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Russell C. Youmans

Recent studies have projected a decline in the timber resource base of Oregon's timbersheds. The purpose of this research effort is to project the economic impacts which this decline in timber harvest potential may imply for Oregon's most highly timber-dependent economy--Douglas County, Oregon. Specifically, this study, using an input-output model, projects household income and employment over a five decade period, given the projections of available timber harvest by Beuter et al. and two different assumptions concerning the allowable cut on public timberlands.

These income and employment impacts are then separated into their direct and indirect effects, i.e., into their effects on timber and wood products sector employees and all other employees in the county. Using data from a household sample survey undertaken for this study, these direct and indirect impacts are separated into their effects on

each of nine income groups in Douglas County, Oregon.

Given the results of this analysis, and the projections of available timber harvest potential, the study finds that--under the most restrictive harvest assumptions on public timberlands--an expected loss of approximately $37,000,000 per year is projected to accrue to income to households in Douglas County over the 1995-2005 decade. Of this total annual loss, $22,000,000 is expected to be borne by timber sector employees, and $15,000,000 by non-timber sector employees, over the 1995-2005 decade. This implies an annual employment loss of about 1,800 jobs in the timber sector, and about 1,700 jobs in the non-timber sector, over that decade. The distribution of these economic impacts lies more heavily in the lower income groups in the non-timber sector than in the timber sector.

Given these projected economic impacts, the study concludes that industrial diversification and diversification of the economic base of the county is warranted.

Projected Income and Employment Impacts of a Decline in the Timber Resource Base of a Highly Timber-Dependent Economy

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I. INTRODUCTION

The Study Setting

Recent studies on timber harvest potential in the Douglas Fir Region in Oregon indicate a decline in timber availability on some of its timberlands in the next few decades (1, 22). This is especially true in the Douglas County timbershed, where the projected reduction in timber harvest will occur mainly on private lands (1, p. 35; 22). While this is not the only timbershed with a projected decline in harvest potential, the Douglas County timbershed provides a particularly dramatic example of economic dependency on the timber industry.

In a 1969 study of regional economic dependence upon the timber industry, the Douglas County economy ranked highest in the Douglas Fir Region in its level of timber dependency (30, p. 100). The timber-dependency ratio for the county, measured as the percent of excess employment[1] in the area dependent upon timber-based employment, was 99.4% (30, p. 100).

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[1] Excess employment was defined as that proportion of a region's employment which exceeds the national average in a particular industry (30, p. 99).

Thus, the Douglas County economy provides a unique setting for the analysis of the linkages throughout the economy in relation to the timber industry. The focus of this study is on the relationship between the household sector and the timber industry in Douglas County, Oregon; especially with respect to the dependence of household income and employment on the timber industry in the county.

Objectives

The general objective of this study is to identify the economic impacts which the projected decline in timber harvest would be expected to imply for the region. While economic impact projections will be reported for all sectors in the county, the specific objectives of this study relate to the household sector. These are basically three:

(1) To attempt to identify the effect of the projected decline in timber harvest on household income over the next approximately five decades;

(2) To identify how these income impacts will be distributed among the different income classes and employees in the region; and

(3) To project the levels of employment, in terms of the numbers of jobs which may be lost as a result of the projected decline in timber harvest potential, and to identify how

these employment impacts will be distributed among the various income groups and employees in the region.

Procedure

In order to accomplish these objectives, data from a large sample survey undertaken for this study are combined with a regional economic model which existed for the county.

The theory which underlies the economic input-output model used in this study and the methodological perspective of the study are discussed briefly in Chapter II.

Chapter III discusses the sample survey design and the empirical implementation of the theoretical input-output model delineated in Chapter II. Since a portion of the sample data were collected for the purpose of updating an already existing input-output model for Douglas County, this procedure will also be covered in Chapter III.

Chapter IV is, basically, the purpose of this research effort. In this chapter, the findings of the expected impacts on household income are presented. These impacts are separated into their direct and indirect effects, given two different assumptions regarding forest policy decisions, and are then distributed among the various income groups in the region.

Chapter V presents estimates of the potential employment losses which may be implied by the loss to household income resulting from the projected decline in timber harvest potential.

Chapter VI attempts to draw some conclusions from the previous results, and to state some possible policy implications of the projected impacts.

II. METHODOLOGICAL PERSPECTIVE AND THEORETICAL FRAMEWORK

A Note on Methodology

According to the traditional scientific approach to the understanding and prediction of empirical phenomena, the researcher uses an abstract logical construct--a theory--to derive hypotheses which have the property of empirical verifiability or refutation (10). These hypotheses are then subjected to empirical test, and the theory which implied them is either accepted or rejected, depending upon the result of the test, for that particular application. This procedure, then, constitutes a test of the theory.

The reason for briefly delineating the traditional procedure of empirical science is to clarify the nature and purpose of this research effort. The purpose of this study is not to test a theory. Rather, the study will use an existing theory to make projections into the future, given certain assumptions and empirical information about the economy that this study is concerned with. Since these projections of future events are not currently observable, they cannot be used as empirical evidence in support or rejection of the theory which produced them.

The basic justification for this departure from the traditional procedures of science is that the theory used in this study--input-output analysis--has been tested by economists before with results

which would not warrant a rejection of the theory. Some of these tests, as well as some tests of the assumptions required to construct the input-output model, will be briefly discussed in the last section of this chapter.

With this clarification of the methodological perspective of this study, we move to a concise delineation of the theoretical input-output model.

The Theoretical Input-Output Model

In 1936, Wassily Leontief published his first attempt at developing a general equilibrium model of resource allocation that could lend itself to empirical implementation. Since, according to the developments of mainstream economic theory, a general equilibrium model would have required a knowledge of the utility function of every consumer and the production function of every producer, an empirical statement of a general equilibrium model required a set of rather drastic assumptions (12, pp. 54-55). These are discussed in the following section. After 20 years, Leontief formalized the work (20) and subjected the model to some empirical tests.

The purpose of this section is to briefly delineate the theoretical structure of the input-output model. This is done largely for the sake of completeness; better and more thorough statements of the theory can be found in many sources (4, 6, 8, 9, 14, 15).

The input-output model is essentially a system of simultaneous linear homogeneous equations which represent economic production in a region, and take the demand for products as exogenously determined.

Thus, any particular equation in the input-output system can be expressed as:

$$X_i = \sum_{j=1}^{n} a_{ij} X_j + Y_i , \qquad i = 1, \ldots, m;$$

where X_i represents total output of the i'th sector in the economy, $\sum_{j=1}^{n} a_{ij} X_j$ represents the total derived demand for X_i, and Y_i represents the final demand in the i'th sector. This is true by definition.

This system of linear equations can be simplified if written in matrix algebra notation as

$$X = AX + Y,$$

or

$$X - AX = Y$$

where X represents a column vector of outputs for the economy (m elements), A represents the $m \times n$ matrix of trade or input

coefficients, $A = [a_{ij}]$, and Y represents the column vector of final demands for the economy (m elements).[2]

The vector of total outputs for the economy, X, can be multiplied by the identity matrix, I, leaving the system of equations unchanged as

$$IX - AX = Y.$$

Thus, the X vector of total outputs can be factored out, giving

$$[I-A]X = Y.$$

Taking the inverse of $[I-A]$, then, provides a solution for the system in terms of total output for given or predicted levels of final demand; i.e.,

$$X = [I-A]^{-1}Y$$

for given or originally known levels of final demand, and

$$\hat{X} = [I-A]^{-1}\hat{Y}$$

for predicted levels of final demand. Solving the system in this manner and using the model as a predictive device, rather than as a

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[2]Since the matrix A contains coefficients, a_{ij}, giving the proportion of inputs in sector i required to produce a unit of output in sector j, the sectors represented as the rows of A are also represented as the columns of A, and thus, $m = n$ and the matrix is square.

purely descriptive mechanism of the flows of resources throughout an economy, requires a set of assumptions about the nature of the economy which the model seeks to represent.

Assumptions of the Input-Output Model

The construction of the input-output model described above entails three general assumptions (6, pp. 33-42). These are concerned almost entirely with the nature of production in an economy, since the system is essentially a simplified theory of production.

Firstly, it is assumed that each commodity (or group of commodities) is supplied by a single sector. In other words, it is supposed that only one method is used for producing each group of commodities and that each sector has only a single primary output.

The second assumption of the model is the most significant and has, in fact, drawn criticism among economists who feel that it limits the use of the model as a predictive device (8, 11, 13). The first assumption, stated above, essentially aggregates all of the firms in an economy into various and separable sectors. The second assumption relates to the production functions of these sectors.

This assumption states that the form of the production function

$$X_j = F^j(x_{1j}, x_{2j}, \ldots, x_{nj})$$

for each sector, which relates the total output of sector j to its inputs x_{ij}, is of the following type:

$$X_j = F^j = \min\{x_{1j}/a_{1j}, x_{2j}/a_{2j}, \ldots, x_{nj}/a_{nj}\}$$

(9, p. 231). As before, the a_{ij}'s are the technical coefficients of production, nonnegative quantities of the i'th commodity needed to produce one unit of output of commodity j.

Assuming positive prices and profit maximizing producers, this function simplifies to the particularly simple form

$$x_{ij} = a_{ij}X_j \quad \text{(14, p. 228).}$$

Thus, the quantity of commodity i used in the production of commodity j is assumed to be a linear homogeneous function of its own total output, X_j.

The third and final assumption required for the construction of the Leontief input-output system states that the total effect of carrying on several types of production is the sum of the separate effects. This assumption of additivity disallows external economies and diseconomies. In effect, the assumption states that all of the production processes carried on within the economy are independent of each other; no production process has an effect--beneficial or detrimental--on any other production process.

Empirical Basis of Assumptions and Reliability of Projections

As alluded to earlier, the controversy among economists reviewing Leontief's input-output system has largely revolved around the assumption of fixed input coefficient in production (6, p. 157; 8, 11, 13). The assumption that each industry has a production function in which all inputs vary proportionally with the industry's output constitutes a radical simplification of traditional thinking about production functions. Some empirical tests, all of them less than procedurally perfect (18, pp. 188-193), have been made regarding the realism of this assumption and the implications thereof regarding the reliability of the projections of the model.

Until 1959, two main types of tests of the empirical usefulness of the assumption of constant input coefficients had been attempted (6, p. 158). One type consisted of direct comparisons of individual input ratios at different points in time. The other type involved comparing the computed results of an input-output projection with the actual operation of the economy.

The circumstances under which these pre-1959 tests were conducted, and the results obtained by each, were summarized by Chenery and Clark (6, pp. 158-178). We will not repreat them here, but rather quote the general conclusions drawn by the authors after having reviewed them:

> All of the test projections yet made involve a strict application of the original Leontief assumption of constant input coefficients. Although all of the tests have inadequacies . . . at least with the improved U. S. 1947 table, input-output projections appear to be 'better' than either multiple regression or naive projections, but not 'much better' (6, p. 178).

While admittedly somewhat shaky, these tests provide some empirical ground for using the input-output system to make projections such as those made in this study. Further, if projections are to be made, some method must be used to make them, and on this count it appears that the input-output system can be expected to do at least as well as the other methods available.

To the author's knowledge, empirical tests of the input-output system published since 1959 arrived at results similar to the pre-1959 tests. That is, while the empirical performance of the model is far from perfect, results of empirical testing of the model are insufficiently poor to conclude that the input-output system has no value as a predictive device. Some of these post-1959 tests include Long (21), McGilvray and Simpson (24), and Plenske (26); the first two were published in 1969, and the latter in 1970.

In summary, the empirical work done with the theoretical input-output model delineated earlier appears to warrant using the model to make economic impact projections of declining timber availability in the Douglas County economy. We now move to a discussion of the household sample survey and the empirical implementation of the theoretical model to the economy of Douglas County, Oregon.

III. THE SAMPLE SURVEY DATA AND EMPIRICAL IMPLEMENTATION OF THE MODEL

Introduction

In order to accomplish the objectives of this study, a sample survey of 543 households in Douglas County was undertaken in August, 1976. The purposes of obtaining these sample data were two.

Firstly, an input-output model was constructed from primary data for the Douglas County economy by Youmans et al. (34) in 1973. Since the cost of constructing such an input-output model is very high, the household sector could not be sampled directly (34, p. 2). Thus, a portion of the household sample data for the current study were collected to provide primary data for the household sector of the existing model, and to update the model for this sector.

Secondly, the projections of the input-output model provide only a total dollar figure representing, in this case, the total loss to household income in the county resulting from a given decline in timber harvest. In order to determine the effect of this total loss on specific income groups in the county, and to attempt to identify the employment implications of such a decline, information on income and employment patterns in the county was required.

The Sample Survey Design

Toward accomplishing the objectives set forth above, a stratified random sample of 543 households was taken in Douglas County, Oregon. The criterion for determining the strata in the sample was geographic location. The county was divided into six relatively homogeneous sub-regions in terms of economic activity and residential population. The geographic locations of the sampling strata are illustrated in Figure 1.

The size of the sample taken in each stratum was determined by the population density in each sub-region. The sample size in each sub-region is given in Table 1. The object of the sampling scheme was to take a proportional sample. In other words, the proportion of the total sample taken in each stratum is approximately equal to the proportion of households in the county which are located in that sub-region.[3]

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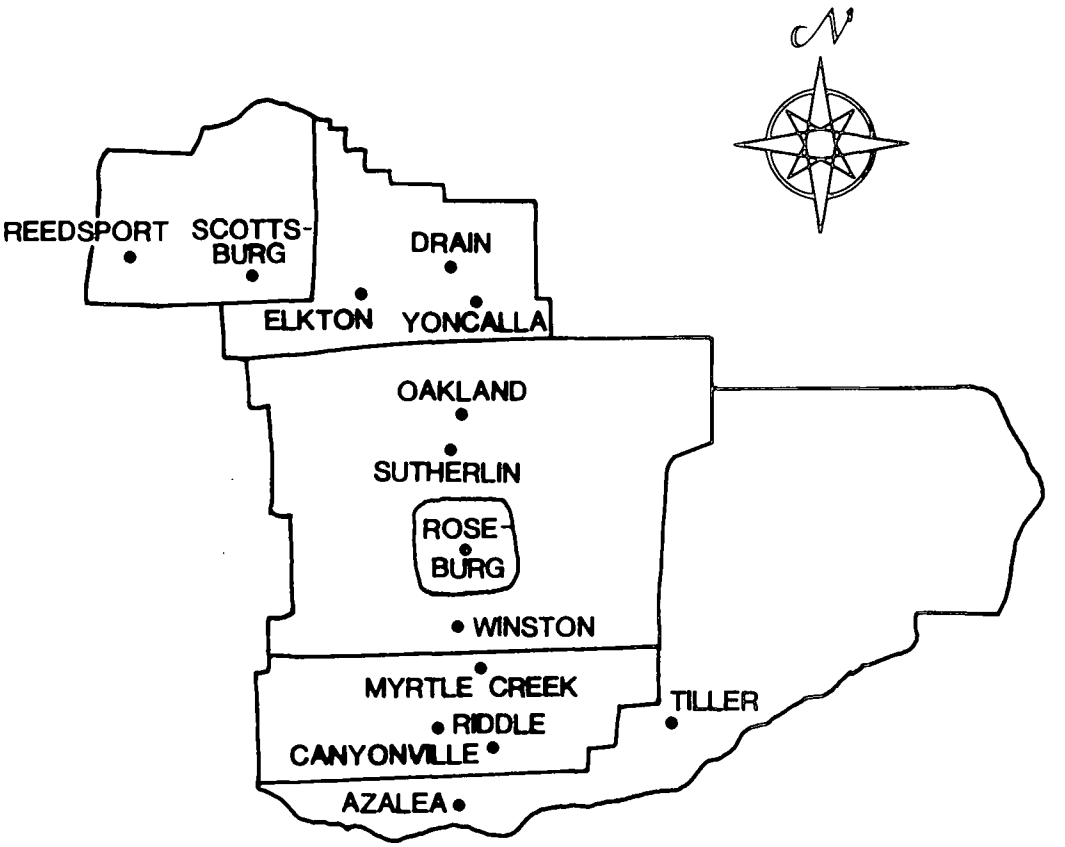
[3]The approximate equality of the sampling proportions and the population proportions in the six strata were checked by consulting the July 1, 1975 population estimates for Oregon counties and incorporated cities of the Portland State University Center for Population Research and Census. When, as is the case here, a population can be divided into relatively homogeneous sub-populations, stratification generally produces a gain in the precision of the overall population estimates. Since the information necessary to allocate the sample optimally among the sub-regions was not available, the sample was allocated proportionally. This is a relatively common practice, and is still expected to produce some gain in the precision of the overall population estimates.

FIGURE 1.

GEOGRAPHIC LOCATION OF SAMPLING STRATA



DOUGLAS COUNTY , OREGON

Table 1. Sample size for each of six regions in Douglas County, Oregon 1976.

Region	Sample Size	Estimated Total Number of Households
Reedsport--Scottsburg	50	3,547
Elkton--Yoncalla--Drain	60	1,241
Sutherlin--Winston--Oakland	154	6,577
Roseburg	191	8,727
Myrtle Creek--Riddle--Canyonville	68	4,102
Tiller--Azalea	20	722
Douglas County	543	24,916

Households were randomly selected in each sub-region until the sample size for that particular stratum was reached. These households were then contacted and interviewed by professional interviewers. Data were collected, for the year 1975, on annual household income, employment of household members, household expenditures, and other information deemed relevant to the study.[4]

[4] More detailed information on the sample, the data obtained, and the sampling estimates--many of which will not be included in the current study--will soon be available by consulting: Flacco, Paul R., and Youmans, Russell C. Income, Employment, and Expenditure Patterns in a Timber-Based Economy: Current Statistics in Douglas County, Oregon. Oregon State University Agricultural Experiment Station.

The Douglas County Input-Output Model

In 1973, an input-output model was constructed for Douglas County, Oregon, based on data collected for the year 1970. The sampling procedure used to construct the model, the size ofthe sample taken in each sector, the A matrix of direct coefficients, and the $[I-A]^{-1}$ matrix of direct and indirect coefficients, were published by Russell C. Youmans et al. (34). This is, basically, the model used in the current study. Some revisions of the original model, however, were deemed necessary.

The first set of revisions of the original Youmans model related to the A matrix, or the matrix of direct coefficients.

Adjustments to the A Matrix

In the original model, the timber and wood products industry in the county was broken into four economic sectors. These were: 1) timber harvesting and hauling, 2) sawmills, 3) plywood and veneer mills, and 4) pulp, paper, and particle board plants. With this breakdown, economic impacts could be determined separately for each of these components of the timber industry.

For the purposes of the current study, however, where the focus is on the impact on the household sector, such a specific breakdown is not required. Furthermore, the projections made here will be

based upon a total decline in timber harvest, and there is no completely reliable method of distributing this total decline among the above four timber sectors. Therefore, these four sectors in the original model were aggregated into a single sector--timber and wood products.

A second revision of the original Youmans model was accomplished as a result of the collection of the household expenditure data described above. Since the households could not be directly sampled in the construction of the original model, household purchases had to be estimated using secondary data sources.

The data collected for the current study included household purchases, for the year 1975, on the economic sectors of the model. Thus, a set of coefficients for the household purchasing column, column 30, of the matrix of direct coefficients, A, were computed from this primary data. These new coefficients, then, replaced the coefficients in the household purchasing column of the original Youmans model.

The result of the above two revisions of the original model is a new matrix of direct coefficients. This is presented in Table 2. While most of the coefficients in this A matrix remain identical to those of the original model, this is not the case for the new matrix of direct and indirect coefficients, $[I-A]^{-1}$, presented in Table 3. The computation of the inverse matrix changes most of the direct and

Table 2. Direct Coefficients Matrix, $A_{31, 31}$; Douglas County, Oregon, 1970 (with household sector purchases updated with 1975 data).

	Sector	1	2	3	4	5	6	7	8	9
1	Timber & wood products	.09028	0	.00072	.00044	.00329	0	0	0	.00024
2	Commercial fishing	0	.01176	0	0	.07976	0	0	0	0
3	Horticulture	0	0	0	.00411	0	0	0	0	0
4	Livestock	.00015	0	.00655	.08811	.00454	0	0	.0038	0
5	Manufacturing	.00322	0	0	0	.00463	.00550	.04362	.00407	0
6	Lodging	0	0	0	0	.00097	0	0	0	0
7	Cafes & taverns	0	.00121	0	0	0	0	.00107	0	0
8	Service stations	.00473	.00082	.19242	.00310	0	0	.00047	.03541	.00275
9	Automotive sales	.01938	.00398	.00342	.00616	.00501	.00104	.00449	.02667	.01598
10	Communications & transportation	.01125	.00957	.08729	.00934	.00522	.11877	.04100	.01304	.01452
11	Professional services	.00115	.00136	.00069	.01010	.00035	.00653	.00724	.00170	.00098
12	Financial services	.03747	0	.21444	.19482	.01415	.23723	.05177	.02173	.01179
13	Construction	.01485	.00179	.01337	.01203	.00226	.02926	.02929	.00156	.00062
14	Retail & wholesale trade	.02877	.22322	.24539	.27975	.02457	.08554	.10633	.00624	.00118
15	Retail services & organizations	.00280	.08393	.10293	.10729	.00496	.25563	.02747	.00541	.01333
16	U. S. Forest Service	.04107	0	0	.00390	0	.00425	0	0	0
17	U. S. F. S. appropriations	0	0	0	0	0	0	0	0	0
18	Bureau of Land Management	.05864	0	0	.00061	0	0	0	0	0
19	B. L. M. appropriations	0	0	0	0	0	0	0	0	0
20	Education	.01167	.00115	.00138	.00546	.00476	.00600	.00148	.00027	.00076
21	Law enforcement	.00014	.00001	.00001	.00006	.00016	.00051	.00021	.00009	.00001
22	County roads	.01084	.00001	.00001	.00006	.00005	.00006	.00002	0	.00001
23	Social services	.00008	.00001	.00001	.00006	.00005	.00068	.00036	0	.00001
24	Administration	.00052	.00130	.00001	.00006	.00012	.00006	.00002	0	.00001
25	City of Roseburg	.00143	0	.00021	.00102	.00105	.00297	.00110	.00039	.00019
26	City of Sutherlin	.00023	0	.00003	.00015	.00013	.00162	.00066	.00022	.00008
27	City of Myrtle Creek	.00024	.00002	.00003	.00013	.00028	.00224	.00062	.00028	.00008
28	City of Reedsport	.00016	0	.00002	.00012	.00010	.00106	.00044	.00014	.00005
29	Other incorporated cities	.00038	0	.00004	.00021	.00039	.00482	.00220	.00008	.00003
30	Households	.24853	.39945	.07282	.14392	.17587	.12408	.29802	.12460	.11235
31	Visitors	0	0	0	0	0	0	0	0	0

Table 2. (Continued)

	Sector	10	11	12	13	14	15	16	17	18
1	Timber & wood products	.00010	0	.00223	.00995	.00136	0	.14230	.01809	.19123
2	Commercial fishing	0	0	0	0	.00003	0	0	0	0
3	Horticulture	0	0	.00002	0	.00064	0	0	0	0
4	Livestock	0	0	.00092	0	.00062	.00649	0	0	0
5	Manufacturing	0	.00536	0	0	.03505	.00205	0	.00374	0
6	Lodging	0	0	.00001	0	0	0	0	.00025	0
7	Cafes & taverns	0	0	0	0	0	0	0	.00001	0
8	Service stations	.00001	0	0	.02483	.00098	.00330	0	.00853	0
9	Automotive sales	.02160	.00348	0	.04557	.00155	.01619	0	.00379	0
10	Communications & transportation	.01311	.01886	.01045	.01459	.02913	.01035	0	.00757	0
11	Professional services	.00082	.01711	.00120	.00222	.00135	.00242	0	.01589	0
12	Financial services	.00377	.03277	.00360	.01363	.00705	.00547	0	0	0
13	Construction	.00080	.00546	.02451	.12539	.00102	.00213	0	.16700	0
14	Retail & wholesale trade	.00399	.02515	.00560	.04191	.03929	.01098	0	.03066	0
15	Retail services & organizations	.00412	.04621	.01309	.01354	.00474	.00777	0	.00346	0
16	U. S. Forest Service	0	0	0	.00013	0	0	0	0	0
17	U. S. F. S. appropriations	0	0	0	0	0	0	0	0	0
18	Bureau of Land Management	0	0	0	.00010	0	.00003	0	0	0
19	B. L. M. appropriations	0	0	0	0	0	0	0	0	0
20	Education	.02617	.00238	.00054	.00156	.00987	.00065	.12832	0	.07308
21	Law enforcement	.00026	.00098	.00001	.00002	.00011	.00007	0	0	0
22	County roads	.00026	.00002	.00001	.00018	.00009	0	.04392	0	.02501
23	Social services	.00026	.00002	.00001	.00002	.00009	0	0	0	0
24	Administration	.00026	.00032	.00001	.00052	.00013	.00013	0	0	0
25	City of Roseburg	.00568	.00082	.00011	.00060	.00257	.00054	0	0	0
26	City of Sutherlin	.00073	.00006	.00002	.00005	.00038	.00012	0	0	0
27	City of Myrtle Creek	.00071	.00024	.00001	.00010	.00044	.00012	0	0	0
28	City of Reedsport	.00060	.00035	.00001	.00006	.00036	.00015	0	0	0
29	Other incorporated cities	.00109	.00009	.00002	.00007	.00083	.00128	0	0	0
30	Households	.26510	.49909	.08504	.20711	.15287	.25344	0	.50487	0
31	Visitors	0	0	0	0	0	0	0	0	0

Table 2. (Continued)

	Sector	19	20	21	22	23	24	25	26	27
1	Timber & wood products	.03527	0	0	0	0	0	0	0	0
2	Commercial fishing	0	0	0	0	0	0	0	0	0
3	Horticulture	0	0	0	0	0	0	0	0	0
4	Livestock	0	0	0	0	0	0	0	0	0
5	Manufacturing	0	.00578	0	0	0	0	0	0	0
6	Lodging	0	0	.00021	.00110	.00083	.00068	0	0	0
7	Cafes & taverns	.00015	0	.00794	.00110	.00567	.00262	0	0	0
8	Service stations	.00908	.00250	.01330	.00263	.00131	.00020	.00233	.00341	.00341
9	Automotive sales	.00626	.00529	.04836	.05919	.01172	.00919	.00380	.00204	.00329
10	Communications & transportation	.00178	.02366	.01004	.00003	.02304	.00892	.00271	0	.00096
11	Professional services	.00056	.00216	.02028	.00087	.00888	.00175	.00190	.04153	.02403
12	Financial services	0	0	0	0	0	0	0	0	0
13	Construction	.00578	.04745	.00069	.36287	.12667	.09440	.02565	.10443	.11471
14	Retail & wholesale trade	.00583	.05031	.04448	.00806	.03320	.01220	.05956	.05356	.03874
15	Retail services & organizations	.00466	.02191	.01116	.01447	.02659	.04465	.02139	.01133	.01119
16	U. S. Forest Service	0	0	0	0	0	0	0	0	0
17	U. S. F. S. appropriations	0	0	0	0	0	0	0	0	0
18	Bureau of Land Management	0	0	0	0	0	0	0	0	0
19	B. L. M. appropriations	0	0	0	0	0	0	0	0	0
20	Education	0	.00384	0	0	0	0	.00289	.03259	.04193
21	Law enforcement	0	0	.00301	0	0	0	0	0	0
22	County roads	0	0	.02220	0	.02081	.00486	0	0	0
23	Social services	0	0	0	0	0	0	.00463	0	0
24	Administration	0	0	0	0	0	0	.00031	.00755	.00085
25	City of Roseburg	0	0	0	0	0	0	0	0	0
26	City of Sutherlin	0	.00018	0	0	0	0	0	0	0
27	City of Myrtle Creek	0	.00018	0	0	0	0	0	0	.01031
28	City of Reedsport	0	.00011	0	0	0	0	0	0	0
29	Other incorporated cities	0	.00053	0	0	0	0	0	0	0
30	Households	.74389	.64953	.76470	.28993	.57539	.45803	.32243	.13484	.10184
31	Visitors	0	0	0	0	0	0	0	0	0

Table 2. (Continued)

	Sector	28	29	30	31
1	Timber & wood products	0	0	.00394	0
2	Commercial fishing	0	0	.00024	.01330
3	Horticulture	0	0	.00161	.00077
4	Livestock	0	0	.00932	.00429
5	Manufacturing	0	0	.00402	.00583
6	Lodging	0	0	.00812	.07059
7	Cafes & taverns	0	0	.02804	.07121
8	Service stations	0	.00580	.06195	.24739
9	Automotive sales	.01450	.02081	.07014	.11759
10	Communications & transportation	.00092	.00469	.02346	.00854
11	Professional services	.00137	.01393	.04331	.03674
12	Financial services	0	0	.07810	.03121
13	Construction	.31725	.08651	.03302	.03529
14	Retail & wholesale trade	.05194	.04688	.28226	.16713
15	Retail services & organizations	.00696	.02336	.05825	.18927
16	U. S. Forest Service	0	0	.00048	.00068
17	U. S. F. S. appropriations	0	0	0	0
18	Bureau of Land Management	0	0	.00016	.00017
19	B. L. M. appropriations	0	0	0	0
20	Education	.03955	.00190	.04046	0
21	Law enforcement	0	0	.00237	0
22	County roads	0	0	.00050	0
23	Social services	0	0	.00101	0
24	Administration	0	.00257	.00078	0
25	City of Roseburg	0	0	.00493	0
26	City of Sutherlin	0	0	.00140	0
27	City of Myrtle Creek	0	0	.00133	0
28	City of Reedsport	0	0	.00113	0
29	Other incorporated cities	0	.03164	.00113	0
30	Households	.19563	.29662	.02161	0
31	Visitors	0	0	0	0

Table 3. Direct and Indirect Coefficients Matrix, $[I-A]^{-1}_{31,31}$; Douglas County, Oregon, 1970 (with household sector purchases updated with 1975 data).

	Sector	1	2	3	4	5	6	7	8	9
1	Timber & wood products	1.12319	.00399	.00381	.00488	.00560	.00414	.00365	.00120	.00125
2	Commercial fishing	.00113	1.01371	.00142	.00169	.08174	.00144	.00472	.00068	.00028
3	Horticulture	.00793	.00127	1.00075	.00540	.00059	.00076	.00094	.00034	.00029
4	Livestock	.00493	.00755	.01176	1.10215	.00843	.00634	.00580	.00257	.00188
5	Manufacturing	.01225	.01901	.01544	.01824	1.01146	.01601	.05614	.00769	.00285
6	Lodging	.00338	.00490	.00238	.00299	.00336	1.00301	.00384	.00149	.00129
7	Cafes & taverns	.01163	.01814	.00818	.01030	.00834	.01034	1.01418	.00513	.00445
8	Service stations	.03425	.04182	.22036	.03045	.01997	.02689	.03293	1.04914	.01359
9	Automotive sales	.05787	.05415	.03774	.04050	.02947	.03995	.04528	.04317	1.02950
10	Communications & transportation	.03335	.04355	.11568	.04074	.02070	.14552	.06684	.02250	.02208
11	Professional services	.02061	.02964	.01560	.02930	.01417	.02512	.02933	.01031	.00837
12	Financial services	.08163	.05834	.25180	.25388	.04333	.27634	.09792	.04023	.02694
13	Construction	.04797	.03142	.03720	.04053	.01783	.06099	.05838	.01139	.00872
14	Retail & wholesale trade	.16598	.42506	.35508	.44078	.13859	.21333	.26161	.06461	.05114
15	Retail services & organizations	.03539	.13060	.13227	.15164	.03457	.29028	.06448	.01983	.02539
16	U. S. Forest Service	.04642	.00061	.00038	.00472	.00045	.00469	.00046	.00016	.00015
17	U. S. F. S. appropriations	0	0	0	0	0	0	0	0	0
18	Bureau of Land Management	.06593	.00034	.00028	.00102	.00038	.00032	.00030	.00010	.00010
19	B. L. M. appropriations	0	0	0	0	0	0	0	0	0
20	Education	.04377	.03175	.02054	.02777	.01921	.02856	.02573	.00923	.00850
21	Law enforcement	.00120	.00155	.00082	.00105	.00090	.00150	.00141	.00055	.00041
22	County roads	.01614	.00050	.00032	.00063	.00034	.00063	.00043	.00014	.00013
23	Social services	.00056	.00070	.00039	.00051	.00038	.00115	.00090	.00020	.00019
24	Administration	.00097	.00188	.00036	.00047	.00049	.00052	.00049	.00016	.00015
25	City of Roseburg	.00439	.00452	.00349	.00452	.00307	.00647	.00467	.00166	.00128
26	City of Sutherlin	.00096	.00110	.00074	.00093	.00064	.00239	.00151	.00054	.00035
27	City of Myrtle Creek	.00098	.00112	.00077	.00093	.00079	.00804	.00149	.00060	.00035
28	City of Reedsport	.00076	.00092	.00062	.00078	.00052	.00171	.00115	.00040	.00027
29	Other incorporated cities	.00123	.00139	.00107	.00136	.00099	.00621	.00330	.00043	.00034
30	Households	.41344	.60220	.29111	.36684	.29340	.36783	.46643	.18290	.15859
31	Visitors	0	0	0	0	0	0	0	0	0

Table 3. (Continued)

	Sector	10	11	12	13	14	15	16	17	18
1	Timber & wood products	.00238	.00426	.00360	.01499	.00319	.00210	.16092	.02679	.21541
2	Commercial fishing	.00068	.00172	.00025	.00077	.00370	.00080	.00048	.00171	.00040
3	Horticulture	.00069	.00128	.00026	.00067	.00111	.00067	.00036	.00138	.00029
4	Livestock	.00422	.00805	.00255	.00407	.00363	.01101	.00224	.00826	.00182
5	Manufacturing	.00685	.01838	.00254	.00801	.04101	.00848	.00512	.01804	.00426
6	Lodging	.00304	.00556	.00105	.00282	.00198	.00277	.00162	.00618	.00129
7	Cafes & taverns	.01051	.01920	.00361	.00973	.00674	.00956	.00548	.02048	.00440
8	Service stations	.02532	.04614	.00943	.05300	.01740	.02640	.01501	.06275	.01232
9	Automotive sales	.05233	.05936	.01208	.08233	.02192	.04411	.02357	.07171	.01980
10	Communications & transportation	1.03041	.05026	.01699	.03491	.04182	.02593	.01428	.04362	.01181
11	Professional services	.01821	1.04903	.00727	.01878	.01261	.01826	.00951	.05018	.00769
12	Financial services	.03878	.09735	1.01647	.05009	.03074	.03891	.02459	.07220	.02300
13	Construction	.02094	.04006	.03444	1.16109	.01406	.01914	.03846	.22623	.02718
14	Retail & wholesale trade	.12301	.24124	.04793	.15940	1.11914	.12020	.07389	.26890	.06037
15	Retail services & organizations	.03231	.09745	.02321	.04226	.02359	1.03374	.01869	.05994	.01454
16	U. S. Forest Service	.00035	.00062	.00023	.00101	.00029	.00033	1.00674	.00159	.00895
17	U. S. F. S appropriations	0	0	0	0	0	0	0	1.00000	0
18	Bureau of Land Management	.00020	.00037	.00023	.00105	.00023	.00021	.00947	.00171	1.01266
19	B. L. M. appropriations	0	0	0	0	0	0	0	0	0
20	Education	.04400	.03472	.00695	.01913	.02248	.01680	.14145	.03503	.08538
21	Law enforcement	.00120	.00271	.00033	.00090	.00073	.00092	.00051	.00185	.00042
22	County roads	.00056	.00057	.00015	.00067	.00031	.00026	.04633	.00091	.02816
23	Social services	.00070	.00078	.00015	.00042	.00038	.00038	.00023	.00081	.00019
24	Administration	.00060	.00093	.00014	.00091	.00037	.00043	.00027	.00075	.00026
25	City of Roseburg	.00811	.00532	.00102	.00314	.00440	.00278	.00152	.00489	.00135
26	City of Sutherlin	.00136	.00121	.00024	.00067	.00082	.00069	.00038	.00123	.00032
27	City of Myrtle Creek	.00134	.00138	.00023	.00073	.00089	.00069	.00039	.00124	.00033
28	City of Reedsport	.00111	.00130	.00019	.00057	.00072	.00062	.00031	.00102	.00026
29	Other incorporated cities	.00182	.00139	.00028	.00078	.00137	.00195	.00049	.00135	.00042
30	Households	.37429	.68324	.12877	.34663	.23996	.34028	.19335	.72881	.15567
31	Visitors	0	0	0	0	0	0	0	0	0

Table 3. (Continued)

	Sector	19	20	21	22	23	24	25	26	27
1	Timber & wood products	.04527	.00587	.00626	.00774	.00935	.01102	.00309	.00322	.00302
2	Commercial fishing	.00170	.00216	.00197	.00098	.00184	.00141	.00098	.00073	.00060
3	Horticulture	.00179	.00165	.00193	.00096	.00158	.00122	.00087	.00057	.00047
4	Livestock	.01080	.01000	.01161	.00589	.00940	.00719	.00521	.00337	.00283
5	Manufacturing	.01706	.02294	.01997	.00995	.01896	.01450	.01008	.00771	.00634
6	Lodging	.00784	.00711	.00859	.00525	.00660	.00511	.00364	.00232	.00194
7	Cafes & taverns	.02721	.02454	.03684	.01543	.02353	.01830	.01258	.00803	.00671
8	Service stations	.07427	.06263	.08309	.04792	.06052	.04500	.03333	.02606	.02331
9	Automotive sales	.08402	.07820	.13334	.12080	.06849	.05131	.04134	.03137	.02958
10	Communications & transportation	.04349	.06389	.05695	.03046	.05134	.03944	.02453	.01793	.01655
11	Professional services	.04484	.04259	.06807	.02546	.06085	.03807	.02281	.05594	.03622
12	Financial services	.09079	.08236	.09740	.05493	.08603	.06124	.04262	.03039	.02559
13	Construction	.05293	.09604	.05902	.43963	.04832	.03327	.05086	.13532	.14660
14	Retail & wholesale trade	.30758	.32793	.36866	.18650	.38586	.29509	.20402	.15421	.12460
15	Retail services & organizations	.07422	.08635	.08775	.05875	.09412	.05871	.05489	.03701	.03308
16	U. S. Forest Service	.00247	.00080	.00091	.00071	.02749	.04550	.00055	.00067	.00033
17	U. S. F. S appropriations	0	0	0	0	0	0	0	0	0
18	Bureau of Land Management	.00282	.00050	.00054	.00058	.00069	.00075	.00026	.00025	.00023
19	B. L. M. appropriations	1.00000	0	0	0	0	0	0	0	0
20	Education	.04516	1.04535	.04805	.02476	.04245	.03604	.02432	.04702	.05450
21	Law enforcement	.00241	.00220	1.00562	.00129	.00206	.00159	.00113	.00076	.00063
22	County roads	.00128	.00069	.02305	1.00054	.02267	.00740	.00046	.00032	.00024
23	Social services	.00106	.00097	.00114	.00057	1.00091	.00070	.00513	.00032	.00027
24	Administration	.00085	.00080	.00091	.00066	.00073	1.00057	.00072	.00788	.00115
25	City of Roseburg	.00609	.00579	.00664	.00359	.00552	.00426	1.00302	.00210	.00177
26	City of Sutherlin	.00158	.00165	.00172	.00088	.00139	.00107	.00076	1.00052	.00043
27	City of Myrtle Creek	.00157	.00165	.00171	.00090	.00139	.00107	.00076	.00052	1.01086
28	City of Reedsport	.00130	.00132	.00142	.00073	.00115	.00089	.00063	.00044	.00036
29	Other incorporated cities	.00170	.00218	.00188	.00099	.00159	.00121	.00087	.00061	.00052
30	Households	.96319	.87366	1.02677	.51033	.80732	.62719	.44762	.28579	.23908
31	Visitors	0	0	0	0	0	0	0	0	0

Table 3. (Continued)

	Sector	28	29	30	31
1	Timber & wood products	.00665	.00396	.00742	.00300
2	Commercial fishing	.00096	.00098	.00218	.01548
3	Horticulture	.00080	.00088	.00234	.00145
4	Livestock	.00475	.00535	.01410	.00985
5	Manufacturing	.00997	.01006	.02176	.02316
6	Lodging	.00334	.00372	.01028	.07291
7	Cafes & taverns	.01152	.01285	.03549	.07927
8	Service stations	.03719	.03969	.08448	.27835
9	Automotive sales	.06523	.06381	.09974	.15682
10	Communications & transportation	.02769	.02860	.05314	.04847
11	Professional services	.02133	.03607	.05791	.05317
12	Financial services	.04435	.04529	.11640	.09183
13	Construction	.38482	.12425	.05933	.06273
14	Retail & wholesale trade	.20059	.19871	.39310	.29120
15	Retail services & organizations	.04347	.06012	.09049	.24135
16	U. S. Forest Service	.00059	.00058	.00110	.00132
17	U. S. F. S. appropriations	0	0	0	0
18	Bureau of Land Management	.00049	.00032	.00065	.00041
19	B. L. M. appropriations	0	0	0	0
20	Education	.06023	.02403	.05788	.01739
21	Law enforcement	.00104	.00117	.00315	.00087
22	Country roads	.00044	.00040	.00094	.00033
23	Social services	.00047	.00051	.00138	.00042
24	Administration	.00056	.00312	.00108	.00038
25	City of Roseburg	.00304	.00314	.00785	.00312
26	City of Sutherlin	.00073	.00078	.00206	.00083
27	City of Myrtle Creek	.00075	.00079	.00204	.00091
28	City of Reedsport	1.00062	.00065	.00169	.00067
29	Other incorporated cities	.00085	1.03358	.00219	.00155
30	Households	.41009	.45731	1.26343	.28381
31	Visitors	0	0	0	1.00000

indirect coefficients. The coefficients in Table 3 represent the quantity of sector i's output required per unit of final demand of sector j.

Adjustments to Final Demand

The final demand vector, Y, in the original Youmans model was given in 1970 prices. Since the data from the household sample survey taken for this study was in 1975 prices, it was decided to use 1975 as the base year for the study. Thus, it was necessary to convert the original final demand vector to 1975 prices.

The inflation of the original final demand vector from 1970 prices to 1975 prices was accomplished by using the relevant price indices for each of the sectors in the input-output model. When these were not available for a particular sector, average price indices were used which approximated the rate of inflation for the products of that particular sector as closely as possible. This procedure yielded the new final demand vector shown in Table 4. This new vector of final demands, when premultiplied by the new matrix of direct and indirect coefficients, yields the new vector of total outputs for the Douglas County economy. This new total output vector, in 1975 prices, is also presented in Table 4.

Table 4. Final Demand and Projected Total Output by Sector for updated Input-Output Model: Douglas County, Oregon, 1975. Figures are in 1975 dollars.

	Sector	Final Demand	Total Output
1	Timber and wood products	402, 136, 000	455, 216, 000
2	Commercial fishing	0	6, 192, 260
3	Horticulture	4, 926, 000	5, 477, 690
4	Livestock	6, 535, 000	10, 779, 500
5	Manufacturing	62, 991, 000	70, 962, 800
6	Lodging	1, 438, 000	5, 523, 600
7	Cafes & taverns	35, 000	9, 183, 650
8	Service stations	331, 000	28, 822, 400
9	Automotive sales	3, 692, 000	39, 812, 000
10	Communications & transportation	8, 199, 000	28, 989, 800
11	Professional services	1, 047, 000	15, 131, 700
12	Financial services	4, 081, 000	51, 424, 800
13	Construction	6, 832, 000	38, 602, 900
14	Retail & wholesale trade	6, 505, 000	115, 727, 000
15	Retail services and organizations	7, 560, 000	37, 797, 500
16	U. S. Forest Service	9, 496, 000	28, 592, 400
17	U. S. F. S. appropriations	13, 421, 000	13, 421, 100
18	Bureau of Land Management	2, 915, 000	29, 666, 100
19	B. L. M. appropriations	2, 372, 000	2, 372, 800
20	Education	6, 795, 000	31, 034, 000
21	Law enforcement	1, 865, 000	2, 600, 210
22	County roads	3, 839, 000	11, 048, 800
23	Social services	1, 922, 000	2, 260, 700
24	Administration	2, 381, 000	2, 886, 920
25	City of Roseburg	147, 000	2, 711, 290
26	City of Sutherlin	460, 000	1, 036, 850
27	City of Myrtle Creek	209, 000	806, 358
28	City of Reedsport	388, 000	849, 817
29	Other incorporated cities	46, 000	810, 767
30	Households	14, 984, 000	254, 911, 000
31	Visitors	27, 334, 000	27, 334, 200

Summary

The theoretical input-output model and some of its empirical bases were discussed in Chapter II. This model was applied to the Douglas County economy in 1970. The current chapter, having described how the 1970 model was revised and updated, sought to provide a new model which would be expected to provide the best projections obtainable with the information available. These projections, when combined with the household sample data, will hopefully provide reasonably accurate estimates of the economic impacts of the projected decline in timber availability on the household sector and the various income groups in Douglas County, Oregon. This task is taken up in Chapter IV.

IV. PROJECTIONS OF IMPACTS ON HOUSEHOLD INCOME AND THE DISTRIBUTION OF INCOME IMPACTS

The Beuter Study

In 1976, a study of timber harvest potential for Oregon's timbersheds over the period 1970-2070 was published by John H. Beuter et al. (1). The study projected levels of timber harvest available in each timbershed, given different assumptions regarding management intensity and forest policy decisions. The Beuter projections which are of particular relevance to the current study are those relating to the Roseburg timbershed, which was defined as Douglas County, Oregon in the Beuter report (1, p. 35).

The two sets of projections of timber availability in the Roseburg timbershed from the Beuter report that are used in the current study are referred to in the report as "run I" and "run II" (1, p. 19).[5] These relate to harvest projections for the Roseburg timbershed by owner class and timberland management intensity (1, p. 35).

The Beuter runs I and II were designed to answer two questions which are of particular relevance to this study. Run I asks the

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[5] In the Beuter report, "run I" is broken into "RUN A-1" and "RUN B-1", with the low and high end of the range assumed for management intensity, respectively. Similarly for "run II". In the current study, we assume a mean level of management intensity, and therefore will refer to the projections as run I and run II.

question:

> Can the present annual harvest (based on the annual average for 1968-1973) be maintained to the year 2000 if public owners maintain their current allowable cuts and private owners continue trying to fill the gap between public harvest and total harvest (1, p. 18)?

Run II asks the question:

> If we assume that the various owner classes are willing to change some of their policies and actions, what is the capability for timber harvest during the next 100 years (1, p. 18)?

The projections of the Beuter report which address these two questions--over the time periods of relevance to the current study--are given in Table 5 (1, p. 35).[6]

Table 5. Mean annual harvest assuming average level of management intensity for Beuter runs I and II; Douglas County, Oregon.

Decade	Cubic Feet of Timber Available per Year Over Decade (Average)
Beuter Run I	
1995-2005	228,200,000
Beuter Run II	
1975-1985	286,100,000
1985-1995	273,900,000
1995-2005	275,100,000
2005-2015	272,500,000
2015-2025	271,600,000

[6]Page 35 of the Beuter report gives only graphical representations of these projections. The actual figures were obtained through personal communication with Dr. Beuter.

Projections of Sectoral Impacts

The figures presented in Table 5 are, essentially, biological constraints of the Douglas County timbershed. In order to make projections of the economic impacts which these biological constraints may imply for the Douglas County economy, these data must be translated into economic data. In other words, the total output of timber available in cubic feet projected by Beuter must be translated into a total output in 1975 dollars for the timber and wood products sector in Douglas County. This is accomplished in Table 6.

Table 6. Value in 1975 dollars of projected total output of timber and wood products sector in Douglas County, Oregon.

Decade	Total Output in 1975 Dollars per Year Over Decade (Average)
Beuter Run I	
1995-2005	355,803,162
Beuter Run II	
1975-1985	446,079,249
1985-1995	427,057,345
1995-2005	428,928,352
2005-2015	424,874,503
2015-2025	423,471,248

The figures in Table 6 were computed by, first, calculating the 1975 dollar value of timber and wood products per cubic foot in Douglas County. This is simply the ratio of the 1975 total output

projection of the input-output model for the timber and wood products sector (given in Table 4) to the total number of cubic feet of timber used in 1975 in the county. The figures in Table 6, then, all in 1975 dollars, are the product of the value per cubic foot of timber and wood products in the county and the projections of the total cubic feet of timber available given in Table 5.

Attempting to use the input-output model to project the sectoral economic impacts of the constrained total output figures in Table 6 presents an abstruce, but tractable, problem. As described above, the input-output system is designed to project total output for given or estimated levels of final demand. In the case of this study, one of the total outputs is already given. All of the published studies, to the author's knowledge, which faced this problem, either solved it incorrectly (2, p. 22)[7] or made assumptions about specific technological changes in the economy which had no empirical bases (7, pp. 37-41).[8]

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[7] To assume that the change in final demand will exactly equal the known change in total output is obviously inappropriate, since the total output projection of the model does not even equal the known total output for the given sector, e. g. (2, p. 22), to say nothing of the unknown magnitudes of the errors in the projections of the total outputs of the remaining sectors.

[8] To change the technical coefficients in such a manner as to assure that the total output projection of the model will equal the known total output for the given sector is also inappropriate. This amounts to changing the empirical data to suit the problem at hand, to say nothing of the assumption this requires concerning exports, e. g. (7, pp. 37-41).

Thus, we have dealt with the problem in a different manner.[9]

It seems that the best method of dealing with this difficulty of having one of the total outputs in the system already determined would be to find that level of final demand for the relevant sector which would be required to produce the previously determined level of total output for that sector. The only assumption which this procedure requires is that at least that level of final demand will exist over the time period in question. For the timber and wood products sector, where demand continues to increase and supply is projected to decline, this is a completely reasonable assumption.

Thus, we seek to find the level of final demand for timber and wood products in Douglas County which would yield the levels of total output given in Table 6. We know that the equation for the timber and wood products sector of the revised Youmans model is

$$r_{11}Y_1^{75} + \sum_{j=2}^{31} r_{1j}Y_j = X_1^{75} ,$$

where

r_{ij} are the elements of $[I-A]^{-1}$,

Y_1^{75} is the first element of the final demand vector, Y, in 1975, and

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[9]The method used in the study to deal with this problem resulted from a discussion with Dr. John A. Edwards.

X_1^{75} is the total output for the timber and wood products sector in 1975.

Given a timber resource constraint of X_1^k in year k, representing the total obtainable output of the timber and wood products sector (in 1975 dollars) in year k, we can form the following equation:

$$r_{11}Y_1^k + \sum_{j=2}^{31} r_{1j}Y_j = X_1^k ,$$

where

X_1^k is the known total output for the timber sector in year k, and

Y_1^k is the unknown final demand required to produce this output X_1^k, in 1975 dollars.

Combining the information in these two equations and solving for Y_1^k yields

$$Y_1^k = (1/r_{11})(X_1^k - X_1^{75}) + Y_1^{75} .$$

Thus, we can find the level of final demand necessary to produce the constrained total output of timber, since it is a function of the known quantities which appear on the right hand side of this equation. The levels of final demand required to produce the total outputs in Table 6 are given in Table 7.

Table 7. Final demand in 1975 dollars required to produce projected total output of timber and wood products sector in Douglas County, Oregon.

Decade	Final Demand in 1975 Dollars per Year Over Decade (Average)
Beuter Run I	
1995-2005	313,626,631
Beuter Run II	
1975-1985	394,001,356
1985-1995	377,065,749
1995-2005	378,731,546
2005-2015	375,122,319
2015-2025	373,872,971

At this point, all of the information necessary to make the economic impact projections on the sectors in the Douglas County economy resulting from the Beuter projections of timber harvest potential is available. The matrix of direct and indirect coefficients was given in Table 3. These coefficients are assumed to remain constant. The levels of final demand for timber and wood products implied by the Beuter projections are given in Table 7.

Thus, the first element of the original final demand vector given in Table 4 is replaced by the projected levels of final demand given in Table 7 for each decade over which economic impact projections are to be made. Premultiplying the matrix of direct and indirect coefficients (Table 3) by the new final demand vectors obtained by the above procedure results in projections of the sectoral

economic impacts, or expected total outputs, implied by the Beuter projections for the Douglas County economy. The projected levels of total output for each sector in the input-output model are presented in Table 8.

The projections in Table 8 are mean annual total output of each sector for the decade 1995-2005 for Beuter run I,[10] and mean annual total output for each sector over the decades 1975-1985 through 2015-2025 for Beuter Run II.

Table 9 gives the difference in total output for each sector from the mean annual projection year to the 1975 base year. The figures in Table 9 can be more strictly defined as sectoral economic impacts than those in Table 8, since the figures in Table 9 give the change--which in this case is always nonpositive--in the total output of each sector that would be expected to result from the projected decline in timber availability.

Since the focus of this study is on the impacts to household income resulting from the projected decline in timber availability, this section contains two additional tables which simply transcribe the impacts on the household sector from Tables 8 and 9. Thus, Table

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[10]The reason for making projections only for the 1995-2005 decade based on run I is that run I projected no appreciable decline in timber harvest before this decade. After the 1995-2005 decade, run I asks a different question than the one cited above (1, p. 18) and is, technically, not a projection in the same sense as before the 1995-2005 decade.

Table 8. Projected Total Output by Sector Resulting from Decline in Timber Availability from Beuter Runs I and II; Douglas County, Oregon. Figures are mean per year over decade in 1975 dollars.

		Beuter Run I 1995-2005	Beuter Run II 1975-1985	Beuter Run II 1985-1995	Beuter Run II 1995-2005	Beuter Run II 2005-2015	Beuter Run II 2015-2025
1	Timber and wood products	355, 803, 000	446, 079, 000	427, 058, 000	428, 929, 000	424, 875, 000	423, 471, 000
2	Commercial fishing	6, 091, 370	6, 182, 990	6, 163, 680	6, 165, 580	6, 161, 470	6, 160, 040
3	Horticulture	5, 407, 430	5, 471, 230	5, 457, 790	5, 459, 110	5, 456, 240	5, 455, 250
4	Livestock	10, 342, 400	10, 739, 300	10, 655, 700	10, 663, 900	10, 646, 100	10, 639, 900
5	Manufacturing	69, 878, 200	70, 863, 200	70, 655, 600	70, 676, 000	70, 631, 800	70, 616, 500
6	Lodging	5, 223, 740	5, 496, 040	5, 438, 660	5, 444, 310	5, 432, 080	5, 427, 850
7	Cafes & taverns	8, 153, 830	9, 089, 000	8, 891, 950	8, 911, 330	8, 869, 340	8, 854, 800
8	Service stations	25, 790, 700	28, 543, 800	27, 963, 700	28, 020, 700	27, 897, 100	27, 854, 300
9	Automotive sales	34, 689, 600	39, 341, 200	38, 361, 100	38, 457, 500	38, 248, 600	38, 176, 300
10	Communications & transportation	26, 037, 500	28, 718, 400	28, 153, 500	28, 209, 100	28, 088, 700	28, 047, 000
11	Professional services	13, 307, 100	14, 964, 000	14, 614, 800	14, 649, 200	14, 574, 800	14, 549, 000
12	Financial services	44, 199, 400	50, 760, 700	49, 378, 200	49, 514, 200	49, 219, 600	49, 117, 600
13	Construction	34, 356, 700	38, 212, 700	37, 400, 200	37, 480, 100	37, 306, 900	37, 247, 000
14	Retail & wholesale trade	101, 036, 000	114, 377, 000	111, 566, 000	111, 842, 000	111, 243, 000	111, 036, 000
15	Retail services & organizations	34, 664, 700	37, 509, 600	36, 910, 100	36, 969, 100	36, 841, 300	36, 797, 100
16	U. S. Forest Service	24, 483, 200	28, 214, 700	27, 428, 500	27, 505, 800	27, 338, 200	27, 280, 200
17	U. S. F. S. appropriations	13, 421, 100	13, 421, 100	13, 421, 100	13, 421, 100	13, 421, 100	13, 421, 100
18	Bureau of Land Management	23, 829, 900	29, 129, 700	28, 013, 000	28, 122, 800	27, 884, 800	27, 802, 400
19	B. L. M. appropriations	2, 372, 800	2, 372, 800	2, 372, 800	2, 372, 800	2, 372, 800	2, 372, 800
20	Education	27, 159, 200	30, 677, 900	29, 936, 500	30, 009, 400	29, 851, 400	29, 796, 700
21	Law enforcement	2, 493, 800	2, 590, 430	2, 570, 070	2, 572, 070	2, 567, 730	2, 566, 230
22	County roads	9, 619, 450	10, 917, 400	10, 643, 900	10, 670, 800	10, 612, 500	10, 592, 400
23	Social services	2, 210, 990	2, 256, 130	2, 246, 620	2, 247, 560	2, 245, 530	2, 244, 830
24	Administration	2, 801, 060	2, 879, 030	2, 862, 600	2, 864, 220	2, 860, 710	2, 859, 500
25	City of Roseburg	2, 321, 890	2, 675, 500	2, 600, 990	2, 608, 320	2, 592, 440	2, 586, 950
26	City of Sutherlin	951, 025	1, 028, 960	1, 012, 540	1, 014, 160	1, 010, 660	1, 009, 440
27	City of Myrtle Creek	719, 432	798, 369	781, 736	783, 372	779, 828	778, 601
28	City of Reedsport	782, 024	843, 586	830, 615	831, 891	829, 126	828, 169
29	Other incorporated cities	701, 475	800, 722	779, 810	781, 867	777, 410	775, 867
30	Households	218, 317, 000	251, 547, 000	244, 545, 000	245, 234, 000	243, 742, 000	243, 225, 000
31	Visitors	27, 334, 200	27, 334, 200	27, 334, 200	27, 334, 200	27, 334, 200	27, 334, 200

Table 9. Decrease in Total Output from 1975 base year by Sector Resulting from Decline in Timber Availability from Beuter Runs I and II; Douglas County, Oregon. Figures are mean per year over decade in 1975 dollars.

		Decade					
		Beuter Run I 1995-2005	Beuter Run II 1975-1985	Beuter Run II 1985-1995	Beuter Run II 1995-2005	Beuter Run II 2005-2015	Beuter Run II 2015-2025
1	Timber and wood products	99,413,000	9,136,750	28,158,700	26,287,700	30,341,500	31,744,800
2	Commercial fishing	100,889	9,272	28,576	26,677	30,791	32,216
3	Horticulture	70,258	6,457	19,900	18,578	21,443	22,435
4	Livestock	437,100	40,172	123,808	115,582	133,406	139,576
5	Manufacturing	1,084,660	99,687	307,230	286,816	331,046	346,356
6	Lodging	299,858	27,559	84,934	79,291	91,518	95,751
7	Cafes & taverns	1,029,820	94,647	291,696	272,315	314,309	328,845
8	Service stations	3,031,710	278,635	858,730	801,671	925,298	968,092
9	Automotive sales	5,122,340	470,779	1,450,900	1,354,500	1,563,370	1,635,680
10	Communications & transportation	2,952,290	271,336	836,234	780,670	901,058	942,731
11	Professional services	1,824,600	167,693	516,816	482,476	556,880	582,635
12	Financial services	7,225,350	664,061	2,046,580	1,910,590	2,205,230	2,307,220
13	Construction	4,246,260	390,261	1,202,750	1,122,830	1,295,990	1,355,930
14	Retail & wholesale trade	14,690,900	1,350,190	4,161,180	3,884,690	4,483,760	4,691,130
15	Retail services & organizations	3,132,820	287,928	887,369	828,408	956,158	1,000,380
16	U. S. Forest Service	4,109,140	377,659	1,163,910	1,086,580	1,254,140	1,312,140
17	U. S. F. S. appropriations	00	00	00	00	00	00
18	Bureau of Land Management	5,836,220	536,389	1,653,110	1,543,270	1,781,250	1,863,640
19	B. L. M. appropriations	00	00	00	00	00	00
20	Education	3,874,820	356,123	1,097,540	1,024,610	1,182,620	1,237,320
21	Law enforcement	106,408	9,779	30,139	28,137	32,476	33,978
22	County roads	1,429,320	131,364	404,854	377,954	436,238	456,414
23	Social services	49,706	4,568	14,079	13,143	15,170	15,872
24	Administration	85,858	7,890	24,319	22,703	26,204	27,416
25	City of Roseburg	389,400	35,788	110,297	102,969	118,848	124,344
26	City of Sutherlin	85,824	7,887	24,309	22,694	26,194	27,405
27	City of Myrtle Creek	86,926	7,989	24,621	22,985	26,530	27,757
28	City of Reedsport	67,792	6,230	19,202	17,926	20,690	21,647
29	Other incorporated cities	109,291	10,044	30,956	28,899	33,356	34,899
30	Households	36,593,500	3,363,190	10,365,100	9,676,370	11,168,600	11,685,100
31	Visitors	00	00	00	00	00	00

10 gives the total mean annual household income over the relevant decades resulting from the projected timber harvest decline. Table 11, then, gives the changes in mean annual household income from the projection year over the five decades to the 1975 base year. Table 10 is represented graphically in Figure 2, so that the trends can be seen more easily.

In the following section, the figures in Tables 10 and 11 are separated into their direct and indirect effects. In other words, we will attempt to identify the losses to household income given in Table 11 in terms of their impacts on timber sector and non-timber sector employees.

Table 10. Projected total household income associated with Beuter projections of timber availability in Douglas County, Oregon.

Decade	Total Houseshold Income in 1975 Dollars per Year Over Decade (Average)
Beuter Run I	
1995-2005	218,317,000
Beuter Run II	
1975-1985	251,547,000
1985-1995	244,545,000
1995-2005	245,234,000
2005-2015	243,742,000
2015-2025	243,225,000

FIGURE 2.

PROJECTED TOTAL HOUSEHOLD INCOME ASSOCIATED WITH BEUTER PROJECTIONS OF TIMBER AVAILABILITY, DOUGLAS COUNTY, OREGON.

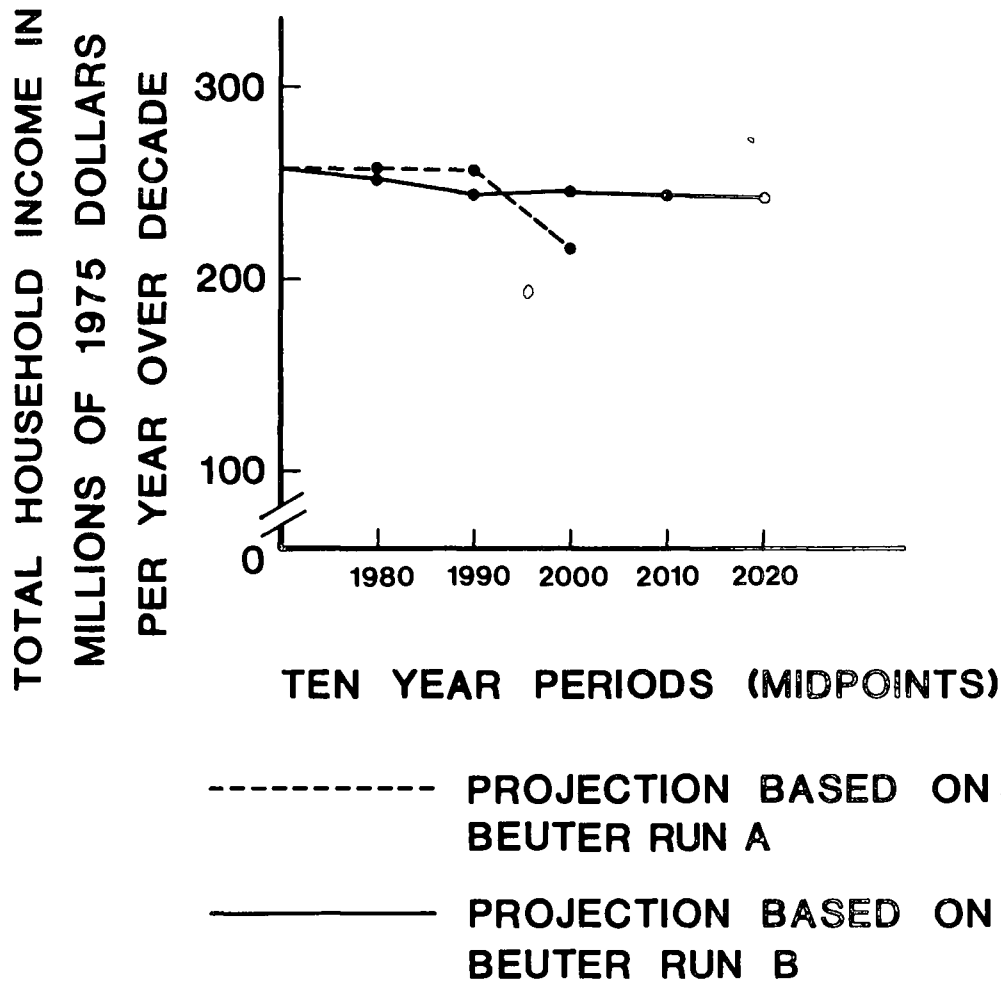

Table 11. Decrease in total household income from 1975 base year associated with Beuter projections of timber availability in Douglas County, Oregon.

Decade	Decrease in Total Household Income in 1975 Dollars per Year Over Decade (Average)
Beuter Run I	
1995-2005	36,593,000
Beuter Run II	
1975-1985	3,363,000
1985-1995	10,365,000
1995-2005	9,676,000
2005-2015	11,169,000
2015-2025	11,685,000

Direct and Indirect Household Income Impacts

The effect of a change in the final demand of any given sector in the input-output model for year k, ΔY_i^k, on the total output of any other given sector, ΔX_j^k, can be expressed as

$$r_{ij}\Delta Y_i^k = \Delta X_j^k ,$$

where r_{ij} is a particular coefficient in the $[I-A]^{-1}$ matrix, as before. Adding and subtracting the quantity $a_{ij}\Delta Y_i^k$, where a_{ij} is a particular direct coefficient in the A matrix, the above expression can be written as

$$a_{ij}\Delta Y_i^k + (r_{ij}-a_{ij})\Delta Y_i^k = \Delta X_j^k .$$

This expression separates the total effect ΔX_j^k into its direct and indirect components. The direct effect of the change in final demand in year k is the quantity $a_{ij}\Delta Y_i^k$, and the indirect effect is the quantity $(r_{ij}-a_{ij})\Delta Y_i^k$.

In this study, we are concerned with the effect of a change in the final demand for timber and wood products on the income of the household sector in Douglas County. Thus, the relevant coefficients for the above equation are

$$(a_{30,1})\Delta Y_1^k + (r_{30,1}-a_{30,1})\Delta Y_1^k = \Delta X_{30}^k .$$

Taking the values of these coefficients from Tables 2 and 3 gives

$$(0.24853)\Delta Y_1^k + (0.16491)\Delta Y_1^k = \Delta X_{30}^k .$$

The quantity $(0.24853)\Delta Y_1^k$ gives the direct effect, that is, the effect on employees of the timber sector, of a change in the final demand for timber and wood products in the county. On the other hand, the quantity $(0.16491)\Delta Y_1^k$ gives the indirect effect, or the effect of a change in the final demand for timber and wood products on those employed by sectors other than the timber and wood products sector.[11] Thus, we have separated the impacts on household income

[11] Actually, as the effects of a decline in timber availability move through the economy, a portion of the quantity $(0.16491)\Delta Y_1^k$

into those borne by wage earners employed directly by the timber and wood products sector, and those borne by wage earners employed by the other 30 sectors in the county.

In order to make these computations, the changes in the final demand for timber and wood products from the projection year, k, to the 1975 base year must be known, i.e. $(Y_1^k - Y_1^{75})$. These changes in final demand are given in Table 12. Table 13, then, provides the figures giving the direct and indirect effects of these final demand changes--stemming from the projected decline in timber harvest potential--on total household income.[12] Again, the direct effect applies to timber and wood products sector employees, and the indirect effect applies to all other employees in Douglas County.

In the following section, we attempt to identify how these impacts on household income will be distributed among the various income groups in Douglas County.

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will be borne by the employees of the timber and wood products sector also. However, this is expected to be only a small portion relative to the portion borne by the employees of the other 30 economic sectors. Given the information available, we have come as close as possible to making and exact separation.

[12] Clearly, the sum of the direct and indirect effects on household income given in Table 13, per year for any particular decade, equals the total impact for that decade given in Table 11. This can be seen by noting that the equation from which the direct and indirect effects were calculated simplifies to the equation giving the total effect.

Table 12. Changes in final demand for timber and wood products from projection year to 1975 base year in 1975 prices.

Decade	Change in Final Demand per Year Over Decade (Average)
Beuter Run I	
1995-2005	-88,509,369
Beuter Run II	
1975-1985	- 8,134,644
1985-1995	-25,070,251
1995-2005	-23,404,454
2005-2015	-27,013,681
2015-2025	-28,263,029

Table 13. Direct and indirect effects of changes in timber harvest on household income in Douglas County, Oregon in 1975 dollars.

Decade	Direct Effect per Year Over Decade	Indirect Effect per Year Over Decade
Beuter Run I		
1995-2005	-21,997,233	-14,596,080
Beuter Run II		
1975-1985	- 2,021,703	- 1,341,484
1985-1995	- 6,230,709	- 4,134,335
1995-2005	- 5,816,709	- 3,859,629
2005-2015	- 6,713,710	- 4,454,826
2015-2025	- 7,024,211	- 4,660,856

Distribution of Household Income Impacts

So far, we have projected the impacts on household income in Douglas County which the Beuter projections of timber harvest potential may imply. These have been separated into their direct and

indirect effects, in terms of timber sector and non-timber sector employees, respectively. In the final section of this chapter, we attempt to identify how these income impacts are likely to be distributed among the various income groups in the county.

This procedure requires no formal theory of income distribution, but some references have been provided for the reader with a particular interest in this area (3, 16, 25, 32). Rather, the method employed here involves using the sample estimates of the proportion of households in each income group to determine the dollar amount of the total income impact which each income class may be likely to bear.[13]

Tables 14 through 19 present the results of this procedure. The figures in each table are mean per year over a single decade, based upon the projected impacts on household income from Tables 11 and 13 for a given Beuter run.

In order to construct Tables 14 through 19, three sampling distributions from the household sample survey discussed in Chapter III were needed. For the column giving the distribution of the loss to timber sector employees in each table, the sampling distribution of the proportion of households whose principal wage earner was

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[13] It is assumed that the income impacts are distributed proportionally among the various income groups in the county. This harmonizes with the proportionality assumption regarding the production function stated in Chapter II.

Table 14. Distribution of Projected Impacts on Household Income by Income Group of Declining Timber Availability in Douglas County, Oregon. Figures are mean per year over decade 1995-2005 from Beuter Run I in 1975 dollars.

Household Income in 1975	Loss to Household Income		
	Timber Sector Employees*	Non-Timber Sector Employees	All Employees
less than $3,000	153,981	554,651	914,833
$3,000-$4,999	153,981	1,299,051	2,049,226
$5,000-$7,999	1,385,826	1,707,741	3,476,365
$8,000-$9,999	3,057,615	1,707,741	4,610,757
$10,000-$11,999	5,345,328	1,985,067	6,550,203
$12,000-$14,999	5,499,308	2,744,063	7,794,376
$15,000-$19,999	3,057,615	2,466,738	5,745,150
$20,000-$39,999	2,903,635	1,912,086	4,830,317
above $40,000	461,942	204,345	622,086
Total Projected Loss**	21,997,233	14,596,080	36,593,313

*A given household was defined as being in the timber sector if its principal wage earner was employed by the timber sector, and similarly for non-timber sector households. Thus, the income distributions of the three groups--timber sector, non-timber sector, and all employees regardless of sector of principal wage earner's employment--are different. Therefore, projected loss for all employees in a given income group does not necessarily equal timber sector plus non-timber sector projected loss.

**Entries in columns do not sum to total projected loss due to rounding of sample estimates of the proportion of households in each income group.

Table 15. Distribution of Projected Impacts on Household Income by Income Group of Declining Timber Availability in Douglas County, Oregon. Figures are mean per year over decade 1975-1985 from Beuter Run II in 1975 dollars.

Household Income in 1975	Loss to Household Income		
	Timber Sector Employees*	Non-Timber Sector Employees	All Employees
less than $3,000	14,152	50,976	84,080
$3,000-$4,999	14,152	119,392	188,338
$5,000-$7,999	127,367	156,954	319,503
$8,000-$9,999	281,017	156,954	423,762
$10,000-$11,999	491,274	182,442	602,010
$12,000-$14,999	505,426	252,199	716,359
$15,000-$19,999	281,017	226,711	528,020
$20,000-$39,999	266,865	175,734	443,941
above $40,000	42,456	18,781	57,174
Total Projected Loss**	2,021,703	1,341,484	3,363,187

*See Table 14.

**See Table 14.

Table 16. Distribution of Projected Impacts on Household Income by Income Group of Declining Timber Availability in Douglas County, Oregon. Figures are mean per year over decade 1985-1995 from Beuter Run II in 1975 dollars.

Household Income in 1975	Loss to Household Income		
	Timber Sector Employees*	Non-Timber Sector Employees	All Employees
less than $3,000	43,615	157,105	259,126
$3,000-$4,999	43,615	367,956	580,442
$5,000-$7,999	392,535	483,717	984,679
$8,000-$9,999	866,069	483,717	1,305,996
$10,000-$11,999	1,514,062	562,270	1,855,343
$12,000-$14,999	1,557,677	777,255	2,207,754
$15,000-$19,999	866,069	698,703	1,627,312
$20,000-$39,999	822,454	541,598	1,368,186
above $40,000	130,845	57,881	176,206
Total Projected Loss**	6,230,709	4,134,335	10,365,044

*See Table 14.

**See Table 14.

Table 17. Distribution of Projected Impacts on Household Income by Income Group of Declining Timber Availability in Douglas County, Oregon. Figures are mean per year over decade 1995-2005 from Beuter Run 11 in 1975 dollars.

Household Income in 1975	Loss to Household Income		
	Timber Sector Employees*	Non-Timber Sector Employees	All Employees
less than $3,000	40,717	146,666	241,908
$3,000-$4,999	40,717	343,507	541,875
$5,000-$7,999	366,453	451,577	919,252
$8,000-$9,999	808,523	451,577	1,219,219
$10,000-$11,999	1,413,460	524,910	1,732,065
$12,000-$14,999	1,454,177	725,610	2,061,060
$15,000-$19,999	808,523	652,277	1,519,185
$20,000-$39,999	767,806	505,611	1,277,277
over $40,000	122,151	54,035	164,498
Total Projected Loss**	5,816,709	3,859,629	9,676,338

*See Table 14.

**See Table 14.

Table 18. Distribution of Projected Impacts on Household Income by Income Group of Declining Timber Availability in Douglas County, Oregon. Figures are mean per year over decade 2005-2015 from Beuter Run II in 1975 dollars.

Household Income in 1975	Loss to Household Income		
	Timber Sector Employees*	Non-Timber Sector Employees	All Employees
less than $3,000	46,996	169,283	279,213
$3,000-$4,999	46,996	396,480	625,438
$5,000-$7,999	422,964	521,215	1,061,011
$8,000-$9,999	933,206	521,215	1,407,236
$10,000-$11,999	1,631,432	605,856	1,999,168
$12,000-$14,999	1,678,428	837,507	2,378,898
$15,000-$19,999	933,206	752,866	1,753,460
$20,000-$39,999	886,210	583,582	1,474,247
over $40,000	140,988	62,368	189,865
Total Projected Loss**	6,713,710	4,454,826	11,168,536

*See Table 14.

**See Table 14.

Table 19. Distribution of Projected Impacts on Household Income by Income Group of Declining Timber Availability in Douglas County, Oregon. Figures are mean per year over decade 2015-2025 from Beuter Run II in 1975 dollars.

Household Income in 1975	Loss to Household Income		
	Timber Sector Employees*	Non-Timber Sector Employees	All Employees
less than $3,000	49,169	177,113	292,127
$3,000-$4,999	49,169	414,816	654,364
$5,000-$7,999	442,525	545,320	1,110,081
$8,000-$9,999	976,365	545,320	1,472,318
$10,000-$11,999	1,706,883	633,876	2,091,627
$12,000-$14,999	1,756,053	876,241	2,488,919
$15,000-$19,999	976,365	647,859	1,834,556
$20,000-$39,999	927,196	610,572	1,542,429
over $40,000	147,508	65,252	198,646
Total Projected Loss*	7,024,211	4,660,856	11,685,067

*See Table 14.

**See Table 14.

employed by the timber sector in 1975 was used. Similarly for the column for non-timber sector employees in each of Tables 14 through 19. These columns, then, in each table, represent the distribution of the direct and indirect effect, respectively, of the loss to household income resulting from the relevant Beuter projections of timber availability in Douglas County for each of the five decades 1975-1985 through 2015-2025.

The column in each of Tables 14 through 19 giving the distribution of the loss to all employees--the total loss to household income--was computed by using the sampling distribution of the proportion of households to each income group which had a wage earner employed in 1975.[14]

This basically completes the analysis of the data and projections of the income impacts to the household sector, and the distribution of these impacts. Up to this point, we have essentially described the procedure through which these projections, and their distribution, were obtained. The final chapter of this study will attempt to draw some conclusions and possible policy implications from these results,

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[14] In an effort not to unnecessarily over-burden the reader with tables, the three sampling distributions of proportions have been omitted. These can be easily recovered if desired, however, simply by dividing each of the dollar figures in any given column by the total figure at the bottom of that particular column.

and to point out some of the limitations inherent in the study. First, however, we seek to determine what the above projections may imply regarding employment, or the loss thereof, in the Douglas County economy.

V. EMPLOYMENT IMPACTS

Introduction

A decline in the amount of timber harvested in Douglas County, especially of the magnitudes projected by the Beuter study, will certainly result in some increase in unemployment in the region. Fewer employees would be required to harvest and process a smaller amount of timber than is currently available to the county's economy.

The causal sequence of events describing the impacts of such a decline would actually be in reverse order to those presented in this study. That is, a decline in timber harvest would cause a decrease in the demand for labor, which then would be expected to result in increased unemployment in the county. This loss of jobs, then, would cause a loss to household income in the county.

This study has, however, presented the loss to household income first. The reason for this is that the nature of the input-output projections and the sample data provide impacts only on household income, and not on employment directly. We can, however, by combining the input-output projections and the sample data, derive the expected impacts of the projected decline in timber harvest on employment in the Douglas County economy from the impacts on household income given in Chapter IV.

Often, when input-output models are used to make economic impact projections, the employment impacts are derived by dividing the changes in household income by the average household income in the relevant region. This, theoretically, would yield the expected number of jobs gained or lost by the original stimuli. This procedure, however, would be expected to yield an exact employment projection only if the mean household income used had a zero variance.

Generally, the variance around the mean household income figure used will be much greater than zero, since household income can vary, say, from $1,000 to $1,000,000 per year or more. Thus, the employment impacts obtained through this procedure could be associated with very large confidence intervals.

We have attempted to minimize the range over which the employment projections can vary in this study, given the constraints of the data available. Since the impacts on household income have been separated into nine income groups, the mean (or expected value) for each of these groups can be divided into the total loss for that income group and decade to provide estimates of the number of jobs lost for each Beuter run.

This procedure should provide more accurate estimates than the procedure described earlier, since the range over which the mean household income can vary in each group is much smaller than the whole range of possible household incomes. The estimate of total job

loss for each Beuter run and decade, then, will be the weighted average of the relevant estimates for each income group, weighted by the mean income in each group.[15] The first procedure described ignores these weights. In addition to the expected increased accuracy of using the weighted average procedure to calculate the employment impacts, we gain the additional information of how these employment impacts are likely to be distributed among the various income groups.

Employment Impacts and Distribution of Employment Impacts by Income Group

Tables 20, 21 and 22 present the results of using the above procedure to calculate the employment impacts for each Beuter run and decade. Each table gives the estimates of expected job loss for each income group per year over each decade, and the total expected job loss per year over each decade (at the bottom of each column). Each of the three tables provides these estimates for a different set of employees.

As in Chapter IV, the economic impacts of the projected timber harvest decline have been separated into their direct, indirect, and total effects; that is, into their effects on timber sector employees,

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[15] In other words, the estimate of total job loss for each Beuter run in each decade is equal to $\Sigma_{i=1}^{9} (1/\bar{y}_i)T_i$, where $\bar{y}_i$ is the average or expected income in the i'th group, and T_i is the total loss to household income in the i'th group in 1975 dollars.

Table 20. Distribution of Projected Employment Impacts on Timber Sector Employees by Income Group of Declining Timber Availability in Douglas County, Oregon.

Household Income in 1975	Mean Number of Jobs Lost per year over Decade					
	Beuter Run I 1995-2005	Beuter Run II 1975-1985	Beuter Run II 1985-1995	Beuter Run II 1995-2005	Beuter Run II 2005-2015	Beuter Run II 2015-2025
less than $3,000	77	7	22	20	23	25
$3,000-$4,999	38	4	11	10	12	12
$5,000-$7,999	213	20	60	56	65	68
$8,000-$9,999	340	31	96	90	104	108
$10,000-$11,999	486	45	138	128	148	155
$12,000-$14,999	407	37	115	108	124	130
$15,000-$19,999	175	16	49	46	53	56
$20,000-$39,999	97	9	27	26	30	31
above $40,000	9	1	3	2	3	3
Total Job Loss	1,842	170	521	486	562	588

Table 21. Distribution of Projected Employment Impacts on Non-Timber Sector Employees by Income Group of Declining Timber Availability in Douglas County, Oregon.

Household Income in 1975	Mean Number of Jobs Lost per year over Decade					
	Beuter Run I 1995-2005	Beuter Run II 1975-1985	Beuter Run II 1985-1995	Beuter Run II 1995-2005	Beuter Run II 2005-2015	Beuter Run II 2015-2025
less than $3,000	277	25	79	73	85	89
$3,000-$4,999	325	30	92	86	99	104
$5,000-$7,999	263	24	74	69	80	84
$8,000-$9,999	190	17	54	50	58	61
$10,000-$11,999	180	17	51	48	55	58
$12,000-$14,999	203	19	58	54	62	65
$15,000-$19,999	141	13	40	37	43	37
$20,000-$39,999	64	6	18	17	19	50
above $40,000	4	*	1	1	1	1
Total Job Loss	1,647	151	467	435	502	549

*Indicates a number less than 1, therefore no job loss is projected for this income group and decade

Table 22. Distribution of Projected Employment Impacts on All Employees by Income Group of Declining Timber Availability in Douglas County, Oregon.

Household Income in 1975	Beuter Run I 1995-2005	Beuter Run II 1975-1985	Beuter Run II 1985-1995	Beuter Run II 1995-2005	Beuter Run II 2005-2015	Beuter Run II 2015-2025
less than $3,000	457	42	130	121	140	146
$3,000-$4,999	512	47	145	135	156	164
$5,000-$7,999	535	49	151	141	163	171
$8,000-$9,999	512	47	145	135	156	164
$10,000-$11,999	595	55	169	157	182	190
$12,000-$14,999	577	53	164	153	176	184
$15,000-$19,999	328	30	93	87	100	105
$20,000-$39,999	161	15	46	43	49	51
above $40,000	12	1	4	3	4	4
Total Job Loss	3,689	339	1,047	975	1,126	1,179

non-timber sector employees, and all employees, respectively.

Table 20 gives the estimates of job loss for timber sector employees (average per year) for each decade and income group for Beuter runs I and II. These were calculated by dividing the figures in the timber sector column of Tables 14 through 19 by the mean income in each group.[16]

Table 21 relates to the expected employment impacts on non-timber sector employees. The figures in Table 21 were calculated in a similar manner to those in Table 20, but the non-timber sector column in Tables 14-19 was used.

Table 22 gives the expected job loss for all employees in Douglas County. These figures are mean per year over each decade for Beuter runs I and II. The column for all employees of Tables 14-19 was used.[17] Table 22 essentially summarizes the economic impacts of declining timber harvest in Douglas County projected by Beuter et al. It is this total loss of employment which would be expected to cause the loss to household income projected in Chapter IV.

[16]The mean or expected value of the income in each range from $3,000 through $39,999 was calculated assuming a uniform distribution, and therefore is the midpoint of each of these intervals. The other two intervals--"less than $3,000" and "above $40,000"--were set at $2,000 and $50,000, respectively, after consulting some statistical sources.

[17]As with Tables 14-19, the projected loss to all employees does not equal timber-sector plus non-timber sector projected loss (see * on Table 14). It is interesting, however, how close the total of the sum of a given column on Table 20 plus 21 is to the sum of a given column on Table 22.

VI. CONCLUSIONS AND POLICY IMPLICATIONS

Limitations of the Study

Before we attempt to draw any conclusions from the results of the above analysis, it seems necessary to point out some of the limitations inherent in the study. Most of these limitations are not confined to this study only, but rather to any research effort which uses the type of model used here to make projections into the future.

To begin with, the input-output system is a static model; that is, it contains no time dimension. While some economists prefer to view the model as a description of an economy at a point in time, the input-output model actually neither embodies nor represents a time dimension at all. Thus, the obvious problem of projection over roughly a 50 year period with a static--or timeless--model presents itself. This procedure essentially assumes that all of the coefficients in the A matrix will remain constant, or relatively constant, over the projection period. This may not be a realistic assumption. In an empirical study of the production function in input-output models, Cameron (4) has indicated that one can be fairly safe in assuming that the direct coefficients will remain approximately constant for about one decade.

One way to circumvent this difficulty is to approach the original question from a different point of view. We can say that, in a sense,

this study confronts the policy makers, the employees, and the owners of the means of production in the Douglas County economy with the assertion that if the system of production and demand in the economy remain as they were in 1970-1975, then the projections given in this study most likely will be the result.[18]

This brings us to the second limitation of this study, which is the ceteris paribus--or "everything else constant"--assumption. This has assumed, for example, that the final demand for each of the 30 non-timber sectors in the model will not change--apart from purely inflationary price changes--over the projection period. Suppose that the final demand for one or more of the sectors' outputs in the economy did increase[19] over the five decade period dealt with in this study. Then the projected impacts on household income would almost certainly be less than those given in this study; and vice versa for a final demand decrease to one or more of the non-timber sectors.

This is just one example of the effects of possible violations of the ceteris paribus assumption. Anything which has been assumed constant over the five decade projection period which, in actuality, changes, would probably cause a change in the projections presented

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[18]This, of course, also assumes that the Beuter projections used here will also come to pass.

[19]This supposed increase could occur inside or outside of the county, or outside of the country for that matter.

here. This could be, for example, changes in federal government policy decisions regarding unemployment compensation, et cetera.

While other limitations to the strict use of the exact projections presented here exist, the author finds one final limitation worth mentioning. This third limitation relates to the ability of the researcher to make probability statements about the range over which the input-output projections presented here may occur. This is generally a crucial criterion upon which the reliability of econometric projections are assessed.

The current state of knowledge, as it relates to input-output analysis, provides no method for computing the variances nor confidence intervals for the projections of input-output models. This problem was taken up--with little practical success--by Quandt in 1958 and 1959 (23, 27) and has not been resolved in the literature since.

The coefficients in the A matrix of the Douglas County input-output model are sample estimates, and therefore possess sampling variances. These variances--and therefore confidence intervals--cannot, however, be computed for the elements of the vector $[I-A]^{-1}Y$, at least at the current state of knowledge. Since all of the projections presented in this study are some function of the

elements of the $[I-A]^{-1}Y$ vector,[20] we cannot compute confidence intervals for these projections at some given level of probability. Thus, we have no concrete idea about the range over which these projections may be expected to occur at some probability level, say, for example, the conventional 95% confidence level. This is somewhat distressing since, to some degree, it limits the concreteness or soundness of the conclusions which can be drawn from this analysis.

Conclusions and Possible Policy Implications

Given the assumptions of the theoretical input output model, the results of the analysis presented in Chapters IV and V, and the limitations of this analysis, what conclusions can be drawn from these results?

Obviously, an economy as heavily dependent on a single resource as the Douglas County economy is on timber will be subjected to substantial economic impacts if the availability of this resource declines. The purpose of this study has been to attempt to quantify these impacts in terms of declining household income and employment.

It was found that, given Beuter's projection of timber availability with no changes in allowable cut (run I), a loss of approximately

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[20] The projections themselves are, of course, included as a special case. They are a function of the form $f(X) = X$.

$37,000,000 per year to household income can be expected over the 1995-2005 decade in Douglas County. Roughly $22,000,000 of this loss will be borne by timber sector employees, and approximately $15,000,000 by non-timber sector employees, per year over the 1995-2005 decade.

In terms of job loss in the county over this decade, Beuter's run I implies a loss of about 1,800 jobs per year in the timber sector, and about 1,700 jobs per year in the non-timber sector. The reason for a larger income loss in the timber sector relative to the job loss, as opposed to the non-timber sector, is that incomes in the timber sector are higher than in the non-timber sector.

Thus, a smaller proportion of the losses to household income and employment are concentrated in the lower income groups in the timber sector than in the non-timber sector. In terms of percentages, 45.9% of the $22,000,000 loss of household income in the timber sector from Beuter run I fall into income groups earning less than $12,000 per year.[21] In the non-timber sector, this figure is 49.7% of the $15,000,000 loss to household income in the non-timber sector. Regarding employment losses, 62.6% of the job loss from Beuter run I fall into income groups below $12,000 for timber sector employees, while 75.0% of these job losses fall into this income group for

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[21] The mean annual income in the county in 1975 was approximately $12,000, with a median of about $11,000.

non-timber sector employees. It is of great concern that a substantial proportion of these indirect effects--those on non-timber sector employees--fall into the very low income groups. For Beuter run I, 52.5% of the job losses fall into income groups earning less than $8,000 per year.

The impacts discussed so far in this section all relate to Beuter run I for the 1995 2005 decade. These projections--the Beuter projections and the projections in this study which are based upon them--assume that there will be no change in forest policy, i.e. no change in the allowable cut on public lands. These represent the worst of all reasonably possible occurrences--in the sense that the run I projections imply the greatest losses to household income and employment in Douglas County. The Beuter projections for run II--those which assume changes in forest policy regarding allowable cut--imply much smaller impacts on employment and household income, as the preceding tables indicate. In fact, over the five decade period 1975-1985 through 2015-2025, the Beuter run II projections imply economic impacts on employment and household income which are roughly 1/3rd as large as those for the run I projections over the three decade period 1975-1985 through 1995-2005.

Thus, the arguments relating to these issues generally focus on the allowable cut on public lands, either arguing that it should be increased, or that it should remain relatively constant over the

relevant projection period, in order to provide for wilderness areas and recreational uses. Rather, it appears that the problem centers around economic dependence upon a single resource. Therefore, other alternatives to increasing or holding timber harvest on public lands constant should be considered.

Furthermore, while the forest is considered to be a "renewable resource", Beuter's report indicates that--even assuming the highest level of management intensity and increases in the allowable cut on public lands--the current level of harvest in the Roseburg timbershed cannot be attained during any decade between 1975 and 2070. It takes little reflection to arrive at the conclusion that if the economic incentives were insufficiently strong to promote renewal of timber on private lands, there would not be sufficient incentives to do so on public lands either--at least not at the expense of the private sector. The only exception would be a great leap in reforestation technology, of which there is no guarantee. Therefore, we seek other avenues to mitigate the losses to household income and employment that have been projected in this study.

Planners and policy makers in Douglas County are not unaware of the problems associated with heavy economic dependence upon a single resource, nor of the anticipated decline in the timber resource base of the region. Regarding these problems, we quote several points contained in the 1977-78 Overall Economic Development Plan

for Coos, Curry, and Douglas Counties (19):

> 1) Overdependence on a single industry . . . inhibits industrial diversification that could provide employment opportunities to offset the anticipated decline in employment opportunities in that (forest products) industry.
> 2) The inherent instability problems of the forest products industry which includes seasonality, automation and cyclical demands.
> 3) Less than optimal application of reforestation and forest management policies and practices which could increase productivity from all commercial forest lands.
> 4) The dwindling forest products resource base.
> 5) The absence of further processing (vertical integration) of the County's forest products industry.
> 6) Limited public and private investment in forest management practices. . . .
> 9) The absence of encouragement and inducements to establish a small wood products industry based on the resources of the area (10, p. X-27).

These points are contained in the Douglas County portion of the report, and basically summarize how the planners and policy makers in the county view their own situation.

It seems clear, then, given the Beuter projections and the OEDP statement, that the focus of the current argument around whether the allowable cut on public lands should be increased or not, is too narrow. An increase in the allowable cut, while it would help mitigate the economic impacts in the short run, would not provide a long run solution to the economic problems that face Douglas County.

It appears that grater economic diversification is urgently needed if the economic impacts projected in this study are to be mitigated in the long run. Encouragement to develop the non-timber

resources of Douglas County is needed. According to the Douglas County portion of the OEDP statement (19), these resources do exist but have not been fully utilized. Thus, the following economic goals have been adopted by the Douglas County OEDP committee, quoted from the 1977-78 OEDP statement:

I. Improvement of the transportation system within Douglas County.
II. Greater economic diversification.
    1) Attraction of new industries to the county.
    2) Development of new products from the county's resource base.
III. Effective utilization of the county's water resources.
. . .
V. Greater development of tourism and recreation in the county.
VI. Increased employment in commercial fisheries and seafood processing.
VII. Increased agricultural production.
VIII. Greater utilization of the county's mineral resources.
IX. Increased trade and service employment in the county.
X. Improved human resource services to provide all the county residents with full economic opportunity.
XI. Improved financial services in the county (19, pp. X-23 to X-36).

These ten areas of industrial and economic improvement and diversification present the county with a possible solution to averting the economic impacts of declining timber harvest over the long run. Some labor dislocation is likely to exist during the transition period, but, fortunately, the skill level in the industries which are recommended for expansion is close to the skill level which the current employees of the timber and wood products sector currently possess. This should make for a relatively smooth transition, if one is to

occur. It appears that this is the only way that the Douglas County economy can continue to provide acceptable levels of employment to its residents in the face of a decline in its timber resource base.

The purpose of this study has been to quantify the already vaguely anticipated decline in employment and household income resulting from the anticipated timber harvest decline. It is hoped that the more concrete information contained in this study will prove useful toward making more specific plans and policies to deal with the expected economic impacts of a declining timber resource base in Douglas County, Oregon.

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