two inputs, labour and capital, not only on account of its importance to the industry at points of origin and destination, but also because of its exclusiveness as a raw material. The inter-industrial use of ponderosa pine lumber is presented from the national economy standpoint in Chapter 4. Because of an extremely skewed distribution, only the most important industrial users are indicated. Against this background a regional (West) network of input flows is presented showing the origin and terminal points, volume and the frequency of purchases. Some consideration is also given to the buyers' side of the market to see if any traces of collusion can be detected. Furthermore, the supply situation as viewed by pine-users is explored in detail, spotlighting some problem areas. Finally, a general marketing profile is construed illustrating consumption patterns, impact of freight rates and regional differences in lumber flows. It is believed that this analysis throws more light on the forces behind the "westward shift" of the millwork industry.

Analysis of labour and capital inputs provides the main topic for discussion in Chapter 5. The former is often regarded by industrial management as a "problem area", consequently, more attention is paid in this part to such institutional aspects as management-labour relationships and the impact of unions. Some consideration is also given to the training programs inspired by an efficiency conscious management to see if it has any effect on improving the quality of this "human capital". Furthermore, size of the labour force and the wage-rate level are related to the incidence of labour problems among firms in order to find out if meaningful relationships can be established.

The analysis of capital inputs usually presents serious difficulties on account of lack of data. However, in this study the situation is not altogether hopeless and an attempt has been made to determine the association between capital requirements and structural characteristics of the industry. Through investigation of capital requirements, for example, some insight was gained as to the conditions of entry into the millwork business. Similarly, testing the relationship between inventories and size of plant (in terms of work force) for significance permitted formulation of certain postulates about the importance of inventory policy in management. Discussions of estimated future trends in demand for inputs, expected growth of the industry and shares of capital and labour in output, conclude Chapter 5 on input markets.

Several aspects of the process of production and demand for output are considered in Chapter 6. Here, an interesting point of how a millwork manager reacts to competitive market forces is investigated. There is no doubt that he endeavours to maximize his profit; but he can do it either through minimizing costs or increasing gross receipts. Apparently he has chosen the former way; the connotation of this choice is discussed at large. Further on, details of the product market are presented and market performance of some more important commodities compared in face of strong competition from aluminum and plastic substitutes. The chapter closes with a description of output flows, changes in volume and direction and some prognostic indication about future developments.

The next three chapters (7, 8 and 9) constitute the quantitative part of the general analysis of the industry, involving application of certain stochastic measures. The measures and the contents have already been described in Section 1.3. The last chapter (Chapter 10) includes the general summary of the study and final conclusions.

CHAPTER 2. STRUCTURAL FRAMEWORK OF THE MILLWORK INDUSTRY

2.1 Historical Development

Forestry and forests since time immemorial have been very intimately connected with the development of human civilization. In the United States a large number of the early millwork plants was established along the Mississippi river; they were known as the 'river mills' (33). The choice of this particular location was motivated by several reasons; probably, the most important were: proximity to the white pine stands of the neighbouring Lake States, cheap river transportation and easy access to the growing mid-western and eastern markets.

As the industry expanded and the choicest stands of white pine were depleted the question of adequacy of existing supply areas become more and more urgent. The industry looked west for the then 'inexhaustible' supply of ponderosa pine, known also as western pine. Speedy construction of the railroads and building of an interstate highway system could only facilitate this 'westward' shift.

Alongside these changes the millwork industry also went through more profound transformation stages. From the early purely hand operations which created real works of art and beauty, millwork went through successive transition periods during which woodworking machinery gradually replaced skilled 'ship carpenters' and 'joiners'. No less significant were also changes in the production line, such as the appearance of the preassembled window unit and prehung doors and kitchen cabinets. Another milestone in millwork's history was the introduction of wood preservative treatments against rot and decay and moisture absorption. These developments alongside the improvements in product standardization and employment of electronic inspection methods have created the modern millwork industry which nowadays can compete successfully with non-wood substitutes: aluminum and plastics.

2.2 Industry in Perspective

The role of forestry in national economy has not been explicitly studied until fairly recently. This can be explained partly by the fact that interest in economic development itself took more serious and penetrating form only a few decades ago and partly by the traditional approach to perpetuate forests as national capital and the storing of wood for fuel, housing, ships and new industries. The change in this attitude has been manifested in a number of papers and articles by such authors as Chapman (8), Santa Crus (26), Westoby (38) and, most forcefully, Zivnuska (40) who discussed models for integrating forest development and national development plans.

The contribution of the forestry sector to national economy can be viewed analytically in two ways: (a) following successive transformation stages of the tree and (b) identifying different structures of industries concerned with various processes of wood manufacture. The first one (7) recognizes three major groups of products: 1. Wood and wood derivative products; this group includes wood in various stages of processing from roundwood, through lumber, to molecules, each successive stage representing an increasing fineness of division of raw material (10); 2. Wildlife and non-arboreous forest plants; this group includes all animals and all vegetable products; 3. Intangible products and services; this group includes forest influence on eco-system (erosion, floods, water, etc.) and environmental values.

The second way is concerned with classification of various industrial activities of wood processing into fairly homogeneous groups identifiable by some specific structural characteristics and measuring contribution of such groups in economic terms. Thus one can distinguish primary forest industries such as logging, secondary industries such as sawmills, veneer and plywood mills and pulp and paper mills and so on. Millwork industry would be placed on the next level in this hierarchy of industries since its raw material inputs consist predominantly of lumber produced by sawmills.

To measure the contribution of forest products it has been suggested that two coefficients derived from input-output tables should be used (38). One coefficient is the value ratio of purchased inputs to total production of a sector (forestry). It indicates indirect use of capital and labour in the production process of the sector. The second coefficient is the value ratio of intermediate to total demand and it shows how much of the sector's output is sold for further use in production. The comparison of these ratios with the average for the whole economy can be regarded as a relative contribution of the sector.

It must be observed that the analysis as described above is theoretically possible for an industry group, such as millwork; however, serious difficulties would arise because of the dearth of statistical data on such a detailed basis.

Importance of Oregon's forest resources may be attested by the fact that about one-half of the total land area of the state (31 million acres) is under forest with standing timber estimated at 451 billion board feet. The state produces two-thirds of the country's plywood, one-quarter of the hardboard and one-quarter of the softwood lumber (33). In 1968 the forest industries in the state employed some 85,000 workers with the payroll of $521 million and produced annual output valued at $1.5 billion. The two major tree species are: Douglas fir in areas west of the Cascade mountains and ponderosa pine east of the mountains. The latter occurs in a broad band stretching roughly in a north-south direction between the 121st and 122nd meridians and in areas east and north-east of Prineville and in the vicinity of Grants Pass and Medford.

Millwork and related products is one of the leading industry groups in Oregon in terms of value of shipments, ahead of sawmills and planing mills, logging camps and contractors and paperboard and paper mills. It accounts for some $800 million worth of annual sales out of which $150 million is a share of the millwork industry proper.[1/] Oregon ranks fifth among the states in terms of total millwork workers employed, payroll and value of millwork shipments; it is in sixth place in terms of large plants (20 and more employees) and value added by manufacture. A similar comparison among the eleven western states shows Oregon second to California in large plants, total employees, total payroll, value added, value of shipments and new capital expenditures.[2/]

A different type of comparison is presented in Table 2.1, where changes in important indicators of productive efficiency for the six western states are shown side by side with the structural and investment changes for the 1954-1963 period. It is significant that during this decade Oregon was one of the three states (the other two being California and New Mexico) where changes in all series shown were consistent and of substantial proportions.

Considering the first structural changes, the number of

1/ i.e., SIC 2431; Annual Survey of Manufacturers 1966. U.S. Dept. of Commerce.

2/ 1963 Census of Manufactures.

TABLE 2.1. CHANGES IN SOME OPERATING CHARACTERISTICS OF THE MILLWORK INDUSTRY IN THE SIX WESTERN STATES: 1954 TO 1963.

	Large plants[a/]		Value added per prod. worker[b/]		Shipments per prod. worker[b/]		New capital expenditures per plant[b/]	
	1954	1963	1954	1963	1954	1963	1954	1963
	(number)		($000's)		($000's)		($000's)	
Arizona	4	9	7.54	11.34	19.95	28.18	5.65	3.49
California	95	117	7.60	11.98	19.06	29.14	3.20	5.26
Colorado	3	3	6.46	7.28	14.94	14.07	4.11	2.38
New Mexico	4	6	7.54	8.40	21.86	25.19	5.25	14.27
Oregon	25	34	7.73	8.97	19.14	23.75	4.74	8.12
Washington	41	27	5.61	9.02	14.77	20.76	3.04	5.44

a/ With 20 or more employees.

b/ All plants.

SOURCE: U.S. Census of Manufactures, 1963 and 1954.

large plants increased in four states (Arizona, California, New Mexico and Oregon); in Colorado it remained stationary, while in Washington it decreased considerably. However, comparing the first two columns of Table 1 in the Appendix, we can see that it was only in Oregon that large plants increased more than all other size plants. Notwithstanding limited data (only 2 years observed), this points out the possibility that the movement towards integration and concentration could have occurred in the millwork industry in Oregon. That it did occur, indeed, will be discussed in the next section of this chapter.

Comparing next the contribution of millwork industry to the regional economy (in terms of value added by manufacture per production worker) the situations at the beginning and the end of the decade are quite different. Oregon's worker, whose contribution was among the highest in 1954, was relegated to fourth place in 1963. However, an important fact is that throughout the region there has been a significant increase in this value added ratio. This could be explained by higher wage rates gained by millwork workers, an improved profit situation and increased new capital investment; it is quite probable that all these factors were at play.

Somewhat similar changes have occurred in the ratio of value of shipments per production worker. Substantial increases were noted for all the states, except Colorado. Since the ratio can be regarded as a very rough indicator of efficiency, it can also be assumed that the millwork industry has made some progress in this respect. This does not seem to be an unreasonable assumption in the light of developments discussed previously, it is also supported by evidence available from other sources.[3/]

The last ratio to be considered here (new capital expenditures per plant) is also interesting since it throws some light on the crucial problem of capital investment in industry. In Oregon, Washington and California capital expenditures increased appreciably while in New Mexico, they increased almost three times in 1963 as compared to 1954 (due to addition of new plants). The rate and direction of change in capital investment per plant seems to be roughly in agreement with the efficiency indicators discussed in the previous paragraphs.

2.3 Current Industry Structure

In order to appreciate fully the structural and functional developments that have occurred among the conglomeration of firms grouped together in what could be named as pine using millwork industry, it is necessary to describe more closely the whole millwork industry, which also includes non-pine users.

Table 2.2 shows the geographical location of the plants

3/ Industry Profiles. BDSA, U.S. Dept. of Commerce.

TABLE 2.2. MILLWORK INDUSTRY IN OREGON. 1966.
DISTRIBUTION OF PLANTS BY COUNTY,
BY VALUE OF SHIPMENTS

County \ Value of Shipments ($000's)	1-49	50-99	100-999	1,000+	Total
	(number of plants)				
Clackamas	3	3	1	-	7
Clatsop	1	-	-	-	1
Coos	1	-	-	-	1
Columbia	-	1	-	-	1
Crook	-	-	-	2	2
Curry	1	-	-	-	1
Deschutes	-	-	2	5	7
Douglas	1	-	1	-	2
Hood River	-	-	1	-	1
Jackson	-	5	1	2	8
Jefferson	-	1	-	-	1
Josephine	-	3	-	-	3
Klamath	-	-	3	2	5
Lake	-	-	1	-	1
Lane	6	3	3	3	15
Linn	-	-	4	1	5
Malheur	1	-	-	-	1
Marion	3	4	5	1	13
Multnomah	12	11	27	6	56
Polk	-	1	1	-	2
Umatilla	-	-	-	3	3
Washington	8	5	2	1	16
Yamhill	-	-	1	-	1
Total	37	37	53	26	153

SOURCE: Dun and Bradstreet Listing, 1966.

engaged in the millwork proper, furniture (not upholstered) and wood partition manufacturing activities. Raw material inputs used include pine, Douglas fir, hemlock and other softwoods in small quantities, as well as plywood, particleboard and hardboard. The first thing to be noticed is a clustering of plants around two urban areas; the large metropolitan area of Portland and the smaller one of Eugene-Springfield. The former includes parts of the Clackamas, Marion, Multnomah and Washington counties; 82 plants or 54 per cent of the total are located here. The latter is in the Lane county where 15 plants are located. Together these areas account for 64 per cent of all the plants in Oregon. The composition of these clusters is interesting, as they include plants of all sizes.

Another type of clustering can be distinguished in Crook, Deschutes, Klamath and Umatilla counties. The attracting force in this case seems to be proximity to raw material sources. The distribution of these clusters is quite different from the previous one; it consists of plants with annual shipments of more than $100,000. It would be tempting to draw a conclusion from this situation, that large plants tend to locate as near as possible to the source of raw material. However, in the previous example we have seen that 11 out of 26 plants with annual sales valued at one million dollars or more are located in the vicinity of urban areas; therefore, there must also be other factors, in addition to the nearness of the raw material source, which influence large plant location. This question will be explored more thoroughly in the next chapter.

We can now turn to the problem of concentration within the millwork industry as a whole including non-pine users. Concentration, for the purposes of this analysis, will be understood as control of a relatively large proportion of marketed output by a relatively small number of firms (4). This is illustrated in Table 2.3.

It can be seen by visual inspection of the table that concentration appears to be most significant in the Furniture group where the seven largest firms (with annual sales equal or exceeding one million dollars), or 13 per cent of the total number of firms, controlled 90 per cent of the marketed output in 1966. In Millwork there were 19 such firms, or 22 per cent of the total, which accounted for 81 per cent of sales in 1966. In the Partitions group there were no firms with annual sales over one million dollars; seven firms with sales above $100,000 per annum control 83 per cent of output. Interestingly, small establishments seemed to be popular in Furniture, while medium size plants ($100 - 499 thousand) were most frequent in the Millwork and Partitions groups.

The concentration aspect of the whole millwork industry and pine users in Oregon is compared with the Cotton Yarn industry in Canada in Chart 2.1. The horizontal axis represents number of plants arranged in ascending order of annual sales and expressed in cumulative per cent of total number of plants. The vertical axis

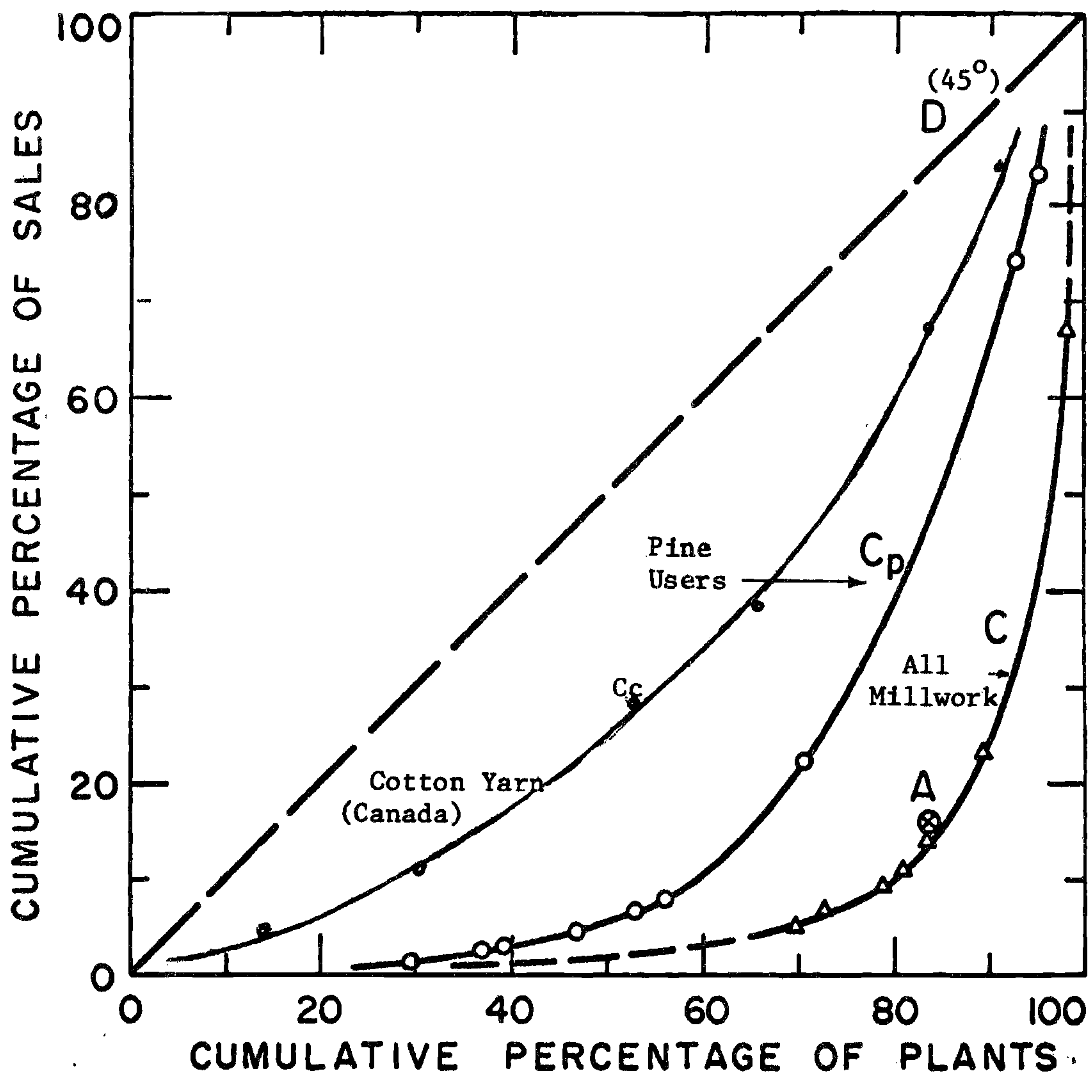
TABLE 2.3. CONCENTRATION IN THE OREGON MILLWORK INDUSTRY, 1966

Value of Shipments ($000's)	Millwork		Furniture		Partitions		All Industry	
	A	B	A	B	A	B	A	B
up to 49	11	.4	21	.9	5	9.3	37	.8
50 - 99	15	1.3	17	2.2	2	7.7	34	1.8
100 - 499	35	12.3	7	3.5	6	49.8	48	9.2
500 - 999	5	4.6	2	3.4	1	33.2	8	4.4
1,000 and more	19	81.4	7	90.0	-	-	26	83.8
Total	85	100.0	54	100.0	14	100.0	153	100.0

A - Number of plants; B - Per cent share of total value of shipments.

SOURCE: Dun and Bradstreet Listing, 1966.

CHART 2.1 CONCENTRATION OF INDUSTRIAL OUTPUT: MILLWORK INDUSTRY IN OREGON AND COTTON YARN INDUSTRY IN CANADA



represents annual sales also expressed in cumulative per cent. Curve C approximates the cumulative distribution of all millwork plants in Oregon, while curve Cp approximates the same distribution of the pine using plants only; Cc represents Canadian Cotton Yarn plants. Thus a point A on curve C reads: slightly more than 80 per cent (actually 83%) of all the millwork plants ranked from the smallest to the largest in terms of marketed output (annual sales) are responsible for slightly less than 20 per cent (actually 16.2%) of the total output marketed by all the plants under discussion. Point A can also be read in a slightly different way: 17 per cent of the plants (this will, naturally, include the largest plants) are responsible for 83.8 per cent of the total marketed output.

Concentration can be measured roughly by a simple visual inspection of a chart: the deeper the concavity of the C curves, the higher the degree of concentration. Looking at it in a different way, the flatter the curve, the lower the degree of concentration. More precisely, concentration can be expressed by the ratio of the area between the diagonal line D and the 'C' curves to the area under the diagonal. This measure is often called the coefficient of concentration.

The diagonal line represents an ideal distribution of plants of equal size (in terms of output) which might theoretically occur under perfect competition. In such cases, an industry consisting of many firms of identical size would be represented by the straight diagonal line and would have the coefficient of concentration equal to zero (the diagonal and the curve would coincide). The opposite limiting case could be imagined under pure monopoly when one huge firm represents an industry; the coefficient then would be equal to one.

In the example, illustrated on Chart 2.1, one can visually verify progressively increasing concavity of the 'C' curves, starting from the relatively flat Cc and ending with the deeply concave C curve. By measuring concerned areas very roughly, it can be said that the co-efficient of concentration for the Oregon pine users is about half-way between that for the Canadian Cotton Yarn plants and the one for the Oregon all millwork plants; in absolute terms it seems to be around 0.60. Concentration aspects of the Oregon pine users will be discussed further in the next chapter.

CHAPTER 3. STRUCTURAL FRAMEWORK OF PINE-USING PLANTS

3.1 Location Characteristics

Five geographic areas are distinguished for the purpose of this analysis, as illustrated in Table 3.1. Each area has been identified by two local cities or towns, being either important urban or forest-based industrial centers. Area (A) includes Portland, the largest urban center in Oregon. Most of the 18 plants in the area are located either at the outskirts or within the city; two plants are in small towns within a 25 mile radius from Portland and two are in Salem. The Eugene-Springfield area (B) has mixed characteristics of both a small urban center and a forest industry town; manufacture of wood products is the leading industrial activity of that area. Although it is represented here by only one pine-user, it has about a dozen plants engaged in millwork activities. In the remaining areas (C, D, E) points of interest are local towns which have grown around expanding logging and wood products manufacturing industries and the proximity of supply sources.

In contrast to the Portland-Salem area where plants are more or less evenly distributed throughout all size ranges, those in the remaining areas tend to be large. Furthermore, most of the pine-users, with annual sales valued at one million dollars or more,

TABLE 3.1. LOCATION OF PINE-USING PLANTS IN OREGON BY VALUE OF SHIPMENTS, 1968

Area of County \ Value of Shipments ($000's)	Up to 49	50-99	100-249	250-499	500-999	1,000	Total
			(number of plants)				
A. Portland-Salem							
Clackamas	-	-	-	1	-	-	1
Marion	1	1	-		-	-	2
Multnomah	-	1	2	3	-	2	8
Washington	2	3	1	1	-	-	7
B. Eugene-Springfield							
Lane	1	-	-	-	-	-	1
C. Medford-Klamath Falls							
Jackson	-	1	-	-	-	2	3
Josephine	-	1	-	-	-	-	1
Klamath	-	-	-	1	-	3	4
Lake	-	-	-	-	-	2	2
D. Bend-Redmond							
Crook	-	-	-	-	-	3	3
Deschutes	-	-	-	2	-	4	6
Jefferson	-	1	-	-	1	-	2
E. Pendleton-Baker							
Umatilla	-	-	-	-	-	1	1
TOTAL	4	8	3	8	1	17	41

are located at relatively short distance from the supply points, usually near a large pine lumber mill. This would seem to indicate that at least one important factor attracting all pine-using millwork plants and affecting their growth into sizeable units is a conveniently located supply of pine lumber.

In fact 25 out of 41 surveyed firms indicated that they considered both good transportation facilities and proximity to raw materials as chief factors before deciding where the plant should be located. Large firms (with annual sales valued at one million dollars or more) tended to regard transportation as the most important factor and placed raw materials in the second order of importance. Familiarity with neighbourhood and tradition, easy access to growing market and labour pool were mentioned as other factors of importance.

It appears then that in considering the original location of a plant, millwork manufacturers gave most thought to transportation facilities; proximity to raw materials was regarded as a second most important factor. Access to growing markets, abundance of cheap labour, familiar neighbourhood, low taxes and overhead, and pleasant living conditions were mentioned as other factors, ranked in that order.

When the same manufacturers were asked which factors would they consider most important if they had to make a decision on plant location now (summer, 1968) their evaluations were quite different as shown below:

Factors	Order of importance 1st (frequency of response)	2nd
Raw materials	17	5
Transportation	4	9
Access to market	6	2
Labour pool	1	9
Familiar neighbourhood	3	1

If memory of the respondents can be trusted and original decisions with regard to location compared with current ones, it is evident that the question of adequate supply of pine lumber has become of paramount importance to the owner of a modern pine-using millwork plant, especially after it had achieved large size. This shift in emphasis must have contributed also to the gradual change in the structural framework of the industry.

3.2 Structural Characteristics

The tendency of marketed output of all millwork plants to concentrate in relatively few large firms (17% of the plants were contributing almost 84% of the output sold) was described in the previous chapter (Table 2.3, Chart 2.1). The comparable situation for pine-users is shown below:

TABLE 3.2. CONCENTRATION IN PINE-USING MILLWORK INDUSTRY

Sales ($000's)	Per Cent of All Plants	Per Cent of Total Output	Cumulative Per Cent All Plants	Cumulative Per Cent Total Output
1 - 49	9.8	0.1	9.8	0.1
50 - 99	22.0	1.0	31.8	1.1
100 - 249	7.3	0.8	39.1	1.9
250 - 499	17.1	4.6	56.2	6.5
500 - 999	2.4	1.3	58.6	7.8
1,000 - 15,000	41.4	92.2	100.0	100.0
TOTAL	100.0	100.0	-----	-----

One striking feature of this distribution of pine-users is that almost one half of the plants belong to the 'large' category and account for 92 per cent of total sales. But on the whole, the degree of concentration is not quite as high as in the previous example. This is more clearly pictured in Chart 2.1 where curve CP showing cumulative per cent distribution of pine-users is flatter than the corresponding Curve C representing all millwork plants.

It should be noted that the concentration discussed here refers to the output (measured in terms of value of annual sales) produced by the Oregon millwork firms. Therefore, strictly speaking it denotes concentration of production within the state boundaries and indicates the distribution of economic power among the concerned firms in a more general sense of controlling local resources rather than the market. This, in turn, leads to the question whether the pine-users purchase significant shares of the market supply of pine lumber and other inputs; in other words, whether there exist oligopsonistic conditions on the input market. Such conditions would create interdependence among pine lumber buyers and lead to either open or tacit collusion among them in order to depress buying prices and increase profits. No firm evidence has been found by the author in support of the collusive practices among pine-users; on the other hand, it cannot be said that the buyers' market in the case of pine lumber is completely devoid of oligopolistic features. This question will be discussed more fully in the next chapter.

Among the factors which are usually recognized as determinants of the concentration tendencies in an industry, those of importance are: size of market, economics of scale, and economic growth. The first and the last ones are related in the sense that when economic growth occurs the market usually grows, too, thus allowing more 'elbow room' for expansion for ambitious firms. The market for millwork products has been growing steadily as shown in Chapter 5. Concurrent with this growth a substantial number of pine-users increased their annual sales as illustrated in Table 3.3 below:

TABLE 3.3. THE 1958-1967 CHANGE IN VALUE OF ANNUAL SALES[a/]

Sales ($000's)	Increase (No)	Decrease (No)	Total (No)
1 - 99	1	5	6
100 - 999	10	--	10
1,000 - 15,000	10	2	12
TOTAL	21	7	28

a/ Current $.

Out of 28 firms which supplied the required information, and which have been in business since 1958, 21 experienced considerable increases (greater than 25%) in their annual sales over the last decade; only in two cases was the increase smaller than 25 per cent. For the two large firms, the decreases in their sales were about 15 per cent and occurred during the second half of the decade.

While considering expansion in sales of pine-users, especially the cases of substantial increases, an intriguing question arose: how to identify an efficient management? It is an important question nowadays, as more and more attention is being paid to this fourth factor of production and, according to some economists, the most decisive one. The problem could not very well be approached from the quantitative point of view, consequently, five questions of the qualitative type were selected and the answers given by manufacturers were assessed according to three criteria: initiative, foresight and aggressiveness.[4/] The cut-off level for 'efficient management' was arbitrarily set at the score of 70 points and more; 11 firms were classified in this group. These firms then were compared with the ones which experienced increases in sales (Table 3.3);

4/ Following weights were arbitrarily assigned: initiative (in product diversification: custom and artistic work) - 50 points, foresight (in planning of output) - 30 points and aggressiveness (in establishing personal contacts with clients and suppliers) - 20 points.

9 such firms were identified as belonging to the same class.

The method described above, crude as it might seem and open to criticism on account of the element of personal judgement it includes, nevertheless it throws some light upon the relationship between the quality of entrepreneurship and growth of a firm.

3.3 Operational Trends

We have seen before that nearly one-half of pine-using millwork firms have reached the size of one million dollars worth or more of annual sales. There are also reasons to believe that it is the medium and the large firms which are likely to expand. Apparently, the industry is subject to economies of scale; the question is whether they are of a technical or operational character. From the opinions voiced by several managers, it would seem that the opportunities for rapid automation and mechanization, are limited. The millwork production function is still determined to a large extent by the labor factor; in most of the plants (including the large ones) many operations require manual handling. However, some economies have been achieved by such improvements as finger-end and edge-joints, factory pre-assembled unit and prefinishing and coating of wood. A different type of economies is offered by the integration movement, both vertical and horizontal. Although there are no hard-fact statistics on such movements within the pine-using millwork industry, yet, there is indirect evidence pointing in that direction. The industry has relatively little product differentiation. One-third of the total surveyed firms were found to be multi-plant operators (two of more plants under one management). Furthermore, several manufacturers revealed that they obtain pine lumber from their own sawmills which would also be indicative of vertical integration.

On the other hand, it must be observed that the industry has certain characteristics, such as relatively easy entry (see also Chapter 4) and production process not easily adaptable to mechanization, which discourages integration. Thus, it would appear on the balance that although integration has occurred in the industry, this process is neither too advanced, nor too rapid. Within this context one interesting example is worth mentioning. Not long ago one of the largest forest industry firms, with well diversified operations, expanded into millwork industry as well. Apparently, the venture did not last long, in spite of the firm's advantages in the form of the well established marketing and distribution networks, and considerable experience in handling forest products.

Looking back for a moment at Table 3.1, one can notice that there is a fair number of small plants among pine-users. This in itself is not a surprising thing considering that skilled labour is scarce and the industry in question is subject to competitive market forces. More interesting, however, is age distribution of plants as depicted in Table 3.4 and Chart 3.1.

CHART 3.1 PINE-USING PLANTS BY SIZE OF SALES AND YEARS IN BUSINESS

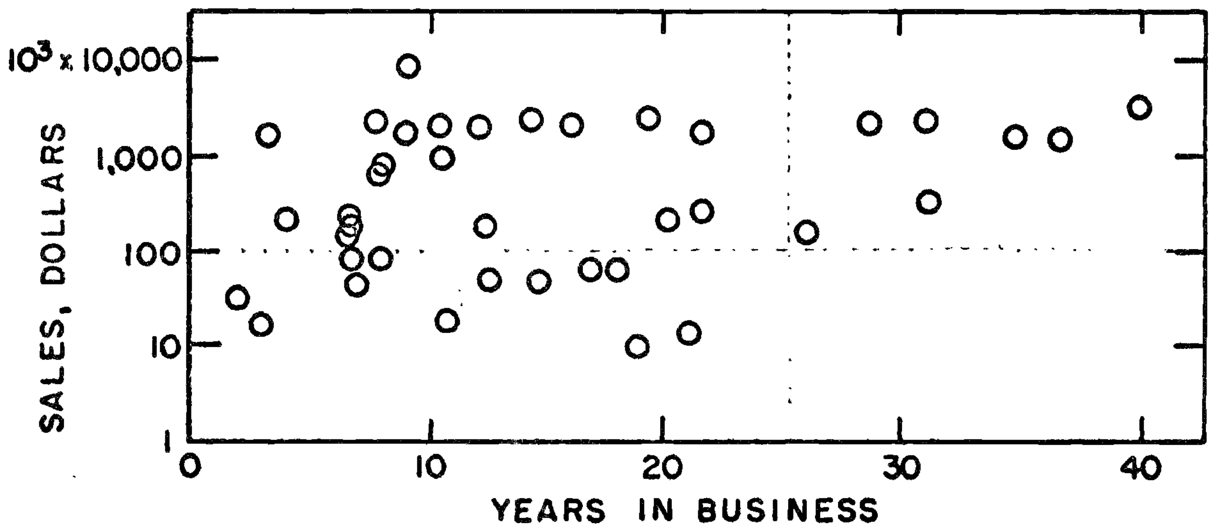


TABLE 3.4 PINE-USERS BY SIZE OF SALES AND YEARS IN BUSINESS

Sales ($000's) \ Years in business	1-4	5-9	10-14	15-19	20-24	25+	Total
	(number of plants)						
1 - 49	1	-	1	1	1	-	4
50 - 99	1	2	1	3	-	1	8
100 - 249	-	1	-	-	-	2	3
250 - 499	1	4	1	-	2	-	8
500 - 999	-	1	-	-	-	-	1
1,000 - 15,000	1	3	3	3	1	6	17
TOTAL	4	11	6	7	4	9	41

It is apparent from both the table and the chart that there is hardly any correlation between a number of years in business and size of firm even though there are no firms with annual sales of $100,000 or less which are more than 25 years old. All size groups are more or less evenly distributed throughout age intervals. Some clustering of large firms occurs in the "25 years and more" interval, but it is not significant. Another structural characteristic which can be read from the table is that small firms (below $100,000 annual sales) show remarkable vitality in their competitive environment. The survival of these sub-optimal firms can be attributed to catering to the needs of small, local markets with faithful clientele.

The interesting subject of an optimal size of pine-using millwork firm can be discussed only briefly and is a matter of conjecture rather than hard facts analysis on account of lack of data.

The only information available on this subject is the opinion expressed by a few manufacturers during personal interviews representing a group of firms employing on average about 35 production workers and selling about one million dollars worth of millwork products. They found that once they reached that size they could substantially increase their output with little additional expense. This would suggest that the firm's size mentioned above might constitute an optimal level at which the average cost curves flatten out for a considerable range of output and seem to represent typical curves for 'mature' firms in industry. Apparently the U shape cost curve so often portrayed in textbooks does not frequently occur in millwork and if it does, it is more often than not characteristic of a firm undergoing early development pangs.[5/]

The most popular form of business organization among pine-users is the corporation, as illustrated below:

5/ Assuming that $AC = \frac{W+M+D}{O}$, where AC - average (unit) cost, W - wages, M - cost of materials, D - depreciation allowances and O - output, AC curve can be flat when M increases proportionately to O (W & D remaining fixed), or even declining, when labour productivity increases.

TABLE 3.5 PINE-USERS BY TYPE OF BUSINESS AND SIZE OF SALES

Type of business \ Sales ($000's)	1 to 49	50 to 99	100 to 249	250 to 499	500 to 999	1,000 to 15,000	TOTAL
	(number of plants)						
Corporation	1	4	2	6	1	15	29
Individual Ownership	3	4	1	1	-	1	10
Partnership	-	-	-	1	-	1	2

There does not seem to be significant relationship between the two structural characteristics, though one may be tempted to say that individual ownership tends to prevail among smaller firms, while incorporated business is more typical of larger firms. Similarly, no significant correlation has been noticed between type of business and age of firm, though among the firms less than 10 years old only one was individually owned, while the other 14 were incorporated. The distribution in other age-classes was what could be expected, considering the total number of firms in each type of business.

CHAPTER 4. INPUT MARKETS: PINE LUMBER

4.1 Industrial Use of Ponderosa Pine

A general picture of importance of different types of wood in selected manufacturing industries in the U.S.A. is presented in Table 4.1 below.

TABLE 4.1 TYPES OF WOOD USED IN SELECTED MANUFACTURING INDUSTRIES. 1960

Industry	All Wood	Lumber	Bolts	Veneer	Plywood	Hard-board	Particle-board
	(In equivalent MM sq. feet 1 inch basis)						
Millwork Plants	1701	1557	1	12	115	9	7
Furniture	1339	1135	1	34	167	24	26
Containers	1560	1170	19	242	129	1	-
All Mfg. Industry	14300	-	-	-	-	-	-

SOURCE: USDA, USFS, Statistical Bulletin No. 353, February, 1965.

Lumber was, by far, the most important type of wood used by millwork industry, which is what could be expected. It is surprising, however, that it was found also predominant in furniture industry. Other types of wood material such as plywood and particleboard apparently have not yet made significant in-roads in the manufacture of furniture by 1960. It is only recently (1968) that these processed types of wood became more important in furniture and cabinetry (Section 4.2).

A more revealing picture is illustrated in Table 4.2 where use of ponderosa pine lumber is compared with softwood and all species of lumber for the same industries (see also Table 6 in the Appendix).

TABLE 4.2 LUMBER USED IN SELECTED INDUSTRIES, 1948 AND 1960 (MM b.f.)

	Millwork			Furniture			Containers		
Species	1948	1960	% change	1948	1960	% change	1948	1960	% change
Ponderosa pine	1135	707	-32	93	149	60	476	304	-69
Softwood	1961	1328	-32	324	362	12	2913	1062	-64
All species	2150	1550	-28	1948	2261	16	3993	1864	-53

SOURCE: USDA, USFS, Statistical Bulletin No. 353, February, 1965.

The most important industrial use of ponderosa pine was in the millwork industry; almost one-half of pine lumber sawn was used there (Table 6 in the Appendix). The next three important consumers of pine were: sawmills and planing mills (captive consumption), wood boxes (containers) and furniture industries. Together, these industries accounted for 32 per cent of all pine lumber consumption.

The pine input flows into the millwork and containers industries decreased significantly between 1948 and 1960. Although the in-flow into the furniture industry increased, the overall pine lumber consumption by these three wood using industries fell from 2.2 billion board feet in 1948 to 1.2 billion in 1960 or by 50 per cent. Since these industries accounted for about two-thirds of all industrial consumption of pine lumber (Appendix Table 6), it seems unlikely that changes in the remaining uses would compensate for this decrease.

Although strictly comparable statistics are not available for recent years, data available from other sources (9) indicate that this declining trend could have been reversed or at least arrested due possibly to an increased cut on one hand and better utilization of materials, (improved jointing techniques and lowering of grades) on the other.

The overall trend in the consumption of pine lumber has not precluded changes occurring in the opposite direction in some regional markets and products (increasing trend in ponderosa pine doors noted in Section 8.1 and Appendix Table 3). Although such conflicting trends are, as a rule, infrequent, it is quite conceivable for the Western market, for instance, to expand at the expense of the Eastern or Southern markets, especially when the former has an advantage over the latter in having a more direct 'touch' with supply points. A necessary condition for such a marked change, however, would be a pull on demand side strong enough to overcome the long established traditional marketing patterns.

4.2 Input Flows

For certain products such as unpainted furniture, mouldings, sash, doors and screens, pine is generally preferred to other softwood species on account of its light weight and colour, ability to take nails and screws without splitting, its softness and uniformity of grain, low shrinkage and pleasant clear colour (24).

These characteristics must have contributed to the fact that the pine-using industries, in spite of growing scarcity of good quality pine lumber, have been reluctant to substitute other softwood species or hardwood. Some change-over to other species, no doubt, must have taken place. But at the same time in response to a very strong market pressure, the pine lumber industry increased the amount of timber cut. In 1960 the total volume of pine used by all manufacturing industries in the country was 1.6 billion b.f. (according to the U.S. Department of Commerce statistics). In 1968 Oregon sawmills alone cut about 1.5 billion b.f. of pine, while another 1.5 billion b.f. was cut in California and Washington (37). In order to have a more complete picture one should allow for some 100 million b.f. of exports and 500 million b.f. of imports in the same year.

TABLE 4.3 PINE LUMBER PRODUCTION IN OREGON, BY COUNTY

County	MM b.f.	County	MM b.f.	County	MM b.f.
Baker	73	Grant	67	Josephine	21
Clackamas	3	Harney-Lake	186	Klamath	412
Crook	136	Hood River	1	Lane	2
Deschutes	142	Jackson	121	Umatilla-Morrow	81
Douglas	89	Jefferson*	87	Union-Wallowa	116

* Incl. Wasco and Wheeler

SOURCE: Statistical supplement, 1968, W.W.P.A.

Considering the geographic areas for millwork production described in the last chapter, three of them accounted also for most of the pine lumber production: Medford with Klamath, Jackson and Josephine counties, Bend with Deschutes, Crook and Grant counties and Pendleton with Union, Umatilla and Baker counties. There were some 25 mills identified in Oregon whose lumber production included pine. Ten of them had an eight hour shift capacity exceeding 100M.b.f., while for 11 mills pine lumber constituted more than two-thirds of total output. The largest mills were situated in or near the following towns: Bend, Hines, Pendleton, Kinzua, Roseburg, Springfield and Grants Pass.

Looking at the distribution of pine users arranged by the volume of pine lumber they consume we see that it has a "U" shape, i.e., that clustering occurs at both ends.

Pine-lumber inputs (b.f.)	Number of plants	Pine-lumber inputs (b.f.)	Number of plants
Under 20M	13	1MM - 9MM	12
20M - 99M	3	10MM and over	10
100M -999M	2		

There is quite a wide range in the amount of pine used by millwork operators as shown above; it actually extends from one thousand b.f. to seventy million b.f. Furthermore, the volume of pine lumber input is not necessarily associated with the size of plant measured either in terms of labour force employed or in value of annual shipments. Several of the fair size firms, employing 10 to 20 workers and selling from $100,000 to $400,000 worth of millwork products have been found to use less than 10M b.f. of pine lumber per year. It is possible that these firms, unable to overcome the growing shortage of better grades of pine, are gradually shifting over to other softwood species or to hardwood.

The total volume of pine lumber used by millwork manufacturers included in the survey was nearly 300 million b.f. This does not seem to be a large amount compared with an estimated 1.5 billion b.f. of pine produced by the Oregon sawmills. This has been reflected in the absence of the oligopsonistic conditions on the pine lumber market. A similar conclusion has been reached by Bruce in his interesting study on the competition in western lumber markets (6). Although his findings refer to all western lumber, a rough parallel can be drawn here since ponderosa pine lumber constitutes more than 20 per cent of all lumber cut in the region.

It must be observed at this point that the note on the absence of oligopsonistic tendencies refers in a strict sense to a broad pine market, both domestic and foreign. Considering the local, Oregon market, the situation is somewhat different. Here we have 10 large buyers purchasing as much as 83 per cent of the lumber sold locally. Although it cannot be said that they control prices, they certainly are in a privileged position as far as obtaining adequate supply and favourable terms of sale is concerned.

The most frequently purchased size of pine lumber was 6/4" as shown in Table 4.4.

TABLE 4.4 PINE LUMBER INPUTS BY THICKNESS AND GRADE

Thickness	Per cent	Grade	Per cent
4/4"	17	Factory & shop 1	16
5/4"	34	Factory & shop 2	44
6/4"*	49	Factory & shop 3	20
	100	Moulding	10
		Common	1
		Selects	9
			100

* Includes some 8/4"

The most popular grade was Factory and Shop No. 2. No specific differentiation patterns were noticed in this respect which could be associated with some particular structural characteristic of the industry. The general tendency of manufacturers to buy middle grade Shop No. 2 was often explained as the one which was reasonably easy to machine. Moulding accounted for 10 per cent of all purchases and there were only 11 manufacturers who used this grade of pine lumber. It is more than twice as expensive as Factory and Shop 2 and, furthermore, only 40 per cent of the original lumber is used in the finished product.

The most popular combinations of thickness and grade were: 6/4" thick Factory and Shop 2 and 5/4" thick Factory and Shop 2; the former accounted for 15 per cent and the latter for 13 per cent of total purchases.

In addition to pine other softwood species were used as material inputs too, but in much smaller quantities. Hemlock, fir, Douglas-fir and Western red cedar were the species and altogether accounted for some eight million b.f.; two large firms were the main users of these species.

There were sixteen firms who used hardwood in addition to softwood lumber; their total consumption of hardwood was about 200M b.f. For one of them almost its entire lumber input consisted of hardwood; the other fifteen used hardwood with varying proportions of softwood species.

Twenty-one manufacturers also purchased materials other than lumber; including plywood and various types of board. Several larger firms stated that they were making their own plywood for captive consumption; the majority, however, had to purchase these materials from outside.

The usual quantity of lumber purchased at one time was a truck or partial car load averaging about 25M b.f. However, one manufacturer stated that he purchased four million b.f. at one time, while for another the usual purchase was one million b.f. This seems to be odd and probably due to a different interpretation of that particular question from the other manufacturer. The pricing point most often quoted was f.o.b. sawmill, i.e., purchasers were paying transportation and insurance costs. Only four firms were found buying lumber on f.o.b. millwork plant basis.

It was interesting to note, that the overwhelming majority of pine users had raw materials delivered by truck, although their plants were located near or at the railway terminals. Only four firms mentioned rail car deliveries. Although railway rates are generally found lower than truck rates, these differences become relatively more important for longer distances (6), thus millwork manufacturers who frequently are located close to lumber mills must have found truck shipments faster and more convenient. This must be true particularly for those firms who purchase lumber in small quantities.

Apart from softwood and hardwood, materials consumed during the millwork manufacturing process included softwood and hardwood plywood, particleboard and hardboard. The total quantity of these inputs amounted to three million square feet of equivalent ¼" thickness. This figure did not include the captive consumption of plywood by several larger firms manufacturing that material in their own plants.

4.3 Supply Situation

In general, pine-users were dissatisfied with the supply situation. Pine lumber of better quality was very hard to get; a substantial proportion of best grades, it was claimed, was being shipped to large millwork plants in the Mid-West. They would also like to see better and more consistent grading systems. On the other hand, they were quite satisfied with the existing moisture requirements and thought that 6-10 moisture content in pine lumber is stringent enough. Throughout the 1958-1967 decade the majority of millwork producers had not recorded any significant change in the proportion of pine to other input materials; six firms who noted the decrease in this proportion were counter-balanced by six firms who experienced increases. Since the value of sold output more than doubled over the decade and only part of this increase could be attributed to rising prices, it may be concluded that the use of pine lumber measured in either volume terms or constant dollars has increased during the 1958-1967 years.

Lumber is a bulky commodity and transportation costs play an important part in any analysis of market behaviour. No special study of transportation costs for Oregon pine lumber was carried out, but for the purpose of this analysis we can apply, with little modification, some of the findings of Richard W. Bruce in his study of the optimal distribution patterns for western softwood lumber (6). Since Oregon is the leading state, as far as the production of ponderosa pine is concerned and the species is second in importance of all lumber cut in the state, most of the key observations made in that study will apply to pine lumber equally well.

According to Bruce the Oregon demand subregions (Portland, Eugene, Klamath Falls, Bend, Baker and Medford) had one of the lowest average transportation cost per thousand b.f. of lumber purchased from outside; the cost was below $10. Actually, of the three demand points which enjoyed the lowest transportation costs (below $6 per thousand b.f.) two were in Oregon, Portland and Eugene. In other words, considering the present capacity and the distribution patterns of the softwood market, buyers who were situated near those points enjoyed considerable cost advantage over buyers from such distant points as New York, for example. Notwithstanding this advantage about 45 per cent of Oregon lumber went to the Lake States and North East, close to 40 per cent was marketed in the West (mainly in California and locally) and the rest was sold on other markets and exported. These figures are compatible with the distribution of pine shipments including "factory and shop" grades available from the Western Wood Products Association (36). The main reason that almost half of the Oregon softwood lumber, including pine still goes East is that the local and Western markets, in spite of enjoying the transportation cost advantage have not yet grown large enough to absorb all the lumber produced in local areas.

4.4 Marketing Profile

Marketing patterns are traditionally determined by the dynamic processes of production and consumption. In the case of bulky commodities it seems reasonable to assume that these patterns might also be influenced by the fluctuations in freight rates. In previous sections we have considered some of these aspects, such as the structural and operational changes of the industry responding to the variation in market forces. In this section we shall discuss the possible effect of the consumption demand and mention briefly the freight rates within the context of the already quoted Bruce's study (6).

Earlier in this study, it was observed that the millwork industry in the West had experienced considerable gains in value of marketed outputs as compared with other regions in the country. During recent years it has moved to a leading position in this respect, accounting for as much as one-third of total sales. It would be interesting to discover whether similar changes have occurred in the ponderosa pine lumber input flows into the industry.

From the visual inspection of Appendix Table 7, it can be noted that the Western millwork plants consume most of all (except one) Moulding grades and are important users of at least one-half of the Factoryand Shop grades. Oregon is a relatively heavy consumer of 4/4 #1 Shop and 5/4 #1, 2 and 3 Shop grades. The importance of the Western market to the inland ponderosa pine sawmills is even more pronounced; more than 50 per cent of total shipments of 12 out of 17 grades goes West (Table 8). Oregon is a leading consumer in eight grades.

Considering all grades about 40 per cent of pine lumber in 1966 was sold in the Western market, 38 per cent in North Central, 19 per cent in the South and only five per cent in the North East market. In 1967 out of some 700 million board feet of pine lumber, 400 million or 57 per cent went West. California and Oregon figured as two states of prominent importance as the users of that lumber.

It may be argued within certain reason, that in addition to other factors it must have been freight rates which were the contributing factor in this westward shift. But if so, it should be remembered that the transportation is not a new problem, that it existed for a long time and was a cost component on the supply side also at the time when most of the pine lumber was going East. The change in the direction of this main input flow into millwork industry then must have been precipitated by market forces other than freight rates. This seems to be a more plausible assumption supported by the field survey findings. The millwork industry, the main user of ponderosa pine lumber, appears to be significantly more supply oriented than it has ever been.

Richard Bruce in discussing the importance and the effects of the changes in transportation rates, as compared with the production and consumption, on the optimal (lumber) distribution patterns regards them as marginal:

"By most standards, such changes would probably be judged as nominal. Certainly the net change in the competitive environment of the western lumber industry as a result of the 1967 freight rate increase was relatively small. The one clear effect of the rate increase was an average increase of $0.45/M board feet in the cost of shipping lumber by rail." (6, p. 22).

If the influence of the changes in freight rates on marketing patterns is rather limited then the question arises what other factors on the supply side are of importance? Some light on this problem is thrown by the way the surveyed millwork firms described their contact with suppliers of pine lumber. Eighty per cent of the respondents specified that they preferred to maintain a personal contact with their suppliers; only one producer replied that in his relations with lumber mills he relied on advertising. It was quite evident that the millwork manufacturers paid a great deal of attention to the question of supply and were in a more intimate contact with the supply sources than otherwise provided for by the traditionally established marketing patterns.

Furthermore, although lumber used by millwork manufacturers lacked the degree of product differentiation normally characteristic of the competitive market, yet loyalties have been established and some buyers may have viewed lumber delivered by some sellers as more valuable than that of other sellers in the sense that they could count on deliveries in times of shortages. This market characteristic was of particular importance in the specific case where the materials input market was the 'sellers' market.

Thus, it does not appear that the marketing profile for the ponderosa pine lumber, the major input into the millwork industry, was clearly defined; it was influenced to some degree, though, by factors on the supply side.

CHAPTER 5. INPUT MARKETS: LABOUR AND CAPITAL

5.1 Labour Input

When discussing factors influencing selection of plant sites (Chapter 3) labour was mentioned in third place, behind raw materials and transportation; yet, when manufacturers were asked whether labour presented any problem, almost one half of them answered affirmatively. This parodoxical situation arose probably from the fact that although a given area might meet the necessary conditions as a good potential labour pool, the harmonious development of labour-management relationship depends on many complex factors, quite a few of them being of intangible, non-economic character.

The distribution of firms by size of labour force either having or not having labour problem is presented below:

TABLE 5.1 FIRMS WITH LABOUR PROBLEM AND UNION CONTRACT BY SIZE

Firm size (workers)	Firms with Labour Problem	Firms with no Labour Problem	Union Contract		
			Union	Open	Closed
Less than 5	3	6	1	6	1
5 - 29	4	11	4	9	..
30 and more	11	4	4	12	..

It seems that the incidence of labour problem varies proportionately to the number of production workers. Large firms had more complaints about labour than either the medium or the small ones. To a certain extent this could be expected from the simple law of averages. More interesting, however, would be a relationship between the type of union contract and labour problem. No such relationship has been observed; firms with unionized labour were evenly divided into the two categories 'with' and 'without' problem. Among the firms with non-union labour the division was slightly in favour of those 'without' problem; 54 percent of firms were counted in the latter category, while 46 per cent registered some complaints.

The non-union workers earned lower wages; their average wage rate was $2.91 per hour, as compared with $3.46 received by union workers. Whether this difference was compatible with similar difference in labour's share in value of output sold will be discussed later on.

Meanwhile let us have a closer look at the association between wage rate and the occurrence of a labour problem:

TABLE 5.2 WAGE RATE AND LABOUR PROBLEM

Rate $/hr.	Firms	
	A	B
1.50-2.49	4	2
2.50-3.49	11	11
3.50-4.50	3	7

A - Firms with labour problem.

B - Firms without labour problem.

It would appear that the manufacturers paying relatively low wages (below $2.50 per hour) complained about labour more often than those who paid relatively high wages (above $3.50 per hour). Those in the middle were equally divided into two groups. While the above relationship may be indicative to certain extent of a general tendency for labour problems to decrease with an increase in wage rate, it is by no means the sole explanatory factor. Local conditions, such as type of labour available, existence of labour intensive industries in the vicinity and the local wage level, are also reflected in the frequency of complaints about labour.

The most frequently quoted single reason for dissatisfaction with labour situation was the difficulty of "getting good workers". Seventy-five per cent of manufacturers claimed that it was extremely difficult to hire an experienced worker at the prevailing market rate. The second most frequent reason was a high rate of turnover; 13 per cent of manufacturers stated that the hired workers did not show much interest in keeping steady jobs and that the rate of turnover was quite high. Only six per cent of firms experienced strikes and another six per cent had trouble in keeping common labourers.

To check how firm are the grounds on which the above statements were made average hourly earnings were calculated separately for the "complaining" and "not complaining" groups of manufacturers. The averages were $2.90 and $3.24 respectively. The former rate was found to be appreciably lower than $3.22 for the total manufacturing sector in Oregon (34). It was also lower than comparable rates for such industries as Food Products, Veneer and Plywood, Logging and Sawmilling and Paper and Allied Products. On the other hand the rate paid by manufacturers who did not complain about labour situation was higher than the average for manufacturing sector and also higher than for veneer and plywood, other wood products, furniture and fixtures and food products industries. Thus, it may be said that wise is the manager who "creams" the local labour market by offering a rate slightly above the 'prevailing' rate because he is likely to avoid the recurring labour headaches. A number of pine-users both of small and large size were found to be wise in this respect.

More light is thrown on the labour problem by the respondents' reaction to the question on employee training program. Seventeen producers stated that to train adequately more than three quarters of their labour force would require a period of time longer than one year. There was not a single employer who would believe that 75 per cent of his employees could be trained in a period shorter than one month; however, three manufacturers stated that one half of their labour could be satisfactorily trained in such a short time. The manufacturers' assessment of labour training program is tabulated below.

TABLE 5.3 ASSESSMENT OF LABOUR TRAINING PROGRAM BY MILLWORK MANUFACTURERS

(Per cent of labour force: in training)

Length of training period:	Up to 25	26-50	51-75	76-100
		Respondents		
Less than 1 month	9	3	1	..
1m - 12 months	3	6	4	10
More than 12 months	6	4	2	17

It is interesting to note that out of fourteen firms with a pessimistic view who declared that to train satisfactorily all their employees it would take more than one year, eleven were in the "less than 10 workers" class and three in the "10 to 20 workers" class. Apparently small shop owners took some pride in their occupation and considered the millwork artisan skill could not be acquired in a very short period of time. On the other hand, larger companies tended to be more optimistic with regard to training period, probably because workers they employed had simpler operations to perform.

Seasonality pattern which is usually marked in other forest industries (logging, sawmills) was not noticed in the millwork industry. Most firms kept employment level steady throughout the year. However, few large firms showed some variation because of hiring students during summer vacation months.

The majority of millwork workers were men, but there was a number of firms which also employed women in significant proportion.

The reasons given for continuation of this practice were numerous: male labour was in short supply; women could handle relatively light material better than men; they were also paid lower wages than men.

There were significant differences in wage rates as between the geographic areas described earlier. Portland-Salem and Medford-Klamath Falls areas reported the highest average wage rates with $3.21 and $3.14 per hour, respectively. In Pendleton-Baker and Eugene-Springfield areas rates were $2.95 and $2.90. The lowest rate of $2.86 per hour was noted in the Bend-Madras area. The difference between the highest and the lowest rates was 35¢, or 12 per cent.

5.2 Capital Input

The concept of capital is difficult to describe and it eludes precise definition. For the purpose of this study, however, it is not as important to decide which of the numerous interpretations is the best, as to be able to distinguish between the various concepts. Consequently, capital is regarded here as an input which has entered into a production unit in the past and remained partly or wholly intact until the current period (2). Thus all machinery, equipment and inventories of products manufactured during the current production period and unsold or simply accumulated from previous periods are considered as capital.

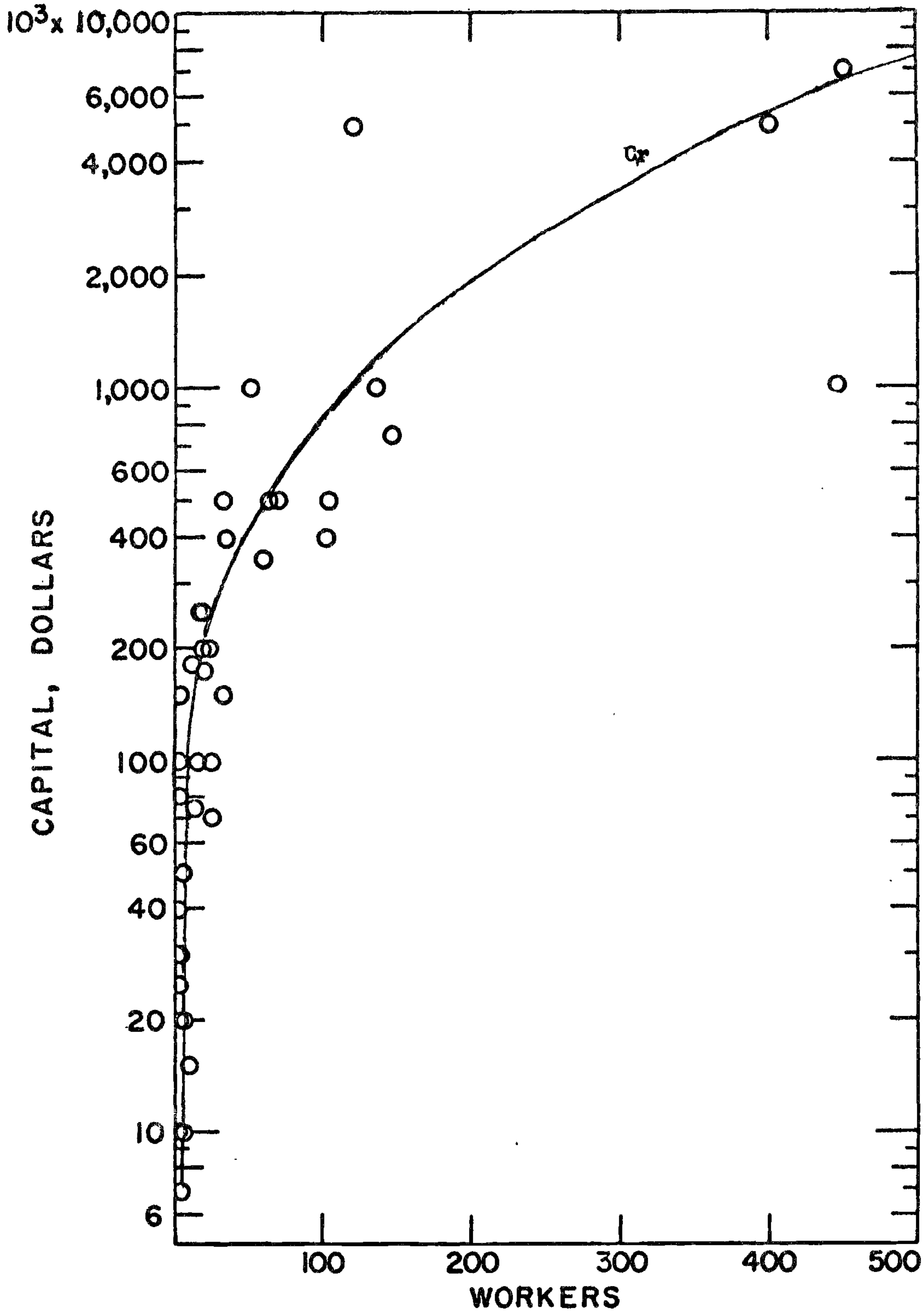
Usually statistics on capital are notoriously difficult to collect and fragmentary, as a rule. Information on capital requirements of pine-users is no exception. Nevertheless, it gives a rough indication of how and to what degree capital is associated with some structural characteristics of the industry and it provides also an insight on the entry conditions. These are illustrated in Table 5.4 and Chart 5.1.

TABLE 5.4 DISTRIBUTION OF PINE-USERS BY CAPITAL REQUIREMENTS AND SIZE OF WORK FORCE, 1967.

Capital requirements ($000's) \ Work force (number)	Less than 10	10-29	30-49	50-99	100 and over
Less than 24	5	1	..	..	..
24 - 50	3	..	..	..	..
51 - 100	2	4	..	..	..
101 - 500	2	6	4	3	2
501 - 1,000	..	..	..	1	2
Over 1,000	..	..	..	..	6

Both the table and the chart indicate a positive association between capital requirements and size of firm expressed in number of workers. There seem to be also the tendency of firms to cluster around the 101 - 500 capital requirements class interval. This might have been caused partly by the respondents' tendency to report round figures, but otherwise is indicative of financial hurdles that expanding firms have to overcome. The latter is well illustrated by approximately normal distribution of firms (all sizes) within a broad interval of capital requirements from $101,000 to $500,000.

CHART 5.1. CAPITAL INTENSIVENESS OF MILLWORK PLANTS.



To check the relationship between capital requirements and number of workers on one hand and value of shipments on the other, two simple regression equations were run through a computer. Both yielded high (squared) correlation coefficients ($R^2 = 0.77$ for the number of workers and $R^2 = 0.81$ for the value of shipments) and fitted the data reasonably well. The curvilinear approximation of the trend (Cr) indicated on Chart 5.1 is due to the use of the semi-log scale for capital requirements.

Further inspection of capital requirements data revealed strong association between the value of machinery and equipment and the type of manufactured product. Firms producing mouldings required, as a rule, expensive machines and thus were faced with heavier capital outlays compared with other products manufacturing firms.

Considering inventories of finished products, the situation was "tight" as one manager observed; generally firms carried a low inventory. Most of the small firms did not carry any stock; they were manufacturing strictly "for orders". On the other hand, the large and medium firms carried sizeable inventory, as shown in Table 5.5.

One half of the firms carried sufficient inventory to last them one month; the other half was divided equally between those with a shorter period (one or two weeks) and longer period (two months). By far the most important lumber specie held in inventory was pine. A number of firms preferred to keep inventory in partly cut-up or ripped

TABLE 5.5 PINE-USERS BY SIZE OF WORK FORCE AND INVENTORIES

Inventories (M.b.f.) / Work force	Less than 10	10-29	30-49	50-99	100 and over
Below 100	3	5	..	1	..
100 - 999	..	2	1	2	1
1,000 and over	..	..	3	1	7

lumber so they could adapt it to the desired order without much waste.

As observed earlier in this section capital requirements are indicative of the conditions of entry into business. From the perusal of available data it looks relatively easy for a marginal firm (less than ten workers) to enter the millwork industry. Actually, according to the opinion expressed by some managers, one self-employed man could easily start a millwork shop with a few thousand dollars. But these firms are usually short-lived and even small fluctuations in input or output prices are likely to drive them out of business. For an investor who would seriously consider his chances of survival and future growth the entry barrier would be within the $101,000 - 500,000 range.

Total capital requirements came to about 32 million dollars. This figure represents also investment demand for input industries such as pine sawmills and millwork machinery and equipment industries.

5.3 Trends in Demand for Inputs

With regard to material inputs only current statistics were collected during this study. No attempt was made to gather information concerning past usage of lumber and other inputs. Consequently, not much can be said about the trend in using pine lumber in millwork from the direct analysis of a historical time series. However, certain assumptions about future developments in the demand of the millwork industry for pine input can be made using indirect information.

TABLE 5.6 CHANGES IN PLANT SIZE: 1958, 1963 AND 1967

Year	Plants (number)	Production Workers (total)	(per plant)	Annual Sales ($000's) (total)	(per plant)
1958	27	1,339	50	25,034	927
1963	37	2,002	54	38,280	1,035
1967	41	2,857	70	57,755	1,409

That the pine-using millwork industry experienced a healthy rate of growth in the last decade is evident from the above table. The number of plants and the average size of plant measured in production workers and annual sales increased by roughly 50 per cent each. The total number of production workers and the total annual sales more than doubled over the same period. This growth was accompanied by an important structural change: small plants (with annual sales below $50,000) declined, while large plants (with annual sales of one million dollars or more) showed a steady increase (Appendix Table 2). This trend can be read also from an increase of the average plant size measured in production workers and annual sales.

Only a small part of this growth in value of sold output could be attributed to the increase in prices which was moderate; thus it can be assumed that the growth in real output was considerable. Assuming further that there was no significant change in input-output coefficients, quite a reasonable assumption in this case, it can be said that inputs must have grown substantially, too. Recollecting from previous findings (Section 4.3) that the proportion of pine lumber to other material inputs remained basically the same, the logical conclusion is that the consumption of pine lumber in the millwork industry must have increased over the 1958-1967 decade, though perhaps not at such a high rate as the value of sold output.

Information on capital input was not available from the field survey. The best that could be done was to use the Bureau of the Census statistics, though they included both pine-users and non-pine-users. According to this source between 1954 and 1963 years the new capital expenditures per millwork plant in Oregon increased from 4.7 thousand dollars to 8.1 thousand dollars or almost doubled. This was the second highest increase, after New Mexico, of all the western states. Judging from the data on capital requirements and share of capital in the value of marketed output (next section) it appears that this increasing trend continued past 1963.

5.4 Factors' Shares in Output

It is not possible to show in an exact manner how labour and capital share in output of pine using millwork industry. However, some idea of what these shares are may be derived indirectly by inspecting labour to output and capital to output ratios for a group of millwork and related industries.

TABLE 5.7 LABOUR AND CAPITAL SHARES IN VALUE OF OUTPUT. SELECTED INDUSTRY GROUPS. OREGON, 1966.

	Ratios			
Industry group	Labour to Capital	Labour to Shipments	Capital to Shipments	Materials to Shipments
Millwork and Related Products	8.822	.1395	.0251	.5918
Meat Products	5.320	.0694	.0130	.8555
Sawmills and Planning Mills	5.035	.2211	.0439	.5932
Nonferrous Foundries	2.337	.2464	.1054	.5110

SOURCE: Annual Survey of Manufacturers, 1966, U.S. Bureau of the Census.

Before arriving at hasty conclusions some caution is necessary, since the figures in the above table refer to groups of industries which are, as a rule, broader than a single industry such as millwork. Furthermore, 'capital' includes only new capital expenditures, thus it is considerably smaller in absolute terms than 'capital requirements' discussed earlier. However, since we are interested in a relative comparison only, it can be assumed that the ratios are indicative also of factor shares within the pine-using millwork industry.

It is clear from the above table that the millwork group is relatively more labour intensive than the other groups; this is evident from the high labour to capital ratio and also from the low capital to shipments ratio. The Nonferrous Foundries, as could be expected, is the least labour-intensive and most capital-intensive group. Another feature of interest is the materials to shipments ratio. It indicates the relative importance of material input in each group: assuming that other intermediate inputs are small.

A more rigorous treatment of labour intensity in each of the mentioned industrial groups would require analysis of their respective production to determine relative factor shares. However, this would be a major undertaking in itself requiring a separate survey.

To what extent the above analysis of labour-intensiveness applies to the pine-using millwork industry is difficult to say with certainty. From the evidence presented so far and also judging by feelings of some manufacturers, it seems that the industry is labour-intensive, but the capital share in output is slowly growing with the changing industrial structure.

CHAPTER 6. PRODUCTION AND DEMAND FOR OUTPUT

6.1 Characteristics of Millwork Production

In countries which elect to implement a theoretical program for economic development, planners have a rare opportunity to test empirically their theoretical considerations. Thus, in choosing between more or less capital-intensive production they are likely to be governed by the length of time horizon: a more capital-intensive technique will be selected for a longer time period, because it will yield relatively smaller current output than the less capital-intensive method, it will have larger surplus and higher rate of growth in the future (27). In a competitive industry, such as millwork, an intelligent entrepreneur motivated partly by experience, partly by intuition but most of all by his desire to increase profits, will trod very likely the same developmental path. He will be limited in his choice of a more capital-intensive production method by technical characteristics of the production function, assuming given availability of financial means.

The millwork production process does not lend itself easily to mechanization, and innovation as indicated by a rather slow-rising trend in capital/output ratio. However, the technology made some inroads into the industry. When new machinery replaced a worn out one, it was usually capable of performing more complicated and faster operations. When additional or replacement motors were installed, they usually were more powerful and consumed more electricity. Changes pointing in the same direction were also noticed in the structure of the industry (increasing plant size and movement towards integration).

Similar changes were observed also in the composition of output between 1958 and 1967. Among those firms who produced mouldings throughout the decade one-third increased production; there were also two new entrants in that field.[6/] Furthermore, six firms started production of custom millwork rather than standard products such as window and door frames. All these firms expanded their output considerably.

Among manufacturers who continued to produce mainly window and door frames, five reduced this production while two increased it. Likewise, among cabinet manufacturers two noted decreases in the proportion of this product, but on the other hand there were five new entrants.

Generally speaking, it appears that two quite different trends could be discerned in the composition of millwork output. One was towards products requiring relatively more capital inputs, as

---

6/ Production of mouldings requires more intricate and expensive machinery.

discussed above; the other towards component blanks, which could be easily adapted to the vagaries of demand. However, the common feature in both cases was the tendency on the part of manufacturers to reduce labour input. Some of them were quite emphatic in stressing the fact that products with a large labour component as a rule brought least returns.

The tendency towards less labour-intensive methods of production could have been more pronounced but for the difficulties in financing such change over. The prevailing market rate of interest (up to 8½%) was found too high for a number of would-be investors in labour-saving equipment.[7/]

The above described trends indicate the understandable desire on the part of producers to maximize their profits; yet it is significant that their action has been directed towards minimizing costs rather than trying to increase their gross receipts. The latter could take several forms such as more intensive advertising, seeking new products and generally to conduct a more aggressive and imaginative marketing campaign. The absence of such efforts was clearly manifested, among other things, by the fact that only five firms mentioned their interest in new products and considered this attitude an important factor in increasing their sales.

7/ This opinion was expressed by several respondents in personal interviews.

When asked what percentage of their business consisted of custom or architectural work, nine manufacturers disclosed that their entire output was of such kind, three produced between 50 to 90 per cent of custom work and for two the percentage was less than ten. None of these 14 firms were the large ones, five were of 'medium' ($100-499 thousand) class while the remaining nine were small (below $100 thousand). Seven of these were in millwork business for more than 15 years. It might be suspected, then, that one of the factors associated with the survival of a small millwork firm could be catering for special markets.

There was not any specific pattern noticed in residue utilization. Most of the firms simply burned it. Seven firms, all but one being large, apparently found the volume of work large enough to turn it into by-products such as chips and presto-logs. Two used it as a fuel, while 12 others sold it either for bedding or fuel.

To better appreciate the extent of the production activities carried out within the millwork industry and at the same time to have a more complete picture of the competitive forces acting on the product market, the relative market shares (percentage value shipments) have been calculated for some selected major products (Table 6.1).

TABLE 6.1 MARKET SHARES OF SELECTED MILLWORK PRODUCTS BY INDUSTRY OF ORIGIN

Product Group	Millwork Industry	Other Industry *
	%	
Window units	99	-
Sash	97	-
Window and door frames	87	Sawmills & planing mills
Doors, wood	94	Veneer and plywood
Finished wood mouldings	79	Sawmills & planing mills
Cabinet work	96	-
Other millwork products	98	-

* Chief industry producing most of the remaining share of the market.

SOURCE: 1963 Census of Manufacturers, U.S. Dept. of Commerce.

The above figures indicate that more than a fifth of the total mouldings production is carried out outside the millwork industry itself. To a certain extent this is also true of the window and door frames. Therefore, it can be surmised, though in a rather loose fashion, that in order for the control of the market of these millwork products to reach a relatively high degree, both concentration and a vertical integration movement would have to occur simultaneously. Such movements have been discerned in the pine using millwork industry in Oregon, but they have not reached, it seems, the proportion that would disrupt the basicially competitive structure of the product market.

6.2 Product Market

Meanwhile, noteworthy changes also have occurred in the flow of millwork products for the whole country, (Census of Manufacturers, U.S. Dept. of Commerce, 1963, Tables 3 and 5). Between 1958 and 1963 the following products declined both in value and quantity: wood sash (24312-11 and 24312-13), glazed sash (24312-15) and wood screen doors (24315-71). On the other hand, hollow and solid core doors (24314-31, 24314-33, 24314-30 and 24314-43) and garage doors (24315-61) showed considerable increases in total value and quantity. Changes occurred also in unit values of a number of millwork products. Window units and some type of doors, including Douglas fir and pine doors, registered sizeable increases; other types including garage and screen doors, decreased in unit values. The latter phenomenon is interesting; it could have been caused by lower prices and, possibly, quality. A plausible assumption could be made that the sharp competition in these products (with steel and aluminum) took the form of price manipulation rather than product differentiation. This, at first sight seems to be in conflict with findings concerning the elasticity of derived demand (see Section 8.1). However, if we admit the possibility that part of total sales of garage and screen doors is conducted through the retail outlets and thus reaches final consumer (home owner), the demand for these products may be price responsive.

Shipments of millwork products in Oregon illustrated below indicate rather moderate changes between 1958 and 1963. The only decrease occurred in wood doors (of panel and flush type).

TABLE 6.2 CHANGES IN SHIPMENTS OF SELECTED MILLWORK PRODUCTS IN OREGON, 1963 AND 1958

Product	Shipments 1963	Shipments 1958	1958/1963 Change	Oregon's Rank *
	($ millions)		%	
Wood window units	4.6	N/A	N/A	7
Window and door frames	9.0_e	7.0_e	N/A	3
Wood doors	13.9	15.7	-11.5	5
Wood mouldings	23.6	22.2	6.3	2
Cabinet work	2.0_e	0.5_e	N/A	17

e estimated values
* Oregon's ranking among the states in terms of value of 1963 shipments.
SOURCE: Census of Manufacturers, U.S. Dept. of Commerce, 1963.

It is worth noting the ranking of Oregon State in terms of output sold. In mouldings Oregon was second (behind California), in window and door frames third (after California and Washington), while in window units, only four states, California, Wisconsin, Washington and Texas were ahead.

From the opinions expressed by pine-users and from the articles which appeared in various forestry journals and magazines, one can form a broad picture of millwork production and output and the significant trends in these activities. Most millwork producers agree that the practice of cutting to finished size in the producing area (cut-stock) and the use of finger-joint material are the two important characteristics of the industry today. The former has been increasing for the last several years, particularly in the Douglas fir and ponderosa pine areas. Several large mills added cut-stock divisions, while quite a few small plants sprang up close to the supply centers. Although cut-stock practices have obvious advantages, they also have some problems, particularly with cost control, in view of the fluctuating material prices. Thus it requires an efficient management and closely cost-controlled production process for a plant to show a profit. Quite often, it will pay a large mill which is situated at a fair distance from the supply source, to buy cut-stock material at the source rather than lumber, if the mill labour costs are closely comparable.

The trend towards a more intensive use of finger-joint items is another important characteristic of the industry. It originated some years ago at the time when improved wood glues were introduced and it has been making steady progress since then (20). Some millwork producers estimate that as much as 60 to 70 per cent of their total sales consist of finger-joint items.

In a sense, it may be said that finger-jointing has been necessitated by a growing scarcity of 'select' and 'clear' grades of lumber on the one hand and the perennial problem of accumulation of short lengths by mills on the other. It permits much better utilization of lumber, reduces costs of inventories and allows for a more flexible sales policy. Frequently, when combined with wood treatment, it cuts down considerably the 'on-the-job' labour costs, as in the case of finger-jointed and prime-coated jambs, which are very much in demand by industrial users. Also, the jobbers and wholesalers prefer dealing in such items because of their fast turnover compared with relatively slow moving solid lumber.

6.3 Geographic Location and Conditions in Output Markets

The nearly sixty million dollars worth of shipments of millwork products in 1967 were distributed as shown below.

TABLE 6.3 OUTPUT MARKETS BY SIZE OF PLANTS (SHIPMENTS) 1967

Plants with Shipments ($ 000's)	National Markets ($ million)	West*	North East	South	Oregon	Lake States	North Central
		(------- per cent of national market ------)					
less 100	.7	15	-	-	84	-	1
100 -999	4.3	17	12	2	48	18	3
1,000 and more	53.9	25	23	18	12	15	7
All plants	58.9	25	22	16	15	15	7

* Excluding Oregon

SOURCE: Special Survey, 1968.

The importance of the western and local (in-state) markets to the Oregon millwork industry is quite evident from Table 6.3. The western market (including Oregon) accounts for 40 per cent of the total value of shipments from all size plants. To a dozen or so of smaller mills the local market is more often than not, the only one that keeps them in operation. Medium-sized mills sell almost half of their output in-state and two-thirds in the three western states: California, Oregon and Washington. It is the large mills which send an appreciable part of their output to the Northeast, Lake States and Southern markets. This "back east" or, more precisely, South-East flow can be attributed mostly to the plants which were originally set up in the West by large eastern mills during the process of adaptation to changing supply conditions.

We have seen earlier that the production of output of the Oregon millwork industry is concentrated in a relatively few large firms. However, this output, when marketed, represents only about five per cent of the total national millwork output. This representation varies from product to product (Table 6.2); in wood mouldings it is strong, in cabinetry it is weak. But even if we consider various product sub-markets, it is doubtful that any single firm or few firms exercise control over price or quantity of output. Furthermore, there seems to be little product differentiation in the industry. This specific characteristic acts as a deterrent for the tendencies towards market control and, possibly, collusive practices to develop to any marked degree.

Collusive behaviour can take specific forms such as price leadership. In this respect no such action was detected among the pine users. Almost 90 per cent of them quoted the similar percentage and length of discount period; about ten per cent offered the same discount rate but over a longer period. Whether there were concealed price concessions it could not, of course, be ascertained, but it is doubtful that such practices existed, since they could be detected through price movements. Most of the millwork producers simply took prices as "given", over which they did not exercise control. In any case they did not seem particularly concerned with this aspect of the market. Only ten per cent of them used salesmen in order to reach customers. Fifteen per cent of the producers used advertising, mainly in trade journals, while most preferred personal contact with customers.

Wholesalers and jobbers were of secondary importance in marketing millwork output. Some large firms tended to rely on salesmen but most of the producers preferred direct sales to final users through personal contact. In this respect they behaved intuitively in accordance with the economic theory: direct appeal to final consumers is more effective, in cases of products with low elasticity of demand, than price manipulation. Such an attitude, which was also evident in their lukewarm interest in intensive advertising, was necessitated mainly by the lack of product differentiation. On the other hand, there was a growing realization, that collective advertising stressing the advantages of millwork products made of wood as against aluminum or plastic was more likely to pay off in the increased product sales.

Transportation costs are generally regarded as a major portion of distribution costs of wood products. The latter, it is estimated, represents about two-thirds of the total costs of lumber for example (29). This proportion would be somewhat smaller for millwork products, since labour costs component per unit of output is appreciably higher than for lumber. Therefore, when considering the market structure for millwork products, the problem of transportation although still of some importance, is not as crucial as for logs or lumber. To illustrate it with an example, most of the highest grade (and most expensive) of local pine lumber is shipped to eastern millwork plants in spite of the relatively high freight rates.

Some railway rates to selected destinations are shown below, to illustrate the differences between millwork products and lumber.

TABLE 6.4 LUMBER AND MILLWORK RAILWAY RATES
(CENTS PER 100 POUNDS)
SELECTED DESTINATIONS

Destination	Lumber	Millwork	Difference*	Lumber	Millwork	Difference*
	(from Bend)			(from Klamath Falls)		
Minneapolis	119	140	17.6	119	140	17.6
El Paso	130	133	2.3	122	138	13.1
Chicago	135	156	15.5	135	156	15.5
Jersey City	144	162	12.5	144	162	12.5

*Millwork over lumber, in per cent.

SOURCE: International Transport, Inc. MF-ICC 410.

The millwork rates from Klamath Falls are on average 14.7 percent higher than lumber rates. The rates from Bend fifer by the same percentage except to El Paso where the difference is very small. Whether or not the differences are of importance, depends on the value ratio per unit of weight and the profit mark-up of the concerned products. There is no data available on the latter and the statistics on the relative unit values are difficult to compile on account of the variety of products involved. On the whole, however, it does not seem that the difference in rates is important in this case.

The question of transportation was discussed in Sections 3.1 and 4.3. It was shown then that its importance in relation to the location advantages has decreased with time. In any case, judging from the results of the interviews with pine users, it appears that they looked at this problem from the supply point of view. They did not seem to be much concerned with transportation costs in relation to the access to market. Similar conclusions could be drawn from other independent studies relating to the marketing of softwood lumber (6 and 29). Thus, it may be repeated again that transportation, although still of some importance, since millwork products are a bulky commodity, does not appear to be a major factor as far as market characteristics are concerned.

To evaluate the trend in the expansion of marketed output two series were compared over the 1958-1967 period: (A) only those firms which continued production throughout the whole period and (B) all the firms. The number of firms in the former was constant, while in the latter it kept changing; the comparative figures are shown below:

			1958	1963	1967
Firms:	(number)	A series	27	27	27
		B series	27	37	41
Sales:	($ million)	A series	25.0	33.0	48.7
		B series	25.0	38.3	57.8

It is quite evident that the pine-users have considerably expanded their output (evaluated at current market prices) during the last decade. Those who maintained their operations almost doubled annual sales; output marketed by all the firms in the industry increased more than two-fold.

CHAPTER 7. INDUSTRY PERFORMANCE: PRODUCTIVITY

7.1 Concept of Productivity

An industry may be considered as prosperous when corporate income and net return on capital are increasing. But it does not necessarily mean that it is an efficient industry. It may simply be riding the crest of a favourable market wave, with sustained demand for its output and not too many difficulties in input purchases. However, its real costs, that is, inputs per each unit of output measured in physical terms, may not be declining.

Taking as a point of departure the economic theory of production, the concept of productive efficiency can be approached through equating quantities as real product and real factor inputs. These relationships may be expressed in a simple functional form:

$q = f(k,l)$ [8/]

where 'q' stands for output, 'k' for capital and 'l' for labour. When marginal rates of factor substitution are identified with

---

8/ Usually a homogenous production function of first degree is expressed: $Q = AK^{\alpha}L^{\beta}$, where A is a constant coefficient and α and β are positive parameters. With factors awarded according to their marginal product, their combined shares equal Q when $\alpha + \beta = 1$; thus in the constant returns to scale case the function has only one parameter: $Q = K^{\alpha}L^{1-\alpha}$ and is known as the Cobb-Douglas function.

the corresponding price ratios and factor data fitted into the equation, movements along a given production function can be regarded as changes in the rate of growth of inputs, while shifts in the production function can be regarded as changes in total factor productivity. Then, the rate of growth of total productivity is the difference between the rate of growth of real product and the combined rate of growth of real factor inputs; it reflects primarily changes in the technology and organization of production (19).

Such an ideal situation when movements in real output and all inputs can be accounted for in an accurate manner exists only in theoretical considerations. In his empirical studies, a research worker faces serious difficulties and often finds out that the necessary statistics, particularly those on capital, are simply unobtainable. Consequently, he is frequently forced to take less theoretical and more practical approach to the productivity concept. Thus, although according to theoretical considerations the total factor productivity which is obtained by relating net output (i.e., net of intermediate products consumed during the process of production) to an aggregate of corresponding inputs is the preferred method, partial productivity measures are often found useful analytical tools, provided they are used with caution. They have been applied in various research studies by private enterprise and public research institutions with encouraging results. Some researchers define productivity as "the use of various factors, taken singly or collectively, per unit of output" and identify high productivity with a low use of a particular factor (17 p.665). Others regard it as the relationship, usually in ratio form, between output and associated inputs, in real terms (19). Still others are convinced that the most meaningful productivity measures are output per employee ratios (21).

The advocates of the total productivity approach (18,19) argue that output should preferably be related to the aggregate of inputs; their only objection to output per man-hour (or per worker) ratio as an indicator of productivity change is that inter-factor substitution may distort the ratio. The proponents of the partial productivity approach (21,23) realize the theoretical nicety of the total productivity measure, but since estimates of capital factor (particularly of intangible capital, including education and research) are at best of doubtful value in their view and labour in most cases constitutes an important factor of production, they favour output per employee ratio as a productivity measure.

The decision was made to use in this study the latter approach, not so much as a matter of choice, but as a result of necessity. Historical capital series were simply not available, neither was information on business costs. For historical comparison the real (gross) output per employee rather than per man-hour worked has been used, again, because data were available. Conversion into man-hours worked could be achieved, utilizing prevailing hourly wage rates. However, this would have entailed estimating a number of hours worked with the possibility of making more errors. The advantage of having a number of workers, rather than a number of hours in the denominator of productivity ratio was that in this way fluctuations in weekly hours which frequently distort the ratio were avoided (19). In addition to historical real (gross) output per employee series a net output (value added) series was calculated for 1967 to afford a better comparison among various size groups.

Problem of quality changes which usually plagues industries with frequent introduction of new product types was ignored in this case. This does not mean that the millwork products have not improved in quality. Such qualitative changes, however, whenever they occurred, were considered relatively insignificant and involved little or no difference in unit cost of production. Similar treatment was also given to the problem of custom-built products. A slight trend towards more custom work shown by few companies (Chapter 6) was not regarded serious enough to impair comparison of products over successive time periods.

7.2 Estimating Output and Inputs

Sometimes, when calculating a productivity ratio, the question arises whether the numerator should be net or gross output. This question becomes important when the industry under surveillance is characterized by a highly differentiated output. In those cases, when dealing with many products of different qualities and varieties it is preferable to use the net concept of output in order to avoid distortions. However, in cases where output is fairly homogeneous it is more convenient to use the gross concept (21).

In this chapter both concepts have been used. For historical comparison purposes value of annual (gross) sales from companies' records for 1958, 1963 and 1967 were deflated by the corresponding wholesale price indexes (with 1958-59 = 100 base) to yield the constant dollars or real output series. These in turn, were divided by the number of workers (including production and office workers) to obtain the real output per worker series or partial productivity ratios (Table 7.1).

Fairly detailed statistics were available on various materials inputs used in production by the surveyed firms in 1967. These included pine and other softwood lumber, plywood, particleboard and hardboard. Each of the inputs was weighted with corresponding price indexes to arrive at the combined value of all material inputs in constant (1958-59 = 100) dollars. The real input series thus computed were subtracted from the real output series to yield the net output or value added series. These, in turn, were divided again by the number of workers to arrive at the partial productivity ratios (Table 7.1).

The 1958-59 base period for the price deflators was regarded

TABLE 7.1 PRODUCTIVITY RATIOS IN THE PINE-USING MILLWORK INDUSTRY, OREGON

	Plant Size (workers)	Real Gross Output Per Worker (dollars) 1967	1963	1958	(Index 1958 = 100) 1967	1963	1958	Real net output per worker 1967
'small'	Less than 10	14,186	19,227	11,717	121	164	100	10,930
'medium-small'	10 - 29	14,272	14,646	9,714	147	151	100	9,333
'medium'	30 - 49	34,930	34,649	26,263	133	132	100	16,486
'medium-large'	50 - 99	28,693	25,793	23,134	124	111	100	15,620
'large'	100 - 199	22,693	16,715	19,313	118	86	100	10,094
'very large'	200 and over	12,440	9,801	11,250	110	87	100	5,330
	All sizes	17,776	16,908	17,844	100	94	100	8,447

as being fairly recent in respect to the survey year (1968,) therefore whatever tendency existed for relative movements in quantities and prices to be negatively correlated[9/] it was not expected to be significant. In any case, since this tendency normally appears in both outputs and inputs it should have a cancelling effect when computing productivity ratios.

7.3 Productivity of Millwork Workers

When discussing the characteristics of production of the pine-using millwork industry (Section 6.1) it was noted that manufacturers by and large made conscious efforts to substitute capital for labour in order to reduce the rate of growth in labour inputs which is usually commensurate with an expansion of output. However, progress in that direction has been rather slow on account of intricacies of the production process itself, with many operations requiring manual handling. As indicated earlier (Table 5.6), both the total work force and the average number of workers per plant increased substantially throughout the period under consideration.

Whether capital inputs have increased much more than labour inputs, it is difficult to say with reasonable accuracy. Considering,

---

9/ Shifting of purchases towards cheaper items.

though, the fact that new capital expenditures per millwork plant almost doubled between 1954 and 1963 (Section 5.3) and the lack of evidence which would point towards slackening in that rate of increase between 1963 and 1967, it can be surmised that an overall increase in capital inputs might have been somewhat higher than that in labour inputs. Therefore, it is possible to argue that the expansion of output of pine-using millwork plants in Oregon has occurred while the capital-labour ratio was increasing at the same time. In other words, some substitution of capital for labour might have taken place during the 1958-1967 period, but more likely than not it was of modest magnitude.

For the reasons explained at the beginning of this chapter the above considerations of input substitution effects bear some importance upon the ensuing discussion on productivity ratios.

The industry as a whole did not register any productivity gains over the indicated time period; it even showed a decline between 1958 and 1963. Over this period, the real gross output increased by 44 per cent while the number of workers increased by 52 per cent (Appendix Table 10). Comparing the whole time period the gap between the two series reduced to less than one percentage point. This is not very flattering nor usual performance of a competitive industry. But it would be wrong to accept this aggregate picture as is, without probing below the surface.

Looking at the performance of plants as grouped in Table 7.1

it may be noticed that real gross output per worker in all of these groups without exception has shown some growth, but the pattern of this growth was uneven. The first two groups of small plants registered the highest productivity gains in 1963. The 1967 productivity ratios were still higher than in the base year, but somewhat lower than in the mid-period year (1963). The large plants classified into the two last groups displayed the opposite growth trend, with negative "gains" shown for 1963. It was the medium (30 - 49 workers) and medium-large (50 - 99 workers) plants which enjoyed a moderate but steady rate of growth throughout the period.

Considering the influence of size of plant on the productivity of workers it is evident from Table 7.1 that the medium and medium-large firms were most efficient in this respect. Workers in these firms reached a highest real gross and also real net output per head. On the other end of this scale were the very large firms, i.e., those employing 200 and more workers with both gross and net measures of productivity as low as one-third of the top level. The relatively poor performance of these firms in the field of labour productivity can only be rationalized along the lines of diminishing returns to additional units of labour, since other factors, such as quality of management, relative strength on both input and output markets and preferential position in the financial area, would tend to work rather in their favour. The effect of an increase in the size of plant on productivity ratios is portrayed in Chart 7.1. Output per worker declined progressively from the top reached by the medium-sized firms (30 - 49 workers) and this feature was common to all three years under review. The size effect upon the net real output per worker is about the same, as can be seen from the chart, except that variations occur at a lower level. This result is in agreement with the line of reasoning offered in the first section of the preceding chapter (6.1).

In order to better illustrate this influence of the size of plant upon the industry's performance the two component series, i.e., the number of workers and the gross real output, have been cumulated for the firms ranked in an ascending order and ratios thus obtained were presented as a "productivity profile" chart (Chart 7.2). Here, we can observe how the increments of progressively larger firms to the industry resulted in at first increases then decreases of productivity. More important, however, is the fact that had the last group of plants (200 and more workers) been excluded from the industry, the 1958 to 1967 trend would have shown a healthy growth in productivity (in index terms from 100 to 116 or 16 per cent). Counted "in" these plants from 1958 to 1967 added some 15 million dollars to the industry's aggregate output in real terms, which when divided amongst 1,167 additional workers brought down the 1967 overall productivity ratio slightly below the 1958 level.

CHART:7.1 Productivity of Pine-using Millwork Plants in Oregon by size of Plant, 1958, 1963 and 1967

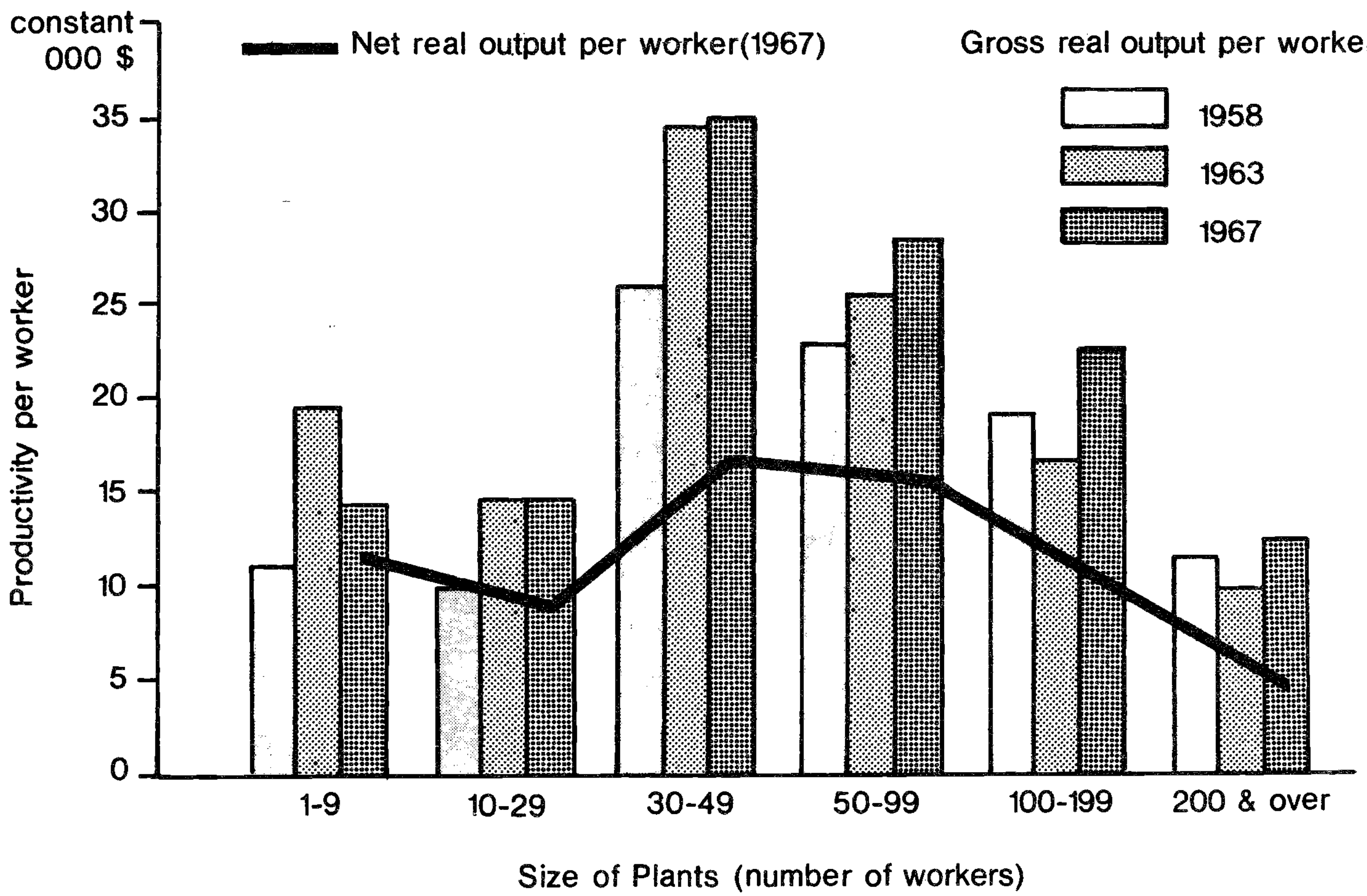
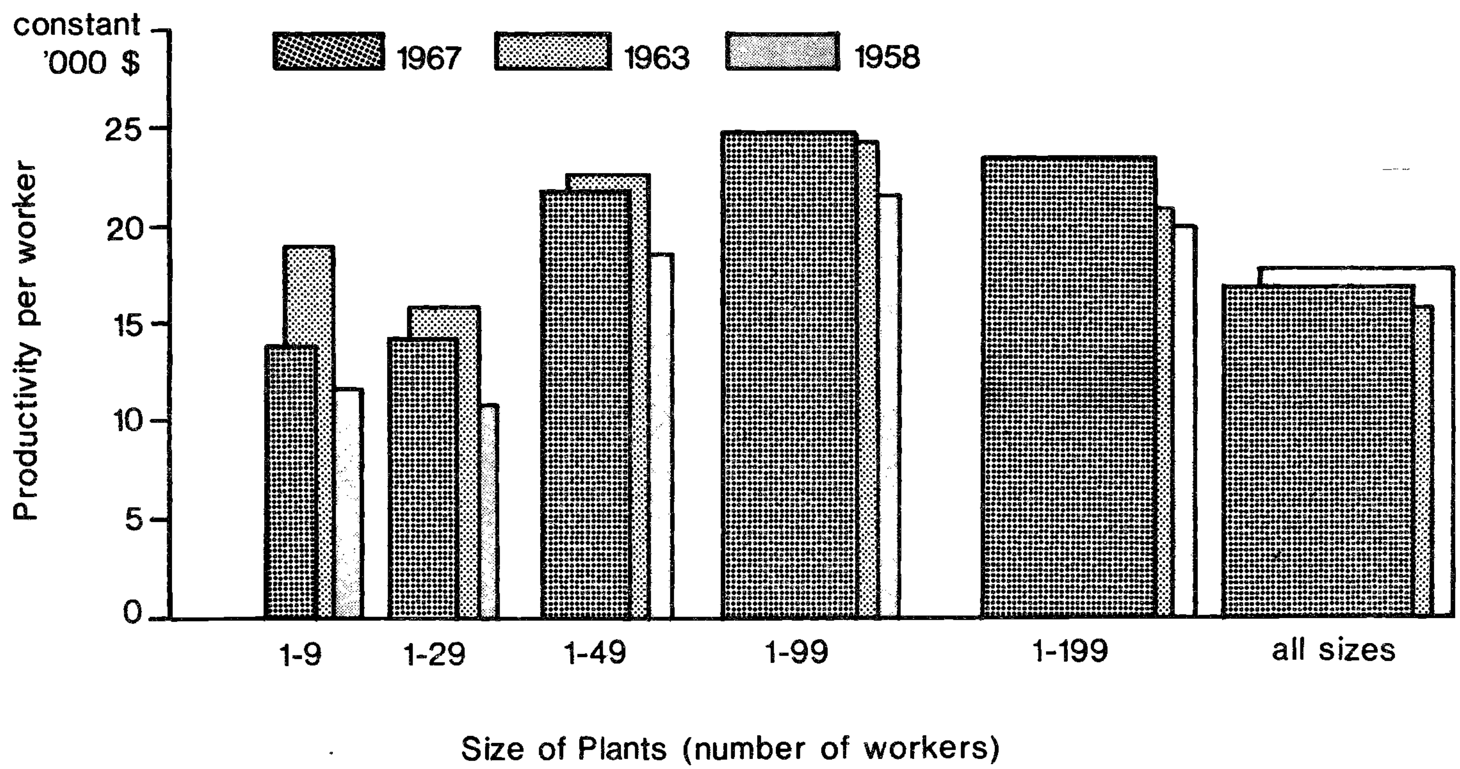


CHART 7.2. Productivity Profile of Pine-using Millwork Plants in Oregon, 1958,1963 and 1967



7.4 Labour Productivity and Wage Rates

Some discussion on wage rates was carried out in Chapter 5 but was confined largely to the differential between union and non-union rates. Here our attention will be concentrated on the association between the rates and productivity for different size groups of pine-using millwork firms and on implications that the trend in these series might have on the overall labour unit costs and capital return rates in the industry. It would also be of interest to see whether the tendency for high productivity ratios associated with the medium-sized firms rather than the large ones, as observed in the preceding section, is commensurate with the similar tendency in wage rates.

When the average hourly earnings were calculated for each size group and arranged in descending order (from one to seven) the ranking of groups by earnings and productivity ratios looked as presented in Table 7.2

TABLE 7.2 RANKING OF PINE-USING MILLWORK PLANTS BY WAGE RATES AND PRODUCTIVITY, 1967

	Number of Workers						
	Less than 10	10-29	30-49	50-99	100-199	200-299*	300 and over*
Hourly earnings	1	4	3	2	7	5	6
Productivity (net) ratios	2	5	3	1	6	4	7

* For the convenience of computation the '200 workers and over' group was split into these two groups.

The Spearman's coefficient of rank correlation computed for the above was found to be: $r_{\sim}$ = 0.89. This seems to be a fair evidence that the two series in question, i.e., the hourly earnings and productivity ratios, are positively correlated. Under certain conditions[10/] the coefficient can be tested for significance; using a small sample test table (28) the coefficient is significant at both five per cent and one per cent levels. In other words, in accepting the hypothesis of rank correlation between wages and productivity there is only one chance in a hundred of committing an error. Therefore, it may be concluded that in 1967 the more productive were the workers in the pine-using millwork industry in Oregon, the better pay they received in general. Whether this tendency has prevailed over the entire period under discussion it is impossible to say as the comparable statistical series for 1963 and 1958 are not available. However, some insight can be gained through inspection of labour unit costs for the pine-users and, more generally, for the whole millwork industry.

The labour-output relationship in terms of man-years per unit of output is shown in Table 7.3.

There was very little difference between the pine-users and the whole millwork industry as can be seen from Table 7.3. The tendency over the compared years was that each unit of output required about 12 per cent less labour to produce it. Had wage rates and prices of

---

10/ Known distribution of $r^{\sim}$, and possible 'null' hypothesis.

TABLE 7.3 LABOUR REQUIREMENTS PER $THOUSAND OF OUTPUT. PINE-USING MILLS AND GENERAL MILLWORK MILLS, OREGON (1958, 1963 and 1967)

	1958	1963	1967	1967/1958 per cent change
Pine-Using Mills	0.0560	0.0569	0.0492	- 12.1
General Millwork Mills	0.0500	0.0475	0.0437	- 12.6

SOURCE: Special Survey, 1967 and the U.S.A. Census of Manufacturers, 1967.

marketed products remained stable, the net result would have been a decline in wage costs. However, there are reasons to believe that exactly the opposite trend took place. Although direct price information was not available, it could be assumed that hourly earnings of workers employed by pine-using mills and prices of products manufactured by them moved approximately in line with wage rates and prices of output of the whole millwork industry. The latter increased by 24% and 14% respectively (U.S. Dept. of Commerce, various years). Thus, the logical conclusion to be drawn from this is that wage costs in pine-using millwork industry in Oregon between 1958 and 1967 must have increased somewhat.

Within this context one might be tempted to speculate whether the stability of unit labour costs would have ensured also price stability on the output markets. This would depend on the movement of real capital assets. Had these assets not appreciated within the observed time period, the answer could be affirmative. But, if the opinion expressed by some managers of pine-using millwork firms on this subject could be taken at its face value, a definite appreciation of real assets has actually occurred between 1958 and 1967, thus product prices would have risen anyway. As it happened, this increase (14%) was considerably smaller than the increase in general millwork wage rates (24%). This observation leads to another interesting conclusion, namely, that the return to capital assets must have declined.

The trends discussed within the context of the last two paragraphs refer largely to the Oregon millwork industry in general and the conclusions about pine-using mills have been drawn by parallel rather than being based on direct empirical observation. Nevertheless these conclusions have frequently been corroborated by the opinion of the interviewed respondents, consequently, they should be given some weight.

7.5 Comparison With Other Forest Industries

In order to see more clearly the industrial performance of the pine-using millwork plants, the important productivity indicators for the millwork and the veneer and plywood industry are presented in Table 7.4.

It appears that the pine-using millwork plants lacked the more vigorous real growth of the veneer and plywood industry in Oregon over the indicated years. It must be remembered, though, that the performance of the same plants grouped by size of employed labour was considerably better, as shown in Section 7.3. Change in the industry structure brought about by an increase in the number of very large

TABLE 7.4 PRODUCTIVITY IN THE PINE-USING MILLWORK PLANTS AND THE VENEER AND PLYWOOD INDUSTRY, OREGON (1958, 1963 and 1967).

	1958		1963		1967		1967/58 % change	
	Millwork	Veneer & Plywood	Millwork	Veneer & Plywood	Millwork	Veneer & Plywood	Millwork	Veneer & Plywood
Gross real output per worker ($)	17,844	19,211	16,908	23,551	17,776	23,107	-0.4	+20.3
Net real output per worker	N/A	8,798	N/A	9,960	8,447	9,183	N/A	+ 4.4
Man-years per $thousand of output	0.0560	0.0520	0.0569	0.0408	0.0492	0.0378	-12.1	-27.3

SOURCE: Special Survey, 1968; U.S. Census of Manufacturers, various years.

plants, highly labour intensive, introduced a downward bias in aggregate performance. Apparently increased output of these plants was realized by proportionally larger inputs of labour. How much of this effect was due to a particular shape of the production function (rapidly decreasing returns to labour) and how much could be attributed to inefficient management, it is a matter of conjecture. However, since there are no obvious reasons to believe that management of large millwork plants was less efficient than that of smaller plants, it may be surmised that it was the characteristics of the production function which were largely responsible for the difference in real growth of the compared industries.

7.6 Conclusions

In synthesizing the productivity picture of the pine-using millwork plants in Oregon it is important to recognize differences in performance by plants of various sizes. It would be misleading to limit the inquiry to aggregate productivity since it is precisely the size of plant which figures here prominently and throws much light upon causal relationships. Plants with number of workers ranging from ten to 49 have shown the highest gains in productivity; as much as 50% compared with base year, 1958. Apparently, this size range is amenable to such a combination of labour with other inputs which tends to produce highest real returns to labour. Interestingly enough, plants of this size have also registered a decline in the average number of workers per plant, while in all other sizes the trend was opposite. Combined with substantial increases in output, this is suggestive of some degree of inter-factor substitution, which resulted in a better utilization of inputs.

An intriguing question may be posed why the large firms' managers somehow have not succeeded in combining all inputs in optimal proportions. It could be argued that they were too much concerned with maximizing the volume of sales, particularly so when faced with a decline in profits per unit of output (decrease in rate of capital return). In this endeavour of expanding output they might very well have been hampered by progressively increasing technical and operational difficulties in substituting capital for labour. In absence of any radical breakthrough in technology, further expansion in output could be achieved largely by increasing labour input with a consequent decline in labour return.

Thus, it may be concluded that following their natural tendency to maximize profits some pine-using millwork manufacturers must have chosen the sales maximizing policy, rather than minimizing real costs which resulted in low labour productivity in their plants. This problem was compounded by a difficulty in replacing manual labour with machinery and equipment, relatively more pronounced than in other industries, such as veneer and plywood. Other manufacturers, however, were able to organize production operations at the high rates of factor utilization, with corresponding high labour productivity. Volume of output and commensurate with it, size of plant, seemed to be the key factor at play; whether this situation resulted from a conscious and deliberate management action or was incidental to the general process of industrial growth is a matter of conjecture and not particularly important for our analysis.

CHAPTER 8. DETERMINISTIC FEATURES OF THE OUTPUT MARKET

8.1 Demand for Output

In the preceding chapters we took a close look at the structure of the millwork industry in Oregon and the forces which determine the process of production itself and the behaviour of the input and output markets. Certain features, such as the tendency towards integration and concentration and the responsiveness of output to prices warranted more attention than other areas. Exposing these features to more intensive analytical probing has also broadened the basis for the stochastic tests carried out in this and the following chapters.

Millwork goods are intermediate products in a wide stream of production activities which originates in the forestry sector and enters the construction sector of the national economy. The demand for these goods can be regarded as an intermediate demand derived from the consumers' final demand for residential and non-residential housing. Thus, in accordance with economic theory, it should be more elastic when: (a) the more readily other construction inputs are substituted for it, (b) the higher is the elasticity of demand for housing, (c) the more elastic is the supply of other construction materials and (d) the greater is the portion of total construction expenditures accountable by millwork products. Findings of the empirical research work done on responsiveness of the demand for forest products used in construction, including lumber and millwork, indicate that price elasticity is generally low, ranging from 0.0 to 0.5 (29). Considering further that millwork inputs into construction are relatively small compared to lumber, the elasticity of the derived demand for millwork products can be expected to fall in closer to the lower end of the indicated interval.

It can be further postulated that the demand for housing is a function of population growth, net family formation, disposable income and the financial conditions on mortgage loans market, to mention only more important factors. Yet, although population and family formation may increase, the effective demand for housing may remain stationary or decrease because of serious shortages of mortgage loans and high rates of interest.

Such a situation seemed to have prevailed during the period under discussion when the population of the United States has been steadily increasing at the annual rate of approximately 1.5 percent. Construction of new housing units in major regions has not kept the pace with this increase (Appendix Table 4); it moved somewhat erratically from year to year, the highest years being 1963 and 1964, although there were differences in this respect between regions. From 1963 to 1966 the number of new houses in the Pacific Region authorized to be built decreased by as much as 58 percent; about the same drop was noted in new starts. California was the state where the number of new units in 1966 was less than one third of that in 1963.

Similar divergent movements can be observed in the flow of physical millwork inputs into the construction sector (Appendix Table 3). While sash and exterior frames did not display any clearly defined pattern, in-flows of Ponderosa pine doors were on the whole increasing. This trend prevailed in face of the generally increasing prices of millwork products (Appendix Table 5). Here we find confirmation of the previously mentioned low price-responsiveness of the derived millwork demand.

It follows from the above considerations that the volume of new construction and prices of millwork products are important factors in the demand for the output and should be included in the econometric model describing this demand. Further, it stands to reason that factors influential on the money market, such as disposable income, mortgage loans and interest rates should also be included in the model. These are the variables which have been selected for the regression equation described in the next section (Section 8.2). Two other variables have been added to the equation: prices of pine lumber and volume of mobile homes. Pine lumber constituted a major input into the millwork industry and was a significant component of output costs. Recent strongly increasing trend in the number of mobile homes warranted addition of this series to supplement the trend in residential construction. It would also be worth while to include in the equation the prices of plastic or aluminum substitutes for the wood-based millwork products. This was not done because of the difficulty in obtaining comparative data with a regional breakdown.

8.2 The Framework for Model A: Single Equation

In order to provide the formal representation of the notions about the market for millwork output two variants of an econometric model will be used: Model A, a multiple regression equation and Model B, a recursive system. In both cases the economic structure or a set of behavioural relationships will be described by the same variables. However, in the first case we shall stipulate that there is only one equation with one endogenous variable, all others being determined outside the system, while in the second we shall examine a set of equations with several endogenous and exogenous variables arranged in a certain orderly fashion. It is postulated that the structure of Model 'A' can be explained through the following linear multiple regression equation:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + E$$

where Y is a demand for annual shipments of millwork products,

X_1 is an index of wholesale prices of millwork products,

X_2 is an index of wholesale prices of Ponderosa pine lumber,

X_3 is new construction (number of housing units),

X_4 is a number of mobile homes sold,

X_5 is personal disposable income per head,

X_6 is an FHA rate of interest,

and X_7 is the volume of FHA loans for residential houses,

β_0 ... β_7 are structural parameters,

and E is a random disturbance term.

In order that the above demand function could be approximated by a method of least squares the following assumptions must be made:

(a) The independent (X_1 to X_7) variables represent numerical quantities observed without error;

(b) The dependent variable, Y, is random and satisfies the above regression equation;

(c) The unobservable random variable, E, representing disturbance term, is normally distributed, with its expected value zero and a variance σ^2;

(d) The disturbance term is homoscedastic, i.e., the errors are distributed independently of explanatory variables X_1 to X_7;

(e) Regression coefficients b_1 to b_7 can take any values, positive, negative or zero; the model described earlier can be considered to imply this assumption.

The uni-equation Model A described above may appear at first sight too theoretical in the sense of being too far removed from the realistic market conditions. However, the field interviews with responding firms showed that the decisions concerning output and sales policies are institutionalized to a considerable degree and most of the (national) market forces expressed in the model as exogenous variables are taken as given even by large firms.

The simple statement of the personal disposable income variable (X_5) warrants some explanation. Strictly speaking, quite restrictive conditions are required for the inclusion of income into a regression model (22) because not all individuals have the same propensity to consume and it is unlikely that the distribution of incomes is as described by a stable linear stochastic model[11/] (i.e., the dependence of each household expressed by a simple linear relationship). The second limitation is related to the permanent income hypothesis (14) and necessitates a special treatment of the transitory income as chance variations in income which affect observation of the true explanatory variable y_p (in a consumption equation: $C_i = ay_{pi} + b + e_i$).

Stochastic testing of the permanent income hypothesis yielded interesting results (31). It was shown that the permanent income elasticity of the demand for housing is indeed higher than that of the measured income (but smaller than unity), as implied by the hypothesis. More significant, however, were the findings that the proportion of permanent income spent on housing decreases as permanent income rises and that the income elasticity relationship appears to be reasonably stable for different time periods and consistent with time-series

---

11/ $Y_{it} = Q_i Y_t + g_i + e_{it}$ where Q_i and g_i are parameters used in calculation of consumption function coefficients and e_{it} is a random term with zero mean; $\Sigma g_i = 1$ while $\Sigma e_{it} = 0$.

estimates. Therefore, although the permanent income concept is very useful in more rigorous studies of the demand for housing, it does not invalidate the traditional expression of this demand (where it is made a function of measured income).

By using measured income rather than permanent income as an independent variable in the above model the response of the demand for millwork output could be slightly underestimated. But considering the fact that the income variable is by far the 'most explanatory' variable (as shown below) this should not significantly alter the inter-variable relationships.

Observations for Model A are indicated below. Series for Y, X_1 and X_2 are indexes based on 1957 - 59 period (U.S. Bureau of the Census). Those for X_3 and X_4 are in thousand units (Construction Reports, U.S. Bureau of the Census). The X_5 series is in dollars per capita, while that for X_6 is the rate of interest and the last one, X_7 represents billions of dollars (Statistical Abstract, U.S. Department of Commerce).

With only nine observations and seven independent variables in the regression equation caution has been exercised in using R^2 as a measure of success in fitting the equation to the data. Also, close attention was paid to the effects of bringing in additional variables in order to avoid possible overfitting.

TABLE 8.1 MODEL 'A' DATA

Year	Millwork Production	Millwork Prices	Lumber Prices	Construction	Mobile Homes	Income	F.H.A. Percent	F.H.A. Loans
	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7
1960	100.0	104.5	101.7	566.3	144.0	1937	6.16	6.3
1961	103.4	101.9	97.4	665.1	130.7	1983	6.00	6.5
1962	106.8	98.3	95.7	716.5	175.0	2064	5.75	7.1
1963	109.3	104.0	95.4	802.9	223.0	2132	5.46	7.2
1964	118.1	108.5	95.5	765.7	281.7	2268	5.45	8.1
1965	127.7	107.7	97.2	724.0	324.1	2432	5.47	8.7
1966	137.9	111.8	106.8	563.5	340.0	2598	6.38	7.3
1967	148.7	114.4	109.7	650.2	370.8	2744	6.55	7.2
1968	156.0	118.5	121.2	694.6	694.6	2928	7.21	8.3

For the first regression run a modified 'forward' selection (zig-zag regression[12/]) was used. Correlation matrix indicates that independent variables are highly correlated, particularly the following pairs: X_4X_5, X_2X_6, X_1X_4, X_1X_5, X_1X_2 and X_2X_5.

12/ Modification consisted of adding at each consecutive step two independent variables, then removing that variable whose departure causes least increase in the residual sum of squares. This procedure avoids a 'closed cycle' phenomenon, i.e., the same subset of X's being accepted and rejected repeatedly, which sometime occurs with step-wise regression.

TABLE 8.2 CORRELATION MATRIX

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	Y
X_1	1.000	.857	-.587	.929	.928	.712	.507	.931
X_2		1.000	-.644	.775	.855	.960	.213	.830
X_3			1.000	-.462	-.550	-.683	.191	-.606
X_4				1.000	.976	.586	.722	.970
X_5					1.000	.710	.585	.994
X_6						1.000	-.351	.689
X_7							1.000	.575
Y								1.000

In view of this high correlation, which in extreme cases (multicollinearity) might increase standard errors of regression coefficients, make coefficients unstable and generally lower the (predictive) efficiency of regression equation, additional runs were made using cross products and separate regression equation for each independent variable. Comparison of the Residual Mean Squares (R.M.S.), R^2, coefficients and standard errors under different runs does not suggest that multicollinearity has occurred in Model A equation.

The difference between the run with individual variables (Table 8.3) and the one with a mix of variables and cross products (Table 8.4) is mainly that in the latter, both the residual mean square

TABLE 8.3 EFFECTS OF ADDING INDIVIDUAL VARIABLES

	X_5	X_5, X_3	X_5, X_3, X_2	X_5, X_3, X_2, X_1	X_5, X_3, X_1, X_6	$X_5, X_3, X_2, X_1, X_6, X_7$	$X_5, X_3, X_2, X_1, X_6, X_7, X_4$
R.M.S.	6.1453	4.3309	1.5439	1.3332	.7316	1.0458	2.0820
R^2	.9873	.9923	.9977	.9984	.9993	.9994	.9994

TABLE 8.4 EFFECTS OF ADDING INDIVIDUAL VARIABLES AND CROSS PRODUCT TERMS

	X_5	X_3X_6	X_2X_5	X_1X_6	X_3	X_1X_2	X_5X_6
R.M.S.	6.1453	2.5924	1.5200	.6350	.4031	.3361	.0805
R^2	.9873	.9954	.9977	.9996	.9992	.9998	.9999

and R^2 decrease slightly faster and that in Table 8.3 the R.M.S. reaches its minimum and then increases with the addition of the last two independent variables (X_7 & X_4).

The effects of introducing additional variables into the regression equation upon the regression coefficients and their standard errors are portrayed in Table 8.5.

The first two coefficients (b_5 and b_3) are stable and their s.e. does not change much; b_2 fluctuates somewhat when new variables are added but its s.e. is relatively small until the last variable appears in the equation. The remaining regression coefficients (b_1, b_6, b_7 and b_4) have large s.e. and are not significantly different from

TABLE 8.5 CHANGES IN REGRESSION COEFFICIENTS AND THEIR STANDARD ERRORS

	X_5	X_5, X_3	X_5, X_3, X_2	X_5, X_3, X_2, X_1	X_5, X_3, X_2, X_1, X_6	$X_5, X_3, X_2, X_1, X_6, X_7$	$X_5, X_3, X_2, X_1, X_6, X_7, X_4$	Significance (5%)
b_5	1.2083	1.1514	1.2869	1.2194	1.2805	1.2913	1.3176	*
s.e.	.0518	.0521	.0502	.0687	.0588	.0782	.4040	
b_3		-.0620	-.0901	-.0867	-.0648	-.0658	-.0660	*
s.e.		.0312	.0204	.0191	.0177	.0214	.0304	
b_2			-.3620	-.3966	-1.1152	-1.0315	-.9965	*
s.e.			.1052	.1012	.3550	.5010	.8754	
b_1				.2458	.4575	.4379	.4537	
s.e.				.1838	.1702	.2128	.3809	
b_6					8.1727	6.8710	6.3843	
s.e.					3.9462	6.2767	11.4075	
b_7						-.0215	.0137	
s.e.						.0683	.1496	
b_4							-.0084	
s.e.							.1238	

zero at 5% level.

After a close inspection of several runs of Model A with all seven independent variables it has become fairly obvious that the X_5 variable (personal disposable income per head) explains by far most of the variations and that the last four variables (X_1, X_6, X_7 and X_4) make very little contribution to the regression. Thus the final run was made with only three explanatory variables, i.e., X_5 (income), X_3 (construction) and X_2 (pine lumber prices), yielding the following results:

	Variable	Regression Coefficient	Standard Error	Constant Term	R^2
X_5	(income)	1.2869	0.0502	16.8884	0.9977
X_3	(construction	-0.0901	0.0204		
X_2	(lumber prices)	-0.3620	0.1052		

All three regression coefficients are significantly different from zero at one percent level and the predictive equation is:

$$\hat{Y} = 16.89 + 1.29X_5 - 0.09X_3 - 0.36X_2$$

It appears that limiting a final selection of explanatory variables in Model A to three has been justified by their performance in the regression equation. Retaining X_2 (lumber prices) in the equation may be regarded as of marginal value, since it is relatively highly correlated with X_5. Nevertheless, its inclusion in the equation provides a better 'fit'. The signs of the regression coefficients, b_5 and and b_2, are what could be expected from the economic analysis viewpoint: demand for millwork increases with disposable income and decreases with the rising prices of pine lumber. However, the negative sign of b_3 implies decreasing demand with increasing new construction which is not realistic. This unexpected result will be discussed further in Section 8.4.

8.3 The Framework for Model B: Four Simultaneous Equations

In this section we shall examine a model consisting of the set of four equations representing simultaneous behavioural relationships which explain the levels of production, consumption and prices of millwork products and ponderosa pine lumber. These relationships and the variables taking part in them, are:

$Y_1 = f(X_1, X_2)$	where Y_1 - pine lumber prices,	X_1 - construction
		X_2 - mobile homes
$Y_2 = f(Y_1, X_3)$	Y_2 - millwork prices,	X_3 - pers. dis. income per capita.
$Y_3 = f(Y_2, X_3, X_4)$	Y_3 - millwork consumption,	X_4 - FHA rate of interest
$Y_4 = f(Y_3, X_5)$	Y_4 - millwork production, (finished goods)	X_5 - FHA volume of loans

The model, then, can be represented by a system of the following simultaneous equations:

1. $Y_1 = A_0 + A_1X_1 + A_2X_2 + e_1$

2. $Y_2 = B_0 + B_1Y_1 + B_3X_3 + e_2$

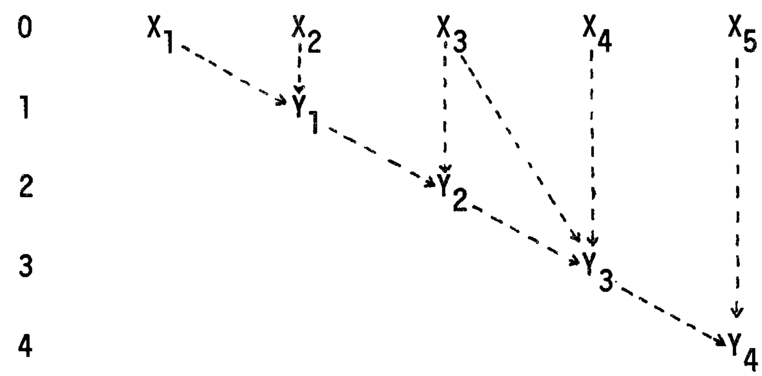
3. $Y_3 = C_0 + C_2Y_2 + C_3X_3 + C_4X_4 + e_3$

4. $Y_4 = D_0 + D_3Y_3 + D_5X_5 + e_4$

where e's are the disturbance terms

Variables are the same as in Model A, but their ordering has been changed. Y_1 to Y_4 are recognized now as endogenous and X_1 to X_5 as exogenous variables; market equilibrium is reached when $Y_3 = Y_4$, or when the quantity of millwork products demanded (finished goods) is equal to the quantity of these products supplied on the market.

The 'pecking order' of the variables can be represented by the following diagram:



All X's are considered as determined outside the system hence they can be assigned 0 order. The first endogenous variable,

Y_1, is determined only by two exogenous variables, X_1 and X_2, thus it can be assigned the first order. Y_2, Y_3 and Y_4 are of the second, third and fourth orders, respectively, since they are functions of one or more exogenous and one predetermined variable.

Applying a simple counting rule (necessary condition) to the model we can see that all four equations are overidentified (9). Arranging these equations in such a way that the disturbance term is left on the right hand side, the following coefficient matrices result:

$$\left[\begin{array}{cccccc:cccc} 1 & X_1 & X_2 & X_3 & X_4 & X_5 & Y_1 & Y_2 & Y_3 & Y_4 \\ -A_0 & -A_1 & -A_2 & & & & 1 & & & \\ -B_0 & & & -B_3 & & & -B_2 & 1 & & \\ -C_0 & & & -C_3 & -C_4 & & & -C_2 & 1 & \\ -D_0 & & & & & -D_5 & & & -C_3 & 1 \end{array}\right] = \left[\begin{array}{cccc} e_1 & e_2 & e_3 & e_4 \\ 1 & & & \\ & 1 & & \\ & & 1 & \\ & & & 1 \end{array}\right]$$

Further exploring conditions for identification (rank condition) arrays of coefficients for each equation were inspected for a non-vanishing determinant. The results below show that such determinant exists for each equation:

Equation	Determinant	Assumption
1	$(1(1-0))$	All A, B, C, and D
2	$(-A_1(1))$	coefficients are
3	$(-A_2(B_1 . D_5))$	different from
4	$(-A_1(B_1 . C_2))$	zero

The matrix of the coefficients of the endogenous variables is triangular and the model therefore can be regarded as fully recursive. Consequently, each equation can be estimated by the least squares method, provided that the error (disturbance) terms are independent. Although there is no evidence suggesting that they are correlated, a method of sequential regression has been chosen to estimate all four equations. $\hat{Y}_1$ or calculated values for Y_1 were used in the second equation, $\hat{Y}_2$ in the third and $\hat{Y}_3$ in the fourth equation. This method is very similar to the two-stage least squares and has an advantage of providing efficient and consistent estimates of coefficients even in cases when errors are not independent (15).

The four equations estimated with this method are:

		R^2
1.	$Y_1 = 116.04 - 0.04X_1 + 0.06X_2,$	.77
2.	$Y_2 = 50.28 + 0.33\hat{Y}_1 + 0.01X_3,$	.89
3.	$Y_3 = -26.21 + 0.15\hat{Y}_2 + 0.05X_3 + 0.80X_4,$	.99
4.	$Y_4 = 3.00 + 1.02\hat{Y}_3 - 0.66X_5.$	.99

The coefficients, except those at $\hat{Y}_1$, X_4 and X_5 which are not significant and have large standard errors, appear to be reasonable. The equations, particularly the last two, seem to fit the data well.

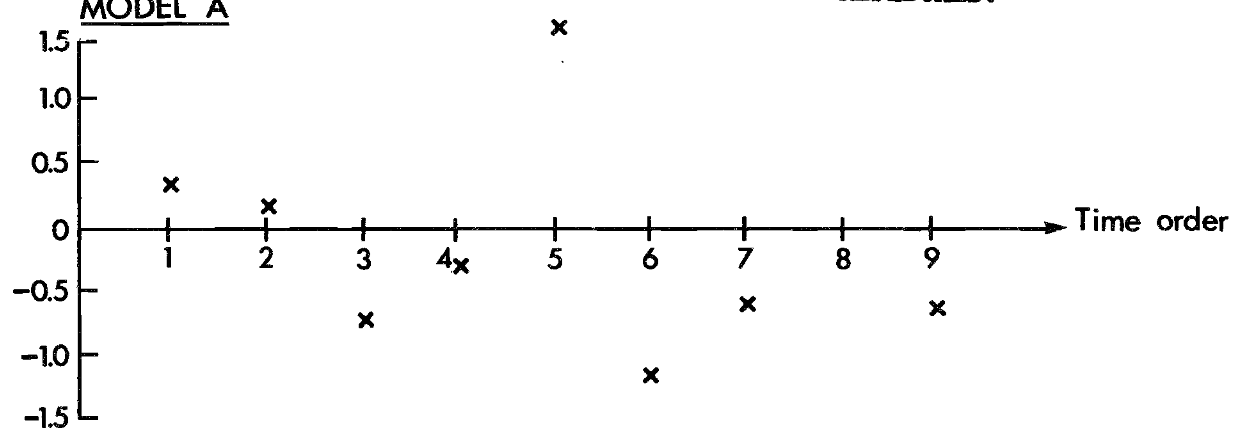
This recursive model which postulated certain behavioural tendencies on the market for millwork products as illustrated above can be justified more generally by the results of other studies which point out that the recursive form is not exceptional characteristic of economic systems (39, 12) and that in the short run forest product markets will often have a similar structure (16).

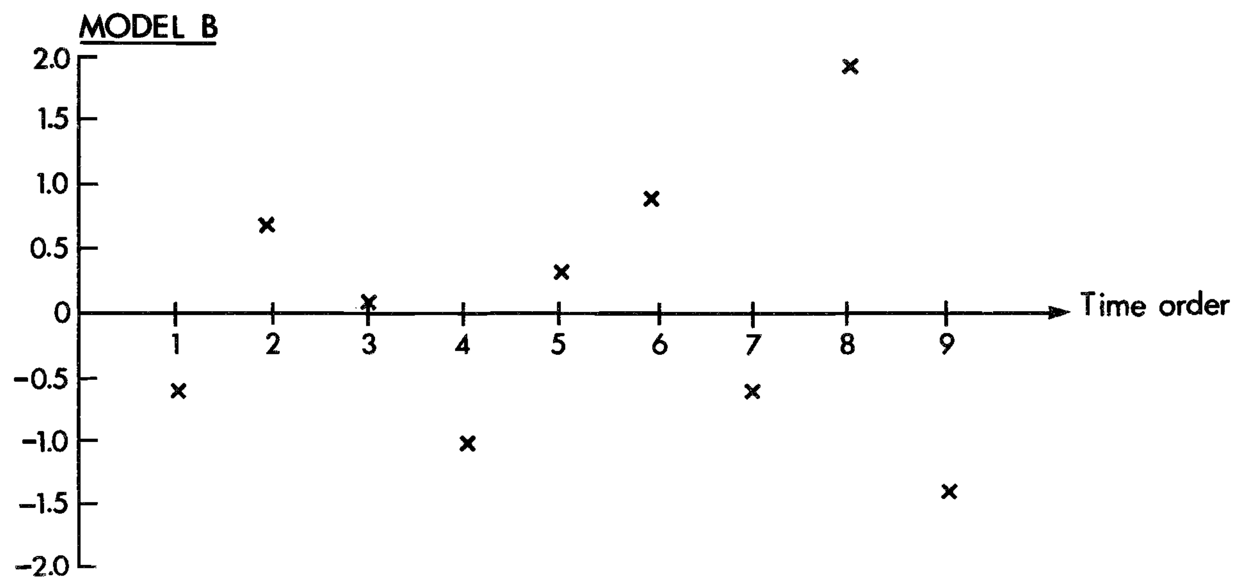
8.4 Comparison of the Models

The predictive equation of the first model (A) has already been tested in order to verify whether a theory is relevant to a given situation. The partial (sequential) F-test was used in order to determine whether the addition (or removal) of one variable provided smaller predictive error than the other. The final three regression coefficients were significantly different from zero. Similar tests were carried out with the model B equations, where the coefficient matrix of the endogenous variables was found triangular and all coefficients, exogenous and endogenous, met the conditions for identification (rank condition).

Looking now at the residuals in both models as the differences between what is actually observed and what is predicted by the regression equation we can examine them for aberrations and, if no unusual behaviour is observed, strengthen our assumption about the predictive power of equation. The plots of the residuals as shown in Chart 8.1 do not display any irregularities. There are no outliers and the positive and negative residuals occur in, what appears, usual pattern (++--+--+- for Model A and -++-++-+- for Model B). Similarly, the envelope

CHART 8.1. EXAMINATION OF THE RESIDUALS.





of residuals does not show a sign of expanding or contracting, which could be indicative of the non-constant variance of the error terms, or heteroscedasticity.

Carrying the examination of the residuals one step further we can test them for serial correlation (autocorrelation) applying the Durbin-Watson test. The results of this test are shown at the bottom of Table 8.6. The d statistic in both cases is larger than the upper critical d_u, therefore, the null hypothesis that the error terms are serially independent (no autocorrelation) is not rejected.

In order to conduct an additional test on the predictive power of the first regression equation (Model A) following values of independent and dependent variables were obtained for 1969:

$$Y = 161.7,\ X_2 = 131.6,\ X_3 = 105.6 \text{ and } X_5 = 161.5.$$

To determine whether the independently observed Y_{1969} came from a population represented by the predictive equation (page 115) we can formulate a hypothesis:

$$E(Y-\hat{Y}) = 0$$

and test it by means of t statistics in the form

$$t = \frac{Y - \hat{Y}}{[V(Y-\hat{Y}]^{1/2}}$$; expanding it, we have:

TABLE 8.6 RESIDUAL ANALYSIS

Observations	RESIDUALS	
	Model A	Model B
100.00	.25	-.64
103.40	.15	.66
106.80	-.76	.02
109.30	-.37	-1.01
118.10	1.51	.38
127.70	-1.17	.78
137.90	-.61	-.56
148.70	1.59	1.80
156.00	-.60	-1.42
Sums $(U_t - U_{t-1})^2$	21.69	21.07
Sums U_t^2	7.72	8.21
Durbin-Watson d	2.81	2.56
Upper critical value d_u	1.73	1.73

$$t = \frac{Y-\bar{y} - b_1(X_1 - \bar{x}_1) - b_2\,(X_2-\bar{x}_2) - b_3(X_3-\bar{x}_3)}{[s^2_{yx}+(1+\frac{1}{n}) + \sum_{i=1}^{3}(X_i - \bar{x}_i)^2 V(b_i) + \sum_{i<j}(X_i-\bar{x}_i)(X_j-\bar{x}_j)\ Cov(b_i b_j)]^{1/2}}$$

where

Y is independently observed value (1969)

$\hat{Y}$ is predicted value from regression equation

$V(Y-\hat{y})$ = variance of $(Y-\hat{y})$

X_1, X_2 and X_3 are 1969 values obtained for X_2, X_3 and X_5, respectively,

$\bar{x}_i$ = mean of X_i

b_i = $i^{\underline{th}}$ regression coefficient estimator

$s^2_{y.x}$ = the residual mean square

n = number of observations

$v(b_i)$ = variance of b_i.

Cov. $(b_i b_j)$ = covariance between b_i and b_j.

Substituting corresponding values into the above expression:

$$t = \frac{161.7 - 123.1 + 0.36(131.6 - 102.3) + 0.09(105.6-108.1)-1.29(161.5 -118.9)}{[1.54(1\frac{1}{9}) + 620(0.0111) + 6361(0.0004)+2286(0.0025)+A + B + C]^{1/2}}$$

[A = 0.0009(-1279.9), B=(-0.0041) 1018.5, C=(0.000003)(-2098.2)] carrying out computations:

$$t = \frac{-6.1}{[11.67]^{1/2}} = -1.78$$

which is smaller than the tabulated t.05 at 5 d.f., consequently there is no reason to reject the null hypothesis or to doubt that the Y_{1969} came from a population represented by the predictive equation of Model A.

There is little difference between the two models as far as their predictive power is concerned. Both should provide a fairly accurate forecast of millwork production. From the convenience point of view Model A is simpler and easier to calculate. It could well fit the role of a short term forecasting tool in a more general analysis of a forest products' market.

Model B, on the other hand, is a more useful tool in analyzing economic problems of interrelationships between factors simultaneously affecting both the demand and supply of millwork products.

Using Model B for the explanation of structural relationships, however, would involve theoretical problems concerned with the aggregation process, since it seldom happens that real conditions will approach perfect aggregation (30). Production functions describing markets for millwork products must be additive and each argument of each function must be itself a function of only one variable.

The perfect aggregation approach represents a neat theoretical treatment which avoids difficulties[13/] usually encountered during the transfer process from the single unit (firm) relationships to those of the system of units (industry). Whether market conditions in the mill-work industry differ little or considerably from those depicting perfect aggregation is an open question. The industry may be considered relatively homogenous both on the input and output sides. Similarly, the prices of millwork products are linked together by a rather well-integrated national market and tend to change by roughly equal amounts. The regional differentials whenever they exist are attributable mostly to varying transportation rates. However, a considerable effort would have to be made in the field of empirical research involving a lot of case studies, before the millwork products market can be subjected with confidence to the rigorous treatment of aggregation.

In this chapter an attempt was made to apply some econometric techniques based on regression analysis to the explanation of economic activity occurring at the millwork products market. The explanation was only partially successful although most of the variations in the products were accounted for by changes in personal disposable income per head, volume of construction and ponderosa pine lumber prices. These results should be regarded with caution because of the small number of

---

13/ Coefficients in the macro time series estimates depend not only on corresponding coefficients in micro series but are influenced also by the time paths of all independent variables in the micro series (12).

observations used in fitting the model. Furthermore, there was one disquieting fact revealed as a result of the quantitative analysis: sales of millwork products were shown to be negatively correlated ($r = -.61$) with changes in construction. This result was opposite to what one would expect to get from an economic analysis of derived demand. In addition to that, the most significant explanatory variable happened to be income rather than construction, which, again, ran against the expectations.

It is hoped that the above exercise demonstrated clearly the importance of quantitative techniques in strengthening the traditional economic analysis and, at the same time, pointed out the pitfalls of relying solely on either method in explaining complex economic activities. Economic analysis alone, would tend to attribute too much weight to the construction as the factor affecting the market for millwork output. On the other hand, the regression analysis by itself would neglect construction and favour income as the most important factor shaping that market. This disparity occurred because the time period for which data was available was short and intercepted adjustment disturbances in the series of residential construction.

CHAPTER 9. GROWTH DYNAMICS OF MILLWORK FIRMS

9.1 Probabilistic Approach to the Problem of Growth

The principal topic of this chapter is centered on the application of one particular concept of the mathematical theory of probability, known as the Markov process, to the analysis of structural changes in the millwork industry in Oregon. It is hoped that as a result of this type of inquiry more insight can be gained about the nature and pattern of these changes, as it seems natural to think of the process of an industrial growth in probabilistic terms.

It will be postulated here that the process of the evolution of firm sizes can be regarded as a size-dependent stochastic process based on the Markov chain principle. In this process an estimate is made of the probability that a firm in a certain size cell will move to another size cell during the period under consideration (1). These probabilities are known as transition probabilities and they provide a basis for a model which can predict the structure of an industry for some future time point, provided certain assumptions are made about the stochastic process. The process considers a sequence of events over a discrete set of time points in which any single event depends only on the outcome at the immediately preceding point of time. The advantage of this approach is that it enables one to describe the pattern of structural changes within an industry without reference to all possible factors which lead to change. It also makes possible derivation from the transition probabilities a tendency towards a "steady state" or the size distribution of firms within industry in some future time period. The steady state is reached when all the exchanges (transitions) between size cells are in balance, that is, the average number of firms moving into a size cell equals the average number of firms moving out. Such a "balanced" size distribution of firms would eventually emerge, subject to specified assumptions, after some finite number of time periods.

9.2 Stochastic Process of Markov Chains

The branch of the theory of probability used to describe the principle and its application to the problem of industrial growth in the above paragraphs was developed by the noted Russian mathematician A. A. Markov (3).

A stochastic process is understood generally as a sequence of experiments which can be subjected to a probabilistic analysis. In a more specific sense used for the purpose of explaining the Markov chain principle this term means a sequence of experiments occurring in time and subjected to random influences. The sequence of experiments is considered to be carried out in stages (between time periods) linked in probabilistic terms. Such a stochastic process is characterized by the states (elements of the state space) which occur and by a measure which specifies the probability that at any given time the process will be in a particular state. This process can be visualized as an independent trials process (32) illustrated by a form of tree diagram in Chart 9.1.

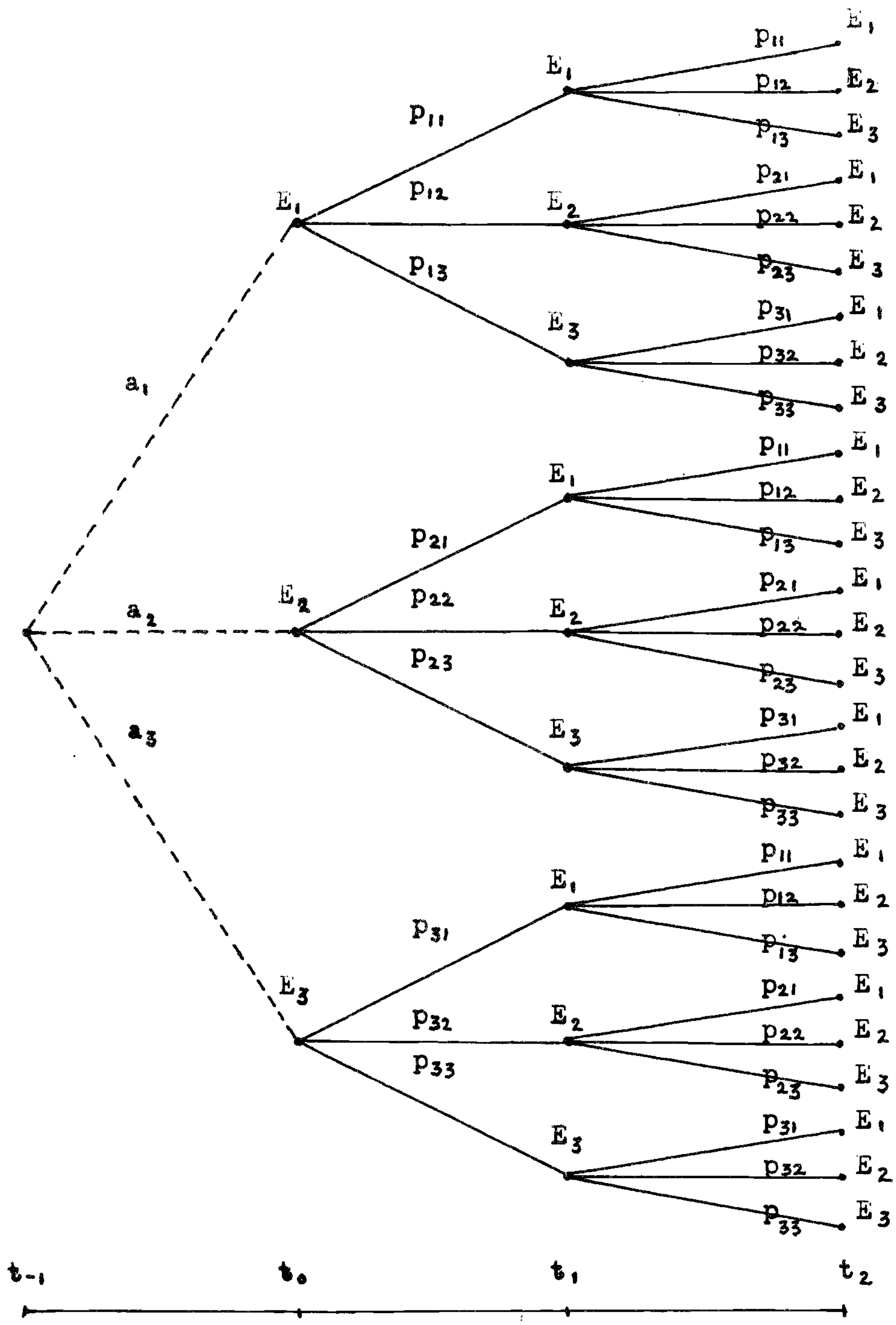
The branching process includes three time periods and there are three states E_1, E_2, and E_3 with initial probabilities a_1, a_2 and a_3. The probability of a particular sequence is given for example:

$P\ (E_2,E_1,E_3) = a_2\ P_1\ P_3 = P_2\ P_1\ P_3$ for an <u>independent trial process,</u> where $a_1 = P_1, a_2 = P_2$ and $a_3 = P_3$.

From Chart 9.1 it can also be seen that although the process may have begun in state E_2 there are three possible routes by which the transition from E_2 to E_3 could take place: $E_2 \rightarrow E_1 \rightarrow E_3$, $E_2 \rightarrow E_2 \rightarrow E_3$ or $E_2 \rightarrow E_3 \rightarrow E_3$ with respective probabilities $P_{21}\ P_{13}$, $P_{22}\ P_{23}$ and $P_{23}\ P_{33}$. The implicit assumption is that the transition process begins in E_2 with $P(E_2) = 1$ or $a_2 = 1$.

Irrespective of what states preceded the present position in a sequence, or what state the process is in at present, the probability of being in state E_i at the next time period is P_i. However, it seems logical that there must be uses where events of the past and present position in a sequence have definite influence on the probabilities of future events. Along such line of reasoning the Markov principle has been developed.

CHART 9.1 A STOCHASTIC TREE DIAGRAM



A stochastic process can be described as possessing what is called Markov property, when the future development is completely determined by the present state and is independent of the way in which the present state has developed. The future is not uniquely determined, but predictions can be made based on probability relations. These relations depend on the present state but not on the manner in which the present state has emerged from the past (11).

Applied to the analysis of the structural changes in the millwork industry, this means that, if a millwork firm is known to be in any given size class at time t_k then knowledge about the size of that firm at previous time points does not affect the conditional probability that the firm will be in any other size class at time $t_k + r$ in the future.

It can be said, then, that a stochastic process has the Markov property when the following conditions are satisfied:

1. There is a finite set of possible outcomes (events) $(E_1, E_2, \ldots E_m)$,
2. The conditional probabilities (transition probabilities) distribution is independent of all previous values (where P_{ij} represents the transition probability, i.e., the probability that the process will make the transition from state E_i to state E_j in one time step) and,

3. The initial state is $E^{o}j$ in which the process started or that the probability distribution for the initial states is $a^{o}j$.

If probabilities in a probability distribution Pij are constant, that is, they do not vary from period to period, such stochastic process is called a Markov chain. It can be represented by a tree diagram very similar to the one in Chart 9.1. The difference is that instead of an outcome Ej being assigned a fixed probability of occurrence Pj, for every pair Ei, Ej there is a conditional probability Pij i.e., probability that the process is in state Ej at the end of the present period given that state Ei occurred on the previous step. In short:

$$Pij = P(Ei, Ej) = P(Ej/Ei) = \frac{P(Ej \wedge Ei)}{P(Ei)},$$

where the event $Ej \wedge Ei$ corresponds to those points in the set Ei at time t_{-1} which are also in the set Ej at time t. In general, the probability of a path through η-step tree will be:

$$P(Ej_0, Ej_1 \ldots Ej_T) = aj_0 \, Pj_0j_1 \, Pj_1j_2 \ldots Pj_{T-1}j_T$$

The sample space (the state space) associated with Markov chain remains the same throughout the entire number of steps of the sequential experiment.

9.3. The Matrix of Transition Probabilities

In a Markov chain the P(Ei Ej) = pij are constant and it is possible to construct a transition matrix P:

$$P = \begin{bmatrix} P_{11} & P_{12} & \cdots & P_{1m} \\ \cdot & & & \\ \cdot & & & \\ \cdot & & & \\ \cdot & & & \\ \cdot & & & \\ \cdot & & & \\ P_{m1} & P_{m2} & \cdots & P_{mm} \end{bmatrix}$$

Each ij-th element pij of P represents the probability that the process will be in state Ej at time t given that at time t-1 the process was in state Ei, with t = 0, 1 ... T.

Several important properties of the transition matrix may be mentioned. It is a square matrix (m x m) of non-negative elements with row sums equal to unity. A matrix satisfying these conditions is called a stochastic, or Markov, matrix; if the column sums also equal unity the matrix is called doubly stochastic (5). Each row of such a stochastic matrix can be regarded as a probability distribution.

Usually in its application to economic analysis the Markov chain is assumed to be finite, irreducible and ergodic. A process is said to be ergodic if it tends in probability to a limiting distribution which is independent of the initial conditions of the process. This assumption seems to be a reasonable one since firms could be expected to be able to move through the size classes and display their intrinsic growth tendency.

Application of the Markov principle to the data concerning the pine-using millwork industry is essentially a stochastic analysis of a time series in which an observation is the size of an individual firm at a point in time with reference to its size at the preceding point in time. The principal characteristics of this analysis are:

1. Time series has a finite number of equidistant time points,
2. There is a finite number of size classes into which an individual firm may be classified,
3. The transition probabilities are constant over all time periods and apply to all firms in a given size class,
4. Information concerning the present situation is sufficient to predict the future (dependence relation of the first order),
5. Elements of the transition matrix P represent the conditional probability that an individual firm will be in a specific size class after the elapse of one time period, given that it began the time period in a particular class.

9.4 Problems of Definition and Interpretation

For the purposes of this analysis an industry is defined as a conglomeration of firms engaged in a similar line of economic activity. The pine-using millwork firms in Oregon fit this definition well and there is no condition for the firms to be primarily engaged in similar economic activity, thus allowing for full consideration of the potential size changes.

There was some problem in selecting a criterion with which to measure an individual firm size and the point of time at which the measurement was to be made. Among several possible criteria, such as employment, value of output, value added and volume of production the first one was chosen as the most appropriate. The average (monthly) number of total workers employed seemed to be a satisfactory indicator of size of a unit and point of time.

The time periods selected for the analysis were the five year intervals, since the data collected referred to these periods. Thus each stage or step in the Markov process was regarded as equivalent to a five year period and there were three such time periods considered in the study.

Another problem which had to be resolved was that of size classes. One could classify the firms in an industry in many ways and each of them could be regarded as good as the other. However, there were used some conventions which helped to limit the number of classifications. These were:

1. The set of states must be finite,
2. Each size class should at some point in the process have a positive probability of occurrence,
3. Large firms could be expected to change size by greater

absolute amounts than small firms; thus it would be logical for each successive size class to be larger than the preceding one,

4. Popular size classes (50, 75, 100, etc.) should be avoided in order not to cause unnecessary clustering.

During the process of classification question arose how to treat new firms entering and old firms leaving the industry. Entering could occur per se, by merger of existing firms or by an outsider-firm expanding its activity. A firm can exit the industry by ceasing to operate completely or partially or by losing its identity through merger. In order to treat in this study the process of growth of the industry as completely as possible and allow for new enterings and exits, an "0" class was added to a five class matrix. Thus a disappearance of a firm from industry was considered as a transition from its class to a "0" class. Similarly, a new entrant was regarded as a transition from a "0" class to its proper active class.

9.5 Analysis of the Application of Markov Principle to the Industry

There were 41 firms considered in this study in the year 1967, 37 in the year 1963 and 25 in the year 1958. They were classified into the five size classes ranging from 1 to 450. The nine and the seven size class system were tried but rejected because of the inconclusive results. The size of each successive class is double the preceding one to allow for the progressively larger expansions. The classification structure is presented in Table 9.1:

TABLE 9.1 INTERCLASS MOVEMENTS OF OREGON MILLWORK FIRMS, 1958-1967

NUMBER OF FIRMS*

Class size (workers)	1958	In Transition	1963	In Transition	1967
0**	-	10 3	-	4 1	-
A 1- 9	12	10	13	11	12
		2 5		2 2	
B 10- 29	2	1	8	7	11
		1		1 1	
C 30- 69	7	6	7	7	9
		1 2			
D 70-149	4	3	6	3	4
		1		3	
E 150 and				1	
over	2	2	3	2	5
TOTAL	27		37		41

* Direction of movements indicated by arrows.

** As explained on page 137.

The probability and the transition matrices were calculated according to the formulas (40):

$$P_{tij} = N_{tij}/\sum_{j} N_{tij} \text{ and } P_{ij} = \sum_{t} N_{tij}/\sum_{t}\sum_{j} N_{tij}$$

where: i = number of classes = 1 ... m in time t
j = number of classes = 1 ... m in time t+1
t = number of years = 1 ... T
N_{tij} = number of firms changing from class i to class j between times t and t + 1.

The frequency matrices for the transition periods 1958-1963 and 1963-1967 are:

To 1963 →

From 1958 ↑ Class	0	A	B	C	D	E	
0	0	3	5	0	2	0	10
A	0	10	2	0	0	0	12
B	0	0	1	1	0	0	2
C	0	0	0	6	1	0	7
D	0	0	0	0	3	1	4
E	0	0	0	0	0	0	2
	0	13	8	7	6	3	37

To 1967 →

From 1963 ↑ Class	0	A	B	C	D	E	
0	0	1	2	1	0	0	4
A	0	11	2	0	0	0	13
B	0	0	7	1	0	0	8
C	0	0	0	7	0	0	7
D	0	0	0	0	3	3	6
E	0	0	0	0	1	2	3
	0	12	11	9	4	5	41

and the transition matrix for the pine using millwork firms is:

Pij =

(t) \ (t + 1)	A	B	C	D	E
A	.84	.16	0	0	0
B	0	.80	.10	.10	0
C	0	0	.93	.07	0
D	0	0	0	.60	.40
E	0	0	0	.20	.80

Had the number of the observed transition periods been larger the Chi-square test of goodness of fit could have been carried out to test the hypothesis that a set of probabilities Pij estimated from observations on a finite Markov chain are equal to a set of specified probabilities P^o_{ij}. However, since there are only two sets of data available and the resulting matrix contains a rather large number of zeros, it seems appropriate to reject the test.

In agreement with an ergodic property of Markov chain (1) the limiting form for the transition matrix can be computed using the sequential approach:

$$P,\ P.P,\ P.P^2,\ \ldots\ P.P^{n-1},\ P^n.$$

The elements of each product matrix P^n are formed by row-column products of the form $P.P^{n-1}$, each element representing probability that the process after n steps will be in state E_j, given that it started in state Ei. For a large class of numbers the matrix P^n approaches a matrix with identical rows. This implies that for sufficiently large n the effects of the initial distribution gradually wear off.

To determine the rate of convergence towards a steady state, P^n was computed for n = 30:

$$P^{30} = \begin{vmatrix} .005 & .016 & .132 & .296 & .550 \\ 0 & .001 & .083 & .313 & .603 \\ 0 & 0 & .108 & .307 & .585 \\ 0 & 0 & 0 & .333 & .667 \\ 0 & 0 & 0 & .333 & .667 \end{vmatrix}$$

which suggests the converging tendency of P^n as n approaches infinity:

$$P^{n} = \begin{vmatrix} 0 & 0 & 0 & .333 & .667 \\ 0 & 0 & 0 & .333 & .667 \\ 0 & 0 & 0 & .333 & .667 \\ 0 & 0 & 0 & .333 & .667 \\ 0 & 0 & 0 & .333 & .667 \end{vmatrix}$$

In order to determine the transitional activity for the period under observation (1953 - 1967) the elements of the Pij matrix (page 139) above and to the right of the diagonal were compared with the elements below and to the left of the diagonal. All elements in the upper right-hand portion of the matrix were larger than those in the lower left-hand portion thus indicating an overall tendency towards an upward movement between the classes. The diagonal elements represent probabilities that the millwork firms will remain in the same size class. In this respect, the C class of firms (30-69 workers) displayed the least pronounced tendency to move to an upper class. It is worth noting that the firms in this size class were found to be most efficient (Chapter 7, Section 7.3). In contrast, the relatively low diagonal probability for the D class (70-149 workers) was indicative of the strong tendency for the firms in this class to move up to the next size class.

In view of the observations made above it can be stated that some movement towards concentration has occurred within the pine-using millwork industry in Oregon. The trend, though, has neither been pronounced, nor rapid, as shown by P^{30} matrix. This can be further illustrated by applying the transition matrix in order to predict the size-class distribution of the industry for the next period, i.e., 1972:

Size-class	Number of Firms	Size-class	Number of Firms
1 - 9	10	70 - 149	5
10 - 29	11	150 and over	6
30 - 69	9		

As can be easily verified the 1972 cell frequencies (number of firms) differ very little from the 1967 frequencies.

Concentration tendency has already been discussed in the earlier part of this study (Chapter 2, Section 2.3). The comparative concentration ratios for the Oregon and Canadian industries were illustrated by C curves in Chart 2.1. Application of the Markov model to the same data, though, provides deeper insight into the transitional movements which make up an overall trend in concentration. It throws light on the detailed shifts in the industry size distribution and on the existence of the very long term tendency towards medium and large size firms. The latter simply expresses the tendencies observed during a given (short) period of time projected towards some very distant point in time.

In conclusion it must be conceded that both the scope of the discussion and the reliability of some of the findings, particularly one on the predictive power of the model, have been severely limited by the scarcity of data.

For a more thorough and reliable application of the Markov principle to the structural changes within the Oregon pine-using millwork industry it would be desirable to divide the time period 1958-1967 into smaller, preferably one year, intervals and to estimate the Markov chain for each of these intervals. Furthermore, the means and variances of first passage times could be calculated showing how long a time a firm can be expected to spend waiting in a specific size class before it moves to the next one. This would provide more insight into the nature of the steady state of the industry. More information would also be gained on the patterns of internal movements by computing the internal mobility indexes from the transition probabilities and thus estimating parameters of the process of structural changes. All these otherwise desirable improvements, however, require more detailed data, which was not available.

CHAPTER 10. SUMMARY AND CONCLUSIONS

10.1 Summary

The 1958-1967 decade can be noted as the period of strong and uninterupted growth for the pine-using millwork industry in Oregon. During these years its gross annual output in terms of current dollars almost tripled and its work force more than doubled. In 1967 the pine-using millwork plants employed close to 3000 workers and marketed an output worth about 60 million dollars. Almost one-half of these plants were relatively large (with annual gross sales ranging from $1 million to $15 million) and accounted for 92 percent of total sales.

The very rapid growth rate, amounting to as much as 14 percent per annum in current dollars was not accompanied by any dramatic changes in either the industry structure or the market conduct. Some movement towards integration has been detected but was not pronounced. Similarly, concentration of output increased somewhat but not to a degree that would disrupt the traditionally competitive character of the market. Oligopsonistic conditions to the extent that they existed in the pine lumber market at all, occurred strictly on a regional basis. In other words, few large buyers of pine lumber enjoyed locally a privileged position in securing adequate supply and better terms of sale.

It appears that there were two principal reasons which retarded the integration and concentration processes in the Oregon millwork industry: a relatively easy entry into the industry and the particular characteristics of production which were not amenable to the swift substitution of capital for labour. For small firms employing less than ten workers capital requirements to set up a shop were below $25,000, while workshops run by one person (owner/operator) required less than $1,000 for a start. Similarly, while attempting to apply technological innovations many managers found that although certain operations could be partly or wholly done by machine, many others still required manual handling. A further obstacle in the substitution of capital for labour was the shortage of capital necessary for the changeover to less labour-intensive methods of production manifested by the prevailing market rates of interest too high for many would-be investors in labour-saving equipment.

Labour was not the problem of prime importance for Oregon millwork plants; the firms were about equally divided on this issue. Generally speaking, large firms complained more often about the difficulties of hiring and keeping 'good workers' than the small ones; this could be expected. The question of good management-labour relations seemed to be more directly related to wage rate. Producers, who paid a wage rate high relatively to the rates existing on the local labour market, were on the whole satisfied with their employees.

Furthermore, collective bargaining did not appear to be a factor influencing management-labour relationship. It did affect, though, the wage-rate itself; unionized labour was paid higher wages.

Closely related to labour was the problem of productivity. It proved necessary to treat it on two levels, aggregate and individual. On the aggregate level the millwork industry did not show much gain over the period under discussion. However, plants with ten to 49 workers noted a 50% increase in productivity, or five percent per year on the average. Other size-class plants showed smaller gains. The smallest gains were noted by the largest plants, i.e., those with 200 and more workers. Apparently the very large firms did not solve entirely satisfactorily the problem of combining labour with other inputs in such a way as to produce highest real returns to labour. They must have achieved further expansion in output largely through increasing labour which resulted in diminishing returns to that factor. It was the medium firms which scored exceedingly well in this respect and whose managers apparently succeeded in combining all inputs in what must have closely approximated optimal proportions.

The most important market for the output produced by the Oregon millwork plants was in the West, including Oregon; about 40 percent of total output was sold here. Small and medium firms catered almost exclusively for the local market. The large firms, in addition to supplying the local market, also sold their output in the Northeast, South and Lake States. Transportation costs, no doubt, were one of the factors which influenced such preferential distribution of output; however, as it was pointed out in Section 6.3, they did not constitute a dominant factor. Those millwork producers who were not branches of the old established 'river mills' in the East, found it more convenient to dispose of their product locally. They cast their appreciative eyes upon the West also because they were convinced that this market has very real potential for expansion.

10.2 Conclusions

In a dynamic economy, such as the American economy, the powerful forces of innovation and change are in a state of flux which makes it difficult to establish the cause-effect relationships in a very precise manner. One researcher may see the effects of innovation as dependent upon the nature of the innovation itself and not necessarily upon the adaptability of the structure of the economic system. Another may regard the effects in which he is interested as an outcome of the interplay of such factors as managerial competence, individual adaptation to change and innovation, entrepreneurial ingenuity, personal judgment and motivation against the economic and social environment. It is extremely difficult to describe a more complex economic process precisely in a theoretical or analytical model. The economic researcher is usually forced to trade off a little bit of precision for a little bit of knowledge and experience.

At the outset of this dissertation several hypotheses were formulated which, later on, were subjected to some analytical and stochastic testing. The one concerned with the integration and concentration process was discussed in the early part of this study. The outcome of this discussion was that although some trend towards integration and use of more capital intensive methods of production was detected in the pine-using millwork industry in Oregon it did not advance too far. The industry could still be regarded largely as competitive and rather labour than capital intensive. In this respect it was found somewhere in between the highly competitive cotton yarn industry (in Canada) and all the millwork industry where concentration was relatively high. It is expected that further technological improvements intensifying the use of capital inputs will occur and that the process of concentration of output in larger firms will continue making advances, but at a slow rate.

While constructing a model for the product market, the demand for millwork output was treated as an intermediate demand derived from the consumers' final demand for residential housing. This is an acceptable procedure from the point of view of economic analysis. Furthermore, it was postulated that the responsiveness of this demand measured in terms of income and price changes should generally be lower than that of final demand. Discussion of empirical findings confirmed this postulate. What remained was to test the hypothesis that the demand for millwork output is functionally dependent upon the activities in the construction sector. The test was not conclusive since the linkage between the sales of the millwork products and construction activities was found to be weak and in the opposite direction to what could be expected. The observed period intercepted strong disturbances in the construction sector to which the millwork product market apparently did not respond. When these results were combined with findings of economic analysis,it became evident that the derived demand for millwork product was not nearly as dependent on construction activities as an economic theory would imply,neither was its functional links with income as strong as suggested by the econometric model.

It is possible that increasing substantially the number of observations would bring the functional dependence of the millwork on volume of construction closer to what is normally expected. However, even with a considerable refinement of the techniques used in this exercise, it would not be feasible to remove all inherent limitations of the econometric model. As Professor L.R. Klein commented:

> "...even if all variables could be precisely measured, econometric equations would not be exact. No matter how detailed and complex we try to make our equations we should find that many variables have not been explicitly taken into account."[14/]

14/ L.R. Klein. A Textbook of Econometrics. Evanston, Ill., Row, Peterson and Co., 1953. p. 284.

The third hypothesis was formulated with reference to a 'westward' shift of the millwork industry. It could not really be subjected to a rigorous testing process, but in the sense that the millwork producing activities based on pine lumber have increased in the West and decreased in the East, one may indeed venture a statement that there had occurred a westward shift in millwork industry. Partly, it came as a result of old-established 'river mills' branching out West and partly through a growth of indigenous industry. Among the important factors which caused this shift were: proximity to abundant supplies of ponderosa pine lumber, availability of relatively cheap labour and increased construction activities within the region induced by a vigourous population growth. Less clearly delineated, however, were the changes in marketing; the combined Northeast and Lake States markets still accounted for close to 40 percent of total millwork output sold. Apparently, the links with the East remain strong in spite of the passage of time.

Turning now our attention towards the fourth and last hypothesis, it may be said that the Pacific region offers good expansion opportunities to the millwork industry, in spite of a problem of scarcity of inputs, principally of ponderosa pine lumber. Taking an overall view of the supply situation, the volume of pine sawtimber and growing stock in Central Oregon has been decreasing during the last three decades, although recently the rate of decrease has slowed down considerably.[15/]

15/ Timber Resource Statistics for Central Oregon, The U.S. Forest Service Bulletin, PNW-24, 1968, p. 29.

There are reasons to believe that with more intensive forestry practices this trend could very well be arrested, if not reversed (25). Furthermore, it must be observed that only a relatively small part of the total supply of pine lumber had been made available to millwork firms. It could have been that lumber producers regarded prices offered by millwork buyers simply not high enough to come forward with increased supplies. It was shown elsewhere in this study that many energetic and aggressive managers among pine users overcame this scarcity and secured enough supplies to enable them to grow and reach the efficient size.

The market conditions, both from the inputs and output point of view, have been found conducive to a high rate of growth for the Oregon pine-using millwork industry. The industry is in advantageous position favouring such a growth; it is situated near the source of the large potential supply of raw materials and it faces expanding markets for its products in the West. It seems almost inevitable that higher prices will have to be paid for choice lumber; the firms will have to absorb these higher prices into their internal cost structure without weakening their competitive position on the product markets. That this is possible, it has been demonstrated in the immediate past.

The large millwork producers would be wise also to take cognisance of some aspects of their productive efficiency and optimal plant size disclosed by this analysis. They stand to gain by streamlining their operations and reducing work force to proportions more compatible with optimal combination of productive resources.

BIBLIOGRAPHY

1. Adelman, C. A stochastic analysis of the size distribution of firms. Journal of the American Statistical Association 53:893-904, 1958.

2. Alchian, A.A. and Allen, W.A. University Economics, 2nd ed. Belmont, Wadsworth, 1967. 825 p.

3. Anderson, T.W. and Goodmand, L.A. Statistical inference about Markov chains. The annals of Mathematical Statistics. 28:92-96, 1957.

4. Bain, J. S. Industrial Organization. New York, Wiley, 1959. 643 p.

5. Bharucha-Reid, A.T. Elements of the theory of Markov process and their applications. New York, McGraw-Hill, 1960. 468 p.

6. Bruce, Richard W. Intraregional competition in lumber markets of the eleven western states. Washington State University, Washington Agricultural Experiment Station. Washington State University, Bulletin 711, August 1969. 31 p.

7. Buttrick, P.L. Forest economics and finance. New York, Wiley, 1948. 484 p.

8. Chapman, G.W. The role of forestry development in national planning. Paper presented at the Sixth World Forestry Congress, Madrid, June 1966. No. 6, C.M.F./E/P1.2/20.

9. Christ, C.F. Econometric models and methods. New York, Wiley, 1966. 705 p.

10. Duerr, W.A. Man and the forest. Syracuse, Syracuse University, 1966. 274 p.

11. Feller, W. An introduction to probability theory and its applications. New York, Wiley, 1957. 298 p.

12. Fox, K.A. Intermediate economic statistics. Ames, Iowa State University, 1968. 422 p.

13. Fox, K.A. Structural analysis and the measurement of demand for farm products. Review of Economics and Statistics 36:121-143, 1954.

14. Friedman, M. A theory of consumption function. New York, National Bureau of Economic Research, 1957. 71 p.

15. Goldberg, A.S. Econometric Theory. New York, Wiley, 1964. 399 p.

16. Gregory, G.R. A statistical investigation of factors affecting the market for forest products - an econometric study. Forest Science, 6:123-134, 1960.

17. Heath, J.B. British-Canadian industrial productivity. Economic Journal 67:665-691. 1957.

18. Jorgenson, D.W. and Griliches, Z. The explanation of productivity change. Review of Economic Studies. 34:249-276. 1967.

19. Kendrick, J.W. and Creamer, D. Measuring company productivity. In: Studies in Business Economics. National Industrial Conference Board, Paper No. 89, 1965. 120 p.

20. Lloyd, W.B. Millwork, principles and practices. Chicago, Cahners, in association with National Woodwork Manufacturers Association. 1966. 426 p.

21. Mahesvri, P.C. How far size affects productivity of the industrial unit. Indian Labour Journal 28:768-780. 1970.

22. Malinvaud, E. Statistical methods of econometrics. Amsterdam, North Holland, 1966. 631 p.

23. Newton, R.G. An international inter-firm comparison study in the glass industry. In: Productivity Measurement Review. O.E.C.D. No. 41, 68-88 p., May, 1965.

24. Panshin, A.J., De Zecuw, Carl and Brown, H.P. Textbook of wood technology. New York, McGraw-Hill, 1964. 374 p.

25. Richards, D.P. Some characteristics of Western Oregon sawmilling industry affecting small woodland owner. Master's thesis. Corvallis, Oregon State University, 1962. 149 numb. leaves.

26. Santa Cruz, H. The forestry sector in process of economic and social development and forestry institutions. F.A.O., I.F.F.D., June, 1966.

27. Sen, A.K. Choice of techniques: an aspect of the theory of planned economic development. Oxford, Blackwell, 1960. 122 p.

28. Snedecor, G.W. Statistical methods. 5th ed. Ames, Iowa, Iowa State College Press, 1956. 534 p.

29. Stanford Research Institute. America's demand for wood. 1954.

30. Theil, H. Linear aggregation of economic relations. Amsterdam, North-Holland, 1965. 267 p.

31. Tong Hun Lee. Housing and permanent income: test based on a three year re-interview survey. Review of Economics and Statistics 50:481-489. 1968.

32. Urbanik, K. Remarks on the equation of branching stochastic processes (in Polish). Zeszyty Naukowe Uniwersytetu Wroclawskiego, ser. B, no. 1, p. 17-26, 1956.

33. U.S. Dept. of Agriculture. State Agricultural Experiment Station. Miscellaneous Publication 904. Washington, D.C., 1962. 37 p.

34. U.S. Oregon State, Dept. of Employment. Oregon's Labor force trends. Salem, Ore., 1968. 45 p.

35. U.S. State of Maine, Dept. of Labour and Industry. Bulletin 621. Augusta, Maine, 1964. 27 p.

36. Western Wood Products Association. Market Facts. Portland, Ore., 1966.

37. Western Wood Products Association. Statistical Supplement. Portland, Ore., 1968.

38. Westoby, J.C. Forest Industries in the attack on economic development. Unasylva 16(4), 1962.

39. Wold, H.D.A. and Jureen L. Demand Analysis, a study in econometrics. New York, Wiley, 1953. 358 p.

40. Zivnuska, J.A. The integration of forest development plans and national development plans. Paper presented at the Sixth World Forestry Congress. Madrid, June 1966, No. 6, C.F.M./G/Pl.2/3.

APPENDIX I

TABLE 1. STRUCTURAL CHANGES IN MILLWORK INDUSTRY IN SELECTED WESTERN STATES, 1954-1963

		Plants			Production Workers						
		Total	Large[a]	Employees	Total	M/H	Wages	Value added	Cost of materials	Value of shipments	New capital expenditures
		(number)		(number)	(no.)	(000's)	($000's)	($000's)	($000's)	($000's)	($000's)
Arizona	1954	23	4	399	328	638	1,216	2,473	4,071	6,545	130
	1963	45	9	607	500	952	2,498	5,671	8,479	14,090	157
	change %	+96	+125	+52	+52	+49	+105	+129	+108	+115	+21
Colorado	1954	26	3	377	325	712	1,197	2,098	2,758	4,856	107
	1963	34	3	273	242	469	1,061	1,761	1,643	3,405	81
	change %	+31	0	-28	-26	-34	-11	-16	-40	-30	-24
N. Mexico	1954	20	4	313	281	584	1,115	2,118	4,025	6,144	105
	1963	22	6	429	367	782	1,753	3,082	6,212	9,246	314
	change %	+10	+50	+37	+31	+34	+57	+46	+54	+50	+199
Mountain Region	1954	136	23	2,195	1,914	3,792	7,151	13,117	21,078	34,196	549
	1963	181	30	2,423	2,089	4,109	9,678	18,871	27,814	46,308	907
	change %	+33	+30	+10	+9	+8	+35	+44	+32	+35	+65
California	1954	454	95	7,443	6,283	12,274	25,234	47,762	71,982	119,774	1,451
	1963	636	117	8,920	7,349	14,097	41,953	88,085	126,496	214,169	3,346
	change %	+40	+23	+20	+17	+15	+66	+84	+76	+79	+130
Oregon	1954	94	25	2,077	1,860	3,661	7,554	14,385	21,223	35,608	446
	1963	102	34	2,946	2,610	4,966	12,417	23,409	39,246	61,994	828
	change %	+9	+36	+42	+40	+36	+64	+63	+85	+74	+86
Washington	1954	110	41	3,496	3,092	5,447	10,844	17,341	28,325	45,667	335
	1963	142	27	2,836	2,521	4,854	12,434	22,727	30,140	52,343	772
	change %	+29	-34	-19	-18	-16	+15	+31	+6	+15	+130
Pacific Region	1954	658	161	13,017	11,237	21,383	43,633	79,489	121,531	201,020	2,232
	1963	895	181	14,979	12,692	24,354	67,882	136,563	198,318	333,320	4,977
	change %	+36	+12	+15	+13	+14	+56	+72	+63	+66	+123

(a) With 20 or more employees.

SOURCE: U.S. Census of Manufacturers, 1963 & 1954.

TABLE 2. PINE USERS BY SIZE OF ANNUAL SALES, 1958, 1963 AND 1967

Annual Sales ($000's)	Number of Plants 1958	1963	1967
Less than 50	6	5	4
50 - 99	5	5	8
100 - 249	2	5	4
250 - 499	1	6	7
500 - 999	1	-	1
1,000 and over	12	16	17
TOTAL	27	37	41

TABLE 3. SHIPMENTS OF SELECTED MILLWORK PRODUCTS INTO CONSTRUCTION, 1960 - 1968

Year	Ponderosa pine doors	Sash	Exterior frames
	(in thousand units)		
1960	1,948	-	-
1961	1,988	-	-
1962	1,987	9,022	5,986
1963	1,986	8,927	5,835
1964	2,094	8,640	5,934
1965	2,041	8,891	6,250
1966	2,384	7,470	5,260
1967	2,452	-	-
1968	2,165	-	-

SOURCE: Construction Review, BDSA, U.S. Department of Commerce, various years.

TABLE 4. NEW HOUSING UNITS AUTHORIZED, SELECTED REGIONS, 1962-1967

Year	Pacific				North East	Lake States*
	Oregon	Washington	California	Total		
1962	11,316	23,877	244,963	289,523	252,307	174,685
1963	13,918	25,539	305,524	351,859	249,801	201,172
1964	14,367	19,661	260,197	303,547	250,644	211,613
1965	14,200	21,620	180,197	229,345	263,506	231,195
1966	12,391	26,408	99,083	149,292	219,010	195,196
1967	14,100	44,200	110,600	178,100	221,900	250,200

* Michigan, Ohio, Indiana, Illinois, Wisconsin, Minnesota.

SOURCE: Construction Reports, Bureau of the Census, U.S. Department of Commerce, various years.

TABLE 5. WHOLESALE PRICE INDEXES OF CONSTRUCTION MATERIALS, 1962-1968 (1957-59 = 100)

Year	All Materials	Softwood Lumber		General Millwork
		Douglas fir	Southern Pine	
1962	98.3	97.7	95.7	n/a
1963	98.5	101.5	95.4	n/a
1964	99.6	103.2	95.5	109.0
1965	100.8	102.4	97.2	109.9
1966	103.9	107.3	106.8	111.8
1967	106.7	116.0	109.7	114.4
1968	111.1	133.3	121.2	118.5

SOURCE: Construction Reports, Bureau of the Census, U.S. Department of Commerce, various years.

TABLE 6. INDUSTRIAL USE OF PONDEROSA PINE (1960)

SIC Industry number	Industry		
		(MM b.ft.)	(%)
2421	Sawmills and planing mills	231.4	14.5
2431	Millwork plants	704.7	44.2
2433	Prefabricated wood products	57.1	3.6
2441	Nailed wood boxes and shook	211.1	13.2
2499	Wood products (not elsewhere classified)	20.1	1.3
2511	Wood household furniture (except upholstered)	66.4	4.2
2531	Furniture of fixtures (not elsewhere classified)	29.7	1.7
2621 & 2631	Paper mills and paperboard mills	21.4	1.3
344 & 345	Fabricated structural metal products; screw machine products and bolts	24.0	1.5
394	Toys and sporting goods	20.4	1.3
	Sub-total	1384.3	86.8
	Other industries	109.1	13.2
	TOTAL	1593.4	100.0

SOURCE: USDA - USFS Bull. No. 353, 1965.

TABLE 7. MARKET DEMAND FOR PONDEROSA PINE LUMBER, BY GRADE AND REGION, 1966

Grade	Total Shipments	North East	North Central	South	West*	Oregon
	(MM b.f.)	(p e	r c	e n	t a	g e)
5/4 C+	-	19.1	33.0	19.1	28.8	-
6/4 ""	-	7.6	29.7	31.7	31.6	-
5/4 D	-	23.1	32.3	17.5	27.1	-
6/4 "	-	6.8	35.7	25.8	31.7	-
4/4 Moulding	-	10.8	26.2	36.9	26.2	-
5/4 "	-	4.6	8.5	27.4	59.4	-
6/4 "	-	5.2	13.6	25.7	55.4	-
8/4 "	-	2.2	22.6	39.0	36.2	-
5/4 " +	-	0.1	2.8	18.6	78.6	-
6/4 " "	-	..	1.1	2.9	96.0	-
4/4 Factory	28.4	14.2	22.7	23.5	39.6	-
5/4+Factory	5.8	4.1	38.6	23.7	33.7	-
4/4 #1 Shop	67.7	5.9	40.0	16.6	37.4	23.0
4/4 #2 Shop	10.9	10.2	21.7	11.4	50.7	-
5/4 #1 Shop	27.8	5.6	27.1	24.0	43.4	15.9
6/4 #1 Shop	31.5	3.3	41.2	19.4	36.1	7.7
8/4 #1 Shop	5.1	3.0	82.1	12.7	3.8	-
5/4 #2 Shop	76.3	5.4	27.4	23.4	43.8	18.5
6/4 #2 Shop	103.0	3.0	44.9	15.6	36.5	11.1
8/4+#2 Shop	13.8	0.8	85.8	9.8	3.6	-
5/4 #3 Shop	37.9	4.1	28.6	24.7	42.6	20.8
6/4 #3 Shop	55.0	4.4	48.9	12.6	34.2	-
8/4+#3 Shop	7.7	2.2	81.3	2.3	14.1	-
Stained Shop	12.2	2.3	41.7	6.7	49.3	-
Miscellaneous Shop	41.6	2.4	16.8	31.4	49.4	-
Sub-total (Factory and Shop)	524.7	4.7	37.7	19.1	38.5	-

* Including Oregon
+ "and better" or "and thicker", whichever applicable.
SOURCE: WWPA Market Facts, 1966.

TABLE 8. DEMAND FOR PONDEROSA PINE: IMPORTANCE OF WESTERN MARKET, BY GRADES, 1967

Grade	Total* Shipments	West	Leading State
	(MM b.f.)	(Percent)	
5/4 C +	17.6	47.2	California
5/4 D	11.5	44.8	"
6/4 D	7.4	49.5	"
4/4 Moulding	20.5	36.9	Texas
5/4 "	20.7	81.0	California
6/4 "	9.3	69.6	"
5/4 Moulding +	33.0	82.4	"
6/4 " "	21.9	94.5	"
4/4 Factory Select	33.0	48.2	Oregon
4/4 #1 Shop	81.2	49.1	"
5/4 #1 Shop	37.3	60.1	"
6/4 #1 Shop	42.1	50.4	California
4/4 #2 Shop	12.9	52.4	Oregon
5/4 #2 Shop	105.5	57.1	"
6/4 #2 Shop	141.7	53.1	"
5/4 #3 Shop	46.6	57.9	"
6/4 #3 Shop	69.4	50.7	"

* Inland sawmills

SOURCE: WWPA Inland Lumber Sales Analysis, 1967.

TABLE 9a. POPULATION AND CONSTRUCTION TRENDS, U.S.A. (1960 - 1968)

Year	Population	Private Construction	Index*
	(millions)	($ billions)	(1957-59 = 100)
1960	180.7	38.1	101
1961	183.8	38.3	103
1962	186.7	41.7	109
1963	189.4	43.8	112
1964	192.1	45.8	115
1965	194.6	50.3	122
1966	196.9	51.1	122
1967	199.1	50.6	119
1968	201.2	57.0	125

* Total construction, index of physical volume.

SOURCE: Statistical Abstract of the U.S., Dept. of Commerce, 1969.

TABLE 9b. POPULATION AND CONSTRUCTION TRENDS, SELECTED REGIONS (1962-67)

Year	Population			New Housing Units Authorized		
	West	Pacific	California	West	Pacific	California
	(millions)			(000's)		
1960	28.3	21.4	15.9	305.0 e	224.7	194.5
1961	29.2	22.0	16.4	315.0 e	246.9	211.8
1962	30.1	22.7	17.0	360.0 e	289.5	245.0
1963	30.8	23.3	17.6	423.0 e	351.9	305.5
1964	31.4	23.8	18.0	355.0 e	303.5	260.2
1965	32.0	24.3	18.4	273.5	229.3	180.2
1966	32.5	24.7	18.7	182.5	149.3	99.1
1967	33.0	25.2	19.0	218.3	178.1	110.6
1975 p	40.2	30.8	24.1	-	-	-
1985 p	51.2	39.5	31.7	-	-	-

e - estimated from New Housing Starts series. p - projections.

SOURCE: Statistical Abstract of the U.S., Dept. of Commerce, 1969.

TABLE 10. PRODUCTIVITY RATIOS. PINE-USING MILLWORK INDUSTRY IN OREGON, 1958, 1963 AND 1967

Size of plant (number of workers)	All workers 1967	1963	1958	Gross Real Output 1967	1963	1958	1967	1963	1958	Net Real Output 1967	
	(number)			($ 000's)			($ per worker)			($ 000's)	($ per worker)
Less than 10	43	75	60	610	1,442	703	14,186	19,227	11,717	470	10,930
10 - 29	213	130	35	3,040	1,940	340	14,272	14,646	9,714	1,988	9,333
30 - 49	144	111	99	5,030	3,846	2,600	34,930	34,649	26,263	2,374	16,486
50 - 99	329	425	335	9,400	10,962	7,750	28,693	25,793	23,134	5,139	16,620
100 - 199	651	604	466	14,773	10,096	9,000	22,693	16,715	19,313	6,571	10,094
200 and over	1,567	775	400	19,493	7,596	4,500	12,440	9,801	11,250	8,352	5,330
Total	2,947	2,120	1,395	52,386	35,846	24,893	17,776	16,908	17,844	24,894	8,447