DEVELOPMENT AND USE OF A SUPPLY-DETERMINED SOCIAL ACCOUNTING MATRIX TO EVALUATE ECONOMIC IMPACTS OF FOREST PRODUCTIVITY ON DISTRIBUTION OF REGIONAL FACTOR INCOME

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PREFACE

This dissertation identifies the distributional impacts of forest productivity on sources of regional factor income. It is the first analysis which quantifies the interrelationships between generation of factor income resulting from timber production and its distribution throughout a regional economy. Specifically identifying which income levels are impacted and the extent of this impact allows macroeconomic assessment of policies concerned with the benefits of natural resource management to regional populations.

This analysis provides quantification of *economic development* within a region. It is the distinction between economic development and economic growth that provides uniqueness to this study. The primary focus of this dissertation is on the distribution of factor income throughout a regional society. Due to the inextricable nature of social welfare and income generation, *economic development* is an appropriate term applied when referring to issues dealing with equity of resource use and the distribution of income. This is contrasted with the less specific term *economic growth*, which, in this context, is taken to simply refer to increasing the total income within a region regardless of its distribution to specific income groups.

The purpose of this dissertation is to construct a rational model which quantifies the distribution of factor income and allows prediction of socioeconomic impacts resulting from management of timber resources. This model also assesses the distributional impacts that processing of these renewable raw materials exhibit throughout the regional economy.

This dissertation uses procedural technique, published data sources, computer databases operated interactively, and quantitative specification as a basis for drawing conclusions. Whenever possible, data specific to the region under analysis is used. If not available, data specific to other regions is applied with appropriate specification of assumptions and adjustments.

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This work is dedicated to the individuals I value most. To Margaret, my wife; thank you for instilling in me the concept of equity and for always providing support. To William, Eleanor, and Joseph, my three children; thank you for forcing me to understand the benefits of hard work and persistence. To Bill and Annabel, my father and mother; thank you for raising me with a firm understanding of efficiency mixed with a generous amount of broad-minded and tolerant liberality. To my siblings and in-laws, thanks for providing me a competitive spirit. Your encouragement and support has kept my eyes constantly trained on the final goal.

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Thanks also go to Debby Nolting, Melissa Dunn, Donna Lovett, Darla Fuxa, and Gloria Cook, whose attention to clerical accuracy has greatly aided the communication of detail found within the tables and figures of this dissertation.

The preface of a dissertation written in Oklahoma would not be complete without at least one quote from Will Rogers. I will present two of my favorites. The first has meaning to my family. Over the past five years, my wife and children have dealt with my early mornings and late nights at the office with yeomanly perseverance. Mr. Roger's opinion on this provides some solice.

Nothing makes a man [1] broad minded like adversity

Will Rogers

The second provides perspective on liberal ideological foundations upon which I hold to as true. Mr. Rogers said it best ...

We will never have true civilization until we have learned to recognize the rights of others.

Will Rogers

1. Of course, there are no implied overtones to anything but generic gender reference.

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CHAPTER I

INTRODUCTION

Problem Statement

Regional Forest Resources

A regional shift is underway in the source of timber supply in the United States. This is due, primarily, to highly productive lands in the south and to restrictions in western public supply. Haynes and Adams (1992) report that the southern region of the U.S. will expand its influence as the major source of domestic timber supplies throughout the next century. Alig and Wear (1992) specify the extent of this expansion and conclude that the south will experience large increases in timber production particularly on privately owned lands. Market price coupled with focused government policies allowing for long-term investments will provide the incentive for improved timber production on private southern timberlands.

How will these changes in the rural south impact generation and distribution of regional income? Who will gain and at who's expense? Objective answers to these questions are necessary for lucid and pragmatic public policy formation.

Policies and regulations which target the management of forest resources can have important impacts on the distribution of income (Boyd and Hyde, 1989). Differential impacts on various income levels are of concern because they heighten tensions among interest groups and between these groups and policymakers. These differential impacts may also make public policies which encourage forest management unacceptable.

Social and Economic Benefits and Costs

Conflicts surrounding timber production result from a variety of environmental, economic growth, and economic development concerns. Economic growth issues regarding timber production include efficiency of factor input usage, comparative industrial advantage, origin and destination of capital investments, and the contribution of industry to regional employment and tax bases. Economic development issues include the distribution of returns to factor inputs, comparative wage rates, and the availability of and conflict with non-commodity forest uses such as recreation and aesthetics. Dealing with these issues is critical to the future success of timber management. Society's rapidly changing attitudes toward forest usage require land managers to take a broader view of industrial timber management's contribution to both economic growth and development of regions (Carlisle and Chatarpaul, 1984).

To be sure, considerable effort has been expended to incorporate less tangible social impacts into project analysis such as valuation of non-market goods through contingent valuation, travel-cost, and other hedonic methodologies (Driver and Peterson, 1990; Bowker and Stoll, 1988). Within a region, however, little is known about the implications that industrial timber production has on issues of regional economic development and, in particular, the distribution of income resulting from industrial timber production.

An economic analysis focused on income distribution of timber production within regional economies does not exist. The mechanics of economic growth, the impacts of timber production on this growth, and the resulting implications for economic development within regions are not fully understood and require a theoretically consistent foundation. The likely outcome of public policies and private investment decisions will be better understood if based upon distributional impact analysis. Implicit to this analysis is the demonstration of interconnections between the structure of timber production and the distribution of income and wealth among resource owners within the regional economy.

Unique Economic Attributes of Forested Regions

The forested region of Southeastern Oklahoma, in general, suffers from higher levels of unemployment, higher levels of poverty incidence, and lower wage rates when compared to other rural and urban regions of Oklahoma [1]. During 1988, unemployment in McCurtain County was 8.0 percent compared to 6.7 percent statewide (Oklahoma Dept. of Commerce, 1991). Per capita income in McCurtain County was $9,089 compared to $13,321 statewide (ibid).

Growing and processing trees is a significant economic activity in McCurtain County. Roughly 20 percent of McCurtain County's 1985 employment was directly tied to the industrial timber base (IMPLAN, 1991). Indirect and

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1. It could be hypothesized that this situation extends to other forested regions, particularly throughout the southern United States. Further research is required to substantiate this claim.

induced employment based upon this core provides a significant portion of total county employment.

Of the 1.2 million acres of land in McCurtain County, almost 900,000 acres are classified as forest land (Hines and Bertelson, 1987), the bulk of which is commercial and highly productive for growing trees. During the past 25 years, McCurtain County has experienced a change in forest management intensity. During the late 1960's the Dierks Company sold its landholdings and processing facilities in McCurtain County and the adjoining region to the Weyerhaeuser Company. This sale included more than 800,000 acres of forest land, much of which lies in McCurtain County. The Weyerhaeuser Company has transformed roughly half of these forested acres (Birdsey and May, 1988), through scientifically accepted silvicultural practices, into even-aged loblolly pine stands. This has resulted in a modest amount of social conflict within the region (Lustig, 1983).

The southern region of the United States has enjoyed significant economic growth as a result of forest products sector activity since the 1970's (USDA Forest Service, 1988). It is important to note that continued growth of the forest products sector can not be sustained or supported without increases in sustainable raw material supplies. Potential for further intensification of timber management still exists in Oklahoma and throughout the South. These financially attractive and biologically sustainable potentials are documented for the south by the USDA Forest Service (ibid) and for Oklahoma by Vasievich (1987) and Lewis and Goodier (1990).

Roughly 90 percent of forest lands in the south are owned by nonindustrial and industrial private landowners (USDA Forest Service, 1988). Investments to increase sustainable raw material supply from private lands is sensitive to forest policies that support timber production. Public policies to support forest management require political support. Political support is dependant upon issues of economic growth, economic development, and land-use compatibility.

Tourism and recreationally based employment are also important components of economic opportunity throughout the southern United States. In McCurtain County, Beavers Bend and Hochatown State Parks as well as the McCurtain County Wilderness Area and the Broken Bow Reservoir attract a significant amount of business activity to the region. Industrial timber production has been shown to have limited compatibility [2] with tourism and recreationally based development due to aesthetic concerns (Clawson, 1974).

Natural resource policy analysis is hampered by a lack of working tools to determine who gains and who loses from alternative resource allocation decisions (Rose, Stevens, and Davis, 1988). Aggregate measures of benefit-cost analysis provide economic efficiency criterion. These aggregate measures, however, fail to address economic equity criterion important for decision-making by land managers, policy-makers, interest groups, and private enterprise. Distributive economic impact analysis is an increasingly important component of forest management decision-making.

The Study

The objective of this dissertation is to outline a rational model which can assess distributional impacts of changes in natural resource productivities. This

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2. Limited forest use compatibility for wood production, as specified by Clawson (1974), ranges from moderately compatable (the case of providing general recreational opportunities) to completely incompatible (the case of providing wilderness).

model will then be structured and empirically estimated for a natural resource dependant region given an exogenous increase in timber productivity.

The distribution of returns resulting from timber production are dependant upon the ownership of resources. These resources, referred to as factor inputs, include land, labor and capital. It would appear that differences exist between industrial and nonindustrial private ownership of timber resources and their integration within a region. For example, resident nonindustrial private landowners may control and regionally integrate returns to the entire spectrum of resources used in timber production to a greater extent than absentee nonindustrial forest landowners and industrial forest landowners. Industrial forest owners may, on the other hand, be primarily integrated into a region through significant returns to labor resources.

Objectives

The basic objective of this study is to construct a social accounting matrix for McCurtain County, Oklahoma to facilitate analysis of distributional impacts of timber production potentials on sources of income for three income groups and the resulting impact on factor markets. The model will emphasize three timber production ownership groups and the wood processing sectors.

The specific objectives of this study are:

1. To review literature regarding the role of forest resources in economic growth and development.
2. To review literature pertaining to the past and present state-of-the-art in regional economic analysis including development and usage of input-

output analysis, and its extension to social accounting methodologies as it relates to natural resources.

3. To quantify the impacts that timber production have on the spectrum of income levels within a region during a base year.
4. Exogenously interject the potential of timber production to assess distributional change.
5. Describe analysis limitations and suggest areas for further research.

Expected Results

An understanding of past research will provide the foundation for the analysis used in this dissertation. This study allows an empirical assessment to be made regarding distributional impacts of increased timber production throughout the region under examination. Furthermore, this study allows impact differentials to be distinguished between nonindustrial and industrial private forest ownerships as well as public forest ownerships.

Commodity and money flows associated with timber production within the McCurtain County economy are expected to most actively impact middle and high income households, both industrial and nonindustrial forest landowners, and corporate interests. Given general inattention to timber management by nonindustrial private forest landowners, the incorporation of productive potentials should show considerably more activity within this institutional category.

The distribution of timber production economic impacts as well as the description of market equilibrating mechanisms and land-use compatibilities will provide clearer perspective for decision-makers. The risks associated with investing public and private funds within McCurtain County and the surrounding region will be more clearly described. The foresight required for economic development of rural forest-based economies, particularly the pragmatic understanding of how intensive timber management affects people, will be a direct result of this study.

Current policies targeting private forest management throughout the United States can be either re-active or pro-active. The general shift in sources of U.S. domestic timber supplies are real and, to a large extent, an inevitable consequence of current public sentiment. The southern U.S. will experience an increase in timber production on private lands during the twenty-first century. The tradeoffs between economic equity and economic efficiency will be one determinant of societal acceptance. Pro-active policy analysis would focus on the opportunity to foresee these tradeoffs.

Organization of the Study

A literature review of previous work which addresses the ability of forests to provide economic growth and development of rural regions is contained in Chapter II. Chapter III contains review of the literature pertaining to input-output analysis and its extension to social accounting; an identified regional analysis technique appropriate to addressing questions of income distribution. An analytical social accounting matrix framework is presented in Chapter IV. Chapter V details the construction of an empirical social accounting matrix (SAM) for McCurtain County, Oklahoma. Chapter VI provides interdependency analyses as well as supply-constrained, mixed exogenous/endogenous analyses for prediction of impacts which result from increasing the productivity of the regional timber resource. Chapter VII provides a summary, discusses policy implications, and derives conclusions of this analysis.

CHAPTER II

FORESTS AS TOOLS OF REGIONAL ECONOMIC GROWTH AND DEVELOPMENT: LITERATURE REVIEW

Forests and Regional Economies

What do we know about regional economic structures dependant, in large part, on natural resources for economic growth and development? This central question provides the focus of Chapter II. We have an intuitive feeling that forests must have played an integral role in regional economic growth and development through time simply due to their presence and utilization over time. Active research, on the other hand, does not provide comprehensive answers to this central question.

The following discussion brings together fragmentary components which, when combined, provide understanding with regard to this central question. These components begin with literature regarding the historical progression of forest use, viewed primarily from a utilitarian perspective, to social conflict resulting from actual and perceived misuse. Current economic problems of forested regions including market imperfections, issues of equity, social acceptance of timber production, valuation of non-market resources, and the ability of public policy to address these issues provides the necessary context within which analysis can proceed. A broad overview of approaches and concepts of regional economic growth and development identifies approaches to regional analysis.

Historical Context

Throughout the rise of human civilizations across the globe, forests have been relied upon to serve short-term human needs at local levels. Given this time and spatial frame, developments in perceiving forests as longer-term renewable resources serving the total public have occurred only recently.

Global forestry and its progression through time is well documented in a compilation of papers by Westoby (1987). A global perspective provides important insight into the ability of forests to meet the needs of society. Westoby points out that unrelenting pressures of human population inherently abuse natural ecosystems unless constrained through intervening forces. Tropical forestry's ability to meet short-term needs of expanding populations is dynamic in that land-use equilibriums have not yet been reached.

Consider the early development of the United States. It is ironic that argument is rarely offered for successful macroeconomic development of the United States at the expense of forests which were converted to agriculture throughout the East and Midwest. Owen (1975, pages 226-231) discusses the history of exploitation under which the pre-settlement United States' forests have been transformed. An important point is that perception of *wise forest use* is often a function of the stage of economic growth a region or country is currently in. To what degree are people who already enjoy highly advanced stages of economic growth dictating to people in less developed stages of economic growth the appropriateness of using raw material resource stocks for their own improved welfare?

Apportioning land to its *most valuable use* in the short-term has provided for the day-to-day needs of people throughout history (ibid). Sustainability of productive land capacities is often considered a luxury by people grasping for day-to-day economic household requirements. The ability of intervening forces to simultaneously sustain impoverished populations and maintain productive land capacities is a core issue of global 21st Century social, economic, and environmental problems (Laarman and Sedjo, 1992).

The implementation of silviculturally sound forest management practices can provide solutions to this problem. Shifting local people's effort to more sustainable practices will require structural social and economic change. Institutional cooperation, technology transfer activities and market incentives are critical links in attaining environmentally sustainable economic growth and development (ibid, Chapter 8).

Timber production, harvest and processing has been a major employment source in rural forested areas. Sartorius and Henle (1968), in an early work attempted to forecast future forest related employment based upon supply and demand relationships. Their conclusions were based upon the inherent ability of forests to act as instruments of regional employment creation. Fundamentally, the reasons for this are elaborated as follows (ibid, page 305):

> In the context of industry as a whole, forestry and forest industries are characterized by their high degrees of indirectness as to input and output and their many forward and backward linkages to the rest of the economy. This interdependence makes them a particularly advantageous starting point for stimulating wide parts of the economy and investments therein.

It is widely understood that employment is but one of the many important factors involved with economic growth and development. Sartorius and Henle (ibid) elaborate on the general acceptance that many of the economic benefits, including environmental sustainability, derived from improved management of the forestry sector are not immediately measurable and never entirely in monetary terms. These authors generally accept the need for intervening forces in the future success of forest management for economic development.

Forestry in the United States has evolved with the economic growth of the nation. Much of the early forest work practiced throughout the United States was typified by wholesale conversion of forested areas to agriculture (Owen, 1975; page 231 and Davis and Johnson, 1987; page 3). As the need for land to cultivate crops equilibrated with regional populations and regional export demand, current patterns of land use have emerged.

The usage of products derived from forests has also undergone an evolution through time. Early land clearing activities generated timber for shelter, firewood for heat, and miscellaneous products of direct use of the household. As technology was developed, other commodities were produced from the raw materials of the forest and the associated marketing of these products became more sophisticated (Sinclair, 1992; Chapter 2). These include paper products, panel products, chemical by-products and others.

Another major shift in societal demand of forests has occurred during the past 50 years. Marcin (1990) has identified increases in forest use for recreation and aesthetic purposes as resulting primarily from demographic forces. These forces which include age structure and affluence, are continuing to increase forest demand pressures for recreation.

Forestry, as a profession, has its roots in an extension of European silviculture. The work of Gifford Pinchot and others during the late 1800's and early 1900's developed institutions which foster forest management for sustained and renewable production of the many resources society demands of forests (Davis and Johnson, 1987; Chapter 1). Examples of these institutions include the U.S.D.A. Forest Service and the Society of American Foresters.

Management of U.S. forests, since the dawn of U.S. forest management institutions, has differed depending upon ownership. Table I identifies current ownership of U.S. forests and their trends for the next 40 years. Industrial ownership of forest land is primarily focused on intensive silvicultural production of fiber. Smaller private ownerships have widely varying objectives and intensities of management. Public forests have typically embraced *multiple-use* goals which drive forest management (ibid).

The variety of forest uses resulting from management is strongly tied to the social and economic structures of small regions. Alward (1987b) elaborates:

> These land uses, including timber harvesting, livestock grazing, watershed development and wildland recreation, often shape the pattern of economic development and consequently affect social order through the employment of labor and the ownership of primary inputs.

Current relationships which exist among these uses is an important topic in its own light. The competing and complimentary aspects of forest usage has in the past, and will continue to dictate the ability of forests to be used for economic growth and development of regions.

TABLE I

AREA OF TIMBERLAND IN THE U.S.[1], BY OWNERSHIP AND REGION, SPECIFIED YEARS 1952-1987, PROJECTED TO 2040

						Projections				
Ownership and region	1952	1962	1970	1977	1987	2000	2010	2020	2030	2040
						Million Acres				
Ownership										
Public	152.8	152.5	150.2	144.2	136.3	134.3	134.3	134.3	134.3	134.1
Forest Industry	59.0	61.4	67.6	68.9	70.6	71.5	71.5	71.4	71.3	71.0
Farmer and other private	297.0	301.2	286.3	278.0	276.4	270.0	266.9	262.9	259.7	257.5
Total	508.8	515.1	504.1	491.1	483.2	475.8	472.7	468.6	465.2	462.6
Region										
North	154.3	156.6	154.4	153.3	154.6	154.4	153.6	151.7	150.5	149.5
South	204.5	208.7	203.3	198.4	195.4	191.3	190.0	188.6	187.4	186.8
Rocky Mountain	66.6	66.9	64.5	60.2	61.1	59.9	59.7	59.5	59.4	59.2
Pacific Coast	83.4	82.9	81.8	79.1	72.1	70.2	69.5	68.7	68.0	67.1
Total	508.8	515.1	504.1	491.1	483.2	475.8	472.7	468.6	465.2	462.6

Note: Data for 1952 and 1962 are as of December 31; all other years are as of January 1.
1. From USDA Forest Service (1990; Table 70, page 111).

Current and Future Contexts

Intense demand pressures have caused increases in the amount of legislation and regulation within which U.S. forestry operates today. The ability of forests to continue as instruments of regional economic growth and development hinges upon societal acceptance of various practices and the creativity of the forestry profession in adapting to societally determined needs and wants. Ellefson, in a recent work, introduces the study of forest policy with the following (Ellefson, 1992; page 1):

> The physical presence of forest resources on the nation's landscape is vast and richly diverse. But physical presence alone is not a virtue. Forests must be transformed by society according to important social and political values which reflect a broader interest in assuring citizens of healthy and comfortable lives and surrounding them with ample opportunity for leisure pursuits.

Making the right choices in allocating resources from a societal viewpoint is critical to the manner in which forests will be transformed. Davis and Johnson (1987) provide specific evaluation criteria within which successful future utilitarian forestry will necessarily rest. These include:

1. Economic efficiency;
2. Favorable impact on regional and local communities;
3. Equity in the distribution of costs and benefits among the members of society;
4. Economic and social stability; and
5. Security of the environment.

Of primary interest to this study are criteria 1, 2, and 3 which include forestry's economic efficiency, impact on regional and local communities, and equity in the distribution of costs and benefits. A better understanding of these evaluation issues is critical to addressing issues dealing with economic stability and security of the environment.

Davis and Johnson (ibid, page 336) adapt a useful grouping of regional goals and social impact criteria for evaluating changes in forest use. These include regional goals of (1) economic activity (comprised of employment, value added and sales); (2) individual welfare (including unemployment and average wage rate structures); (3) area equilibrium (economic diversity, community lifestyle, social strife, and future development); and (4) local government (comprised of costs and benefits to governments).

Turning goals into active plans which encourage forests to be used as instruments of regional economic development has been discussed by many. An interesting paper by Thomas (1989; page 2) argues:

> ... rural economies will only become stronger when they are able to capture the competitive edge of the rural environment. This competitive edge lies in the natural resource assets of rural areas, the essence of their ruralness.

Thomas further argues that past inability to fully capture forest resource potentials is due to ever-changing *ground rules* of rural economic development, the dawning of landowners considering themselves to be entrepreneurs instead of producers, and the imperfect workings of the United States' market system.

Economic Conditions of Forested Regions

What barriers are present to constrain the use of forests as instruments of regional economic growth and development? The character of this growth and development have bounds which are a function of economic conditions specific to forested regions. These economic conditions, as identified in the literature, consist of general market imperfections, issues of income distribution equity, acceptance of timber production, and the inclusion of social valuation of non-market goods. Political conditions also impact the use and management of forest resources. Active research in policy analysis to support development of policies specific to forestry which meet the needs of society in economic growth and development is an important line of discussion. These topics will now be addressed.

Market Imperfections

It could be argued that the primary objective of a large portion of the private sector in the United States is maximization of profit given relatively short planning horizons. Whereas ensuring the long-term productivity of forest assets could be a potentially important societal goal, its importance is diminished for those interested in short-term gain. This important distinction is quantified in differences between private and societal rates of return as measured by discount rate. Private investment decisions are typically based upon higher discount rates applied to cash-flows. Higher discount rates weight cash flows with more emphasis on short-term returns. Social discount rates, on the other hand, are typically much lower. This implicitly weights cash flows which place more emphasis on longer-term returns. Forest assets, and the costs associated with their management, contain primarily longer-term returns. This is due to the length of time required to produce merchantable commodities.

Another imperfection of the market system specific to forestry and its economic development context is the general inability to efficiently allocate open access, common property resources. A thorough discussion of open access, common property resources can be found in Barlowe (1986). Many of the benefits derived from forest-based recreation, particularly on public lands, are open to all and allocated as common property resources. The simple fact that access to aesthetic resources is open to all foregoes the ability of the market system to efficiently allocate these resources. The system of rights, represented by institutional arrangements, provide a basis for the concept of property (ibid; Chapter 12). To derive a meaningful assessment of the economic potential forest-based outdoor recreation provides, property rights which assign ownership are required.

Tied to this are externalities associated with forest use. When one activity financially impacts another activity within a regional economy, without due compensation, market imperfection exists. The production of timber, particularly through even-aged practices such as clearcutting, has the potential of presenting externalities with tourism and recreational based activities through aesthetic disturbances. A detailed discussion of externalities associated with productive activities can be found in Mishan (1982, Part III).

Other problems associated with larger industrial ownerships of forest land and processing facilities, particularly in remote regions, are the more traditional market imperfections such as monopoly/oligopoly and monopsony/oligopsony. Factor input markets for labor, technology, land, and capital are often dominated by single large corporate forestry interests in remote rural regions.

Markets for timber are particularly vulnerable to domination due to factors of production and hauling costs. Mead (1966), in a dated study, assessed the behavior of buyers in the market for federal timber through analysis of factor-input supply and demand. Results of this study indicate that, whereas lumber markets appear to be very competitive, markets for timber inputs are characterized by factor supply functions which are relatively inelastic. This is, most notably, due to cost structures and the narrowly circumscribed geographical nature of timbersheds.

Issues of Income Distribution

Literature which identifies timber production impacts on income distribution is nonexistent. This is, however, at the core of regional economic development. Rose, Stevens, and Davis (1985) looked at income distribution and policy impacts but focused on the extraction of mineral resources from federal lands. Timber is fundamentally different from extracting depletable natural resources in that if properly managed, it is a renewable resource. Sustainable management of forests for economic growth and development provides maintainable levels of raw material injection into regional economies.

The number and trends of people living with income below what is deemed the "poverty level" correlated with regional natural resources and linked with relevant socio-cultural variables would be a fruitful line of econometric pursuit. Indeed, it appears that forested regions tend to have lower per capita incomes and a larger proportion of people living below the poverty line compared to other rural regions and urban areas [1]. Evidence from Oklahoma statistics (Oklahoma Dept. of Commerce, 1991) provide examples of this. Proportion of people living at poverty levels is one of many economic variables which can be assessed at the regional level. Whereas econometric pursuit of this nature is beyond the scope of this dissertation, it would provide further evidence that problems exist in this area.

Tied to this is labor mobility (or immobility) of people residing in forested regions. People continue to reside in areas with limited employment opportunities and lower wages for other amenity and cultural values. Research is lacking in the quantification of this *rigidity* to labor mobility through specification of a supply elasticity for labor in these regions. It would appear, however, that this regional labor supply function would be relatively inelastic in forested regions thereby leading to a conclusion that poverty may be brought on by people who are not willing to move to other regions for employment due to fundamentally non-economic reasons. This has general implications for regional income distribution within forested areas.

A convenient measure of income distribution is shown graphically using a Lorenz curve. The Lorenz curve, shown in figure 1, is a representation of the cumulative percentage of income received by the cumulative percentage of population. A shorthand summary measure of relative degree of income inequality within a region is found by taking the ratio of the area between the line of equality and the Lorenz curve and the total area under the line of equality. This ratio, developed in 1912, is known as the Gini coefficient named after the Italian statistician C. Gini. This is also shown in figure 1.

1. A testable hypothesis could include consideration of physical forest inventories, demographic statistics, and cultural variables. Research of this nature has not, to the author's knowledge, been reported in the literature. Unfortunately, the scope of this dissertation does not allow for empirical research which independently substantiates these claims and is left for further research needs.

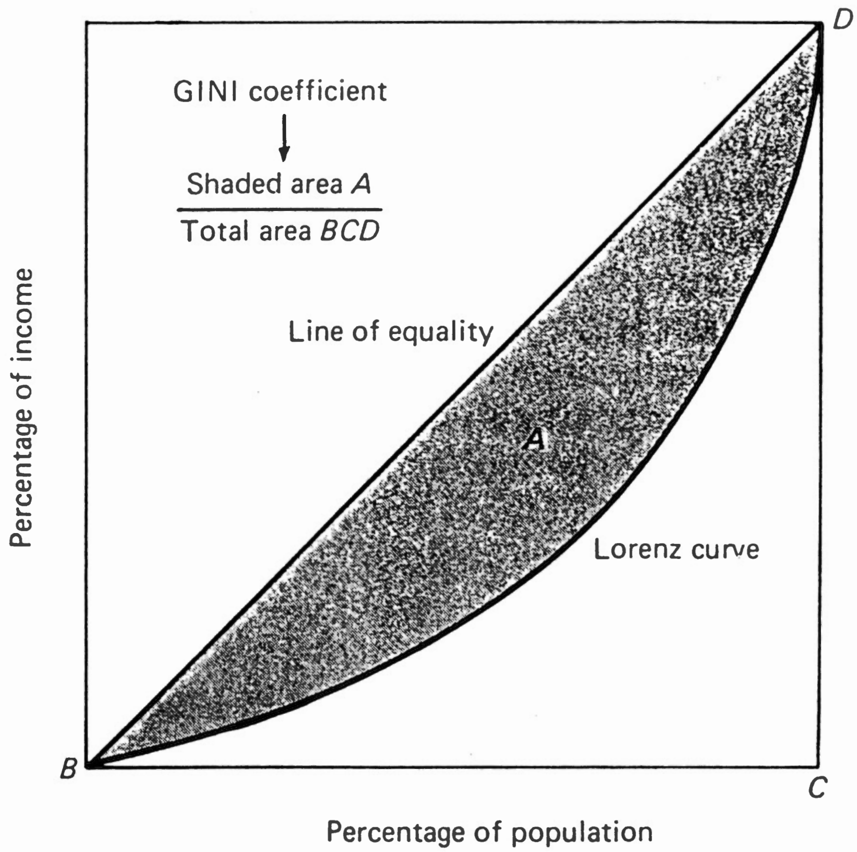

Figure 1. The Lorenz Curve and Resulting Gini Coefficient (from Todaro, 1985; page 146).

As an aggregate measure of inequality, Gini coefficients can range from zero to one. Empirical studies (Todaro, 1985), however show that Gini coefficients in regions with high income inequality range between 0.5 and 0.7 and regions with relatively more equitable distributions range between 0.2 and 0.35. In looking at countries across the world, Todaro (ibid) has developed specific and interesting conclusions. The most important of which is that developed countries, in general, exhibit relatively more equal distributions than most Third World countries. Todaro speculates that this is due to the fact that most industrialized countries have been able to develop effective mechanisms, over the years, to transfer some proportions of their incomes through progressive taxation, social security payments, unemployment compensation and other welfare payments. Aggregate measures such as the Gini coefficient are effective for comparing economic conditions between regions.

Within regions characterized by inelastic labor supply functions, there could be a tendency for a relatively larger proportion of residents to work for lower wage rates. This would tend to lead to a larger inequality of income. The distribution of income within a region will tend to characterize economic issues dealing with equity of resource use. Were this hypothesis to be true, a comparison of Gini coefficients between regions would show that forested regions have higher coefficients as compared to broader areas which include rural agricultural-based regions and urban areas [2].

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2. The comparison of regional Gini coefficients could be incorporated into the previously discussed analysis to justify claims regarding rural forested regions in addition to more succinctly identifying causal income distribution agents. It is, however, beyond the scope of this dissertation.

Social Acceptance of Timber Production

To assess forests in view of regional economic growth and development, an understanding of societal relationships between forest uses is needed. Forests produce many benefits to society. Location with respect to population centers, productive potentials of lands, and other characteristics of forest land dictate the uses to which forests will be put. Clawson (1974) has identified three basic types of forest uses.

The first includes uses put to forest land but not necessarily for forest products themselves. These may include the mining of subsurface mineral, road building and other rights-of-way, residential construction, or forest land grazing.

The second type of forest use is that which is totally or wholly intolerant of another use. The most common is timber harvesting, wilderness use, and intensive recreational use. The essence of one of these forest applications is generally antithetical to the others. Intensity of conflicts arising among these uses are related to proportional combinations and intensities of utilization and management. Table II identifies these relationships.

A third category of forest use is that use which occurs, to some extent, irrespective of man's effort, but which is influenced by his actions. Examples of this may be forests used as a source of water or for wildlife production.

Conflicts generated from forest use incompatibilities have historically been resolved in a zero-sum fashion with the values associated with winners (gain) being completely offset by the values associated with losers (loss). Marcouiller and Ellefson (1987), however, have identified a growing number of natural resource conflicts being resolved using alternative dispute resolution techniques which generate resolutions which are, in essence, positive-sum (i.e. that participants in a conflicting situation can compromise and build consensus to

TABLE II

DEGREE OF COMPATIBILITY AMONG VARIOUS FOREST USES[1]

Primary Use	Maintain Attractive Environment	Provide Recreation Opportunity	Wilderness	Wildlife	Natural Watershed	General Conservation	Wood Production and Harvest
Maintain attractive environment	X	Moderately compatible, intensity dependant	Not Inimical to wilderness	Compatible to most, less so to others	Fully compatible	Fully compatible	Limited compatibility. Often affects extent
Provide recreation opportunity	Moderately compatible, intensity dependant	X	Incompatible; would destroy wilderness character	Incompatible for some, others more tolerant	Moderately compatible, intensity dependant	Moderately compatible, intensity dependant	Limited compatibility. Timing and intensity dependant
Wilderness	Fully compatible	Completely incompatible, intolerant of intensive use	X	Highly compatible to most, less so to others	Fully compatible	Fully compatible	Completely incompatible, precludes all harvest
Wildlife	Generally compatible	Limited compatibility; intensity dependant	Mostly compatible, some require veg. manipulation	X	Generally fully compatible	Generally fully compatible	Generally limits volume and conditions of harvest
Natural watershed	Fully compatible	Moderate compatibility; may require intensity limits	Not inimical to wilderness	Generally compatible	X	Fully compatible	Moderate compatibility; restricts but does not prohibit
General conservation	Fully compatible	Moderately compatible; intensity dependant	Not inimical to wilderness	Generally compatible	Fully compatible	X	Compatible, requires modification in harvest method
Wood production/harvest	Compatible if harvest method strictly controlled	Moderately compatible	Completely incompatible; would destroy wilderness	Compatible if harvest method fully controlled	Compatible if harvest method fully controlled	Compatible if harvest method fully controlled	X

From Clawson (1974)

generate a combined value sum which is positive). The growing use of alternative dispute resolution techniques has shown that conflicts arising from incompatible forest uses can be *managed* thereby giving rise to a greater ability of forests to be integrated into strategies targeting economic growth and development.

Valuation of Non-Market Resources

Valuation can take on various meanings. Peterson and Driver (1990) identify various definitions of value such as psychological value, anthropocentric (human-based) value, and economic value. Important to this discussion is economic value which is "simply the amount of money (or the goods that could be purchased with the money) that one is willing to give up in order to get a (good or service) or that one requires in compensation for the loss of a (good or service)." (ibid, page 3).

The economic value of commodities which are not traded on the market present very real difficulties. Examples of these commodities include recreation, wildlife, and aesthetics. Two key problems arise when assessing the economic value of non-market resources derived from forests. First is the notion that resources such as aesthetic quality, existence value, and other quantifiably difficult commodities are often considered to be common property resources. The ability to possess exclusive property rights which allow appropriate application of microeconomic efficiency criteria to the management of these resources is rare. The second problem is the nonexistence of an operating market structure for active trading of these goods. This leads to an inability to identify and incorporate supply and demand pressures at the firm management level. These commodities generally do not have directly observable prices.

A classic work pertaining to the economics of non-market resources focusing on outdoor recreation can be found in Clawson and Knetsch (1966). Recent effort has been made to more succinctly qualify and quantify the economic value of non-market resources. Methods used include direct and indirect techniques. Indirect methods, sometimes referred to as hedonic or implicit price methods, include the travel cost method and the land valuation method. A direct method is contingent valuation.

The general travel cost model as applied to recreation presumes that users maximize utility subject to time and budget constraints with choice of trip length and destination. The theory behind the travel cost method is discussed in Clawson and Knetsch (1966, Chapter 5). Recent adaptations can be found in Fletcher, Adamowitz, and Graham-Tomasi (1990) and Ward and Loomis (1986). An application of the travel cost method to recreational benefits derived from a mid-southern U.S. navigation system can be found in Schreiner, Badger and Willett (1984). Another summary of the travel cost method is found in Schreiner and Cannock (1989).

Land valuation methods (also known as hedonic or implicit price methods) presume that the value of an environmental feature is reflected in the difference between prices which consumers are willing to pay for property with versus without the specific feature. The specific hedonic methodology is theoretically discussed and applied to food characteristics by Ladd and Suvannunt (1976). Land value methods were applied to recreational values by Musser and Ziemer (1979). In this study, researchers considered consumer income levels, land qualities, and alternative demand specifications to estimate demand for hunting in Georgia.

Contingent valuation is a direct method which surveys individuals for contingent circumstances which are posed in artificial markets. These markets are characterized by contingent payments based upon hypothetical changes. Valuation of the non-market commodity is assessed by experimentation. Bowker and Stoll (1988) use this method to assess the value of the whooping crane resource. Survey bias (including strategic bias, information bias, starting point bias and hypothetical bias) is an important component of value accuracy.

Current efforts of the U.S. Forest Service to quantify non-market resources are extensive. In the Southern Region, integration of non-market commodity production of forests into the forest inventory and analysis process is being standardized. Rudis and Tansey (1991) use the current Southern Region Forest Service inventory to assess the distribution of human influences on southern forests. Future needs include a standardization of suitability indexes for recreational opportunities and wildlife productive potentials, visual preference models, and other non-market areas. Visual preference models for southern pine stands are discussed in Rudis, Gramann, Ruddell, and Westphal (1988). Rudis (1988a, 1988b, 1990 and others) has compiled summaries of nontimber values for various regions in the South.

Addressing Problems Through Public Policies

Governments enact policies which affect forest management activities to accomplish various social objectives. Monke and Pearson (1989), in addressing agricultural policies in general, classify these as either efficiency objectives or nonefficiency objectives.

Policies enacted which target efficiency objectives accelerate the rate of income growth, correct market failures (prices not reflecting true scarcity value), or correct for externalities (costs or benefits not fully reflected in market incentives). Nonefficiency objectives include issues dealing with income distribution, price stabilization, or national concern for the role of a respective commodity in an economy.

Due to finite resources, the success of attaining one objective often is at the expense of another objective. This conflict continually gives birth to a seemingly limitless supply of special interest groups which are major policy enactment players. Quantitative policy analysis, however, provides objective analysis within which policy can be viewed. Monke and Pearson (ibid, pages 16-33) have developed a quantitative policy analysis methodology known as the Policy Analysis Matrix (PAM).

The PAM approach tracks impacts of commodity and macroeconomic policies on the benefits and costs of commodity production using a double entry bookkeeping technique defining profitability and the effects of divergences (policy effects). The PAM builds upon theory developed in social benefit-cost analysis. A PAM was developed and successfully applied to analyze policies which target agricultural development in Kenya (PARD Project Team, 1990).

Federal Forestland Rural Development Policy. The forested regions throughout the Western United States are dominated by federal ownership of timberland. Indeed many of these communities are wholly dependant upon U.S. Forest Service timber sales for the raw material used in dominant local industries. DeVilbiss (1986) studying eight selected areas in the U.S. Forest Service's Rocky Mountain region, found that all areas showed positive economic dependency on their respective export bases. Furthermore, four out of the eight areas showed positive economic dependency on the export bases of logging and milling sectors and two out of eight showed positive economic dependency on the export base of National Forest timber stumpage.

As a result of this, current policies of the U.S. Forest Service in the management of National Forest lands deviate from objectives of economic efficiency in favor of nonefficiency objectives. Hall (1982) studied economic efficiency versus nonefficiency objectives of National Forest management programs. Her study focused on local economic impact as a nonefficiency objective. She showed that deviations from economically efficient timber harvest levels positively impacted local economies. Indeed, local community stability plays an important role in National Forest policy and is, to varying degrees, in conflict with economic efficiency objectives. Further discussion of community stability and national forest timber harvest levels is contained in Daniels, Hyde and Wear (1991).

The current political environment regarding National Forest management operates within dynamic parameters. A tool used by lobbyists to remove Federal timber from harvest is the economic inefficiency of timber management programs. The National Forest System operates within a formalized and rather sophisticated planning process. This is done to provide stable, long-range and somewhat incrementalist forest policy.

U.S. Forest Service policy with regard to rural development has been detailed in a recent strategic plan (USDA FS, 1990). This document outlines six broad goals which include (1) communicating a rural development focus, (2) inclusion of rural development considerations in management decisions, (3) actively participating in rural development activities, (4) integrating diverse needs, (5) strengthening cooperative efforts, and (6) conducting research and extension activities in rural development.

Focusing on the second goal of this strategic plan provides an understanding of agency commitment to rural development. It states (ibid; page 7):

> Include rural development considerations in agency resource decisions to assist rural communities and the Nation achieve long-term economic development and improved quality of life.

The tradeoff between efficiency and nonefficiency objectives of National Forest management will continue to be important in molding the future of the National Forest system.

Quantitative analysis of National Forest management policy has evolved over time. IPASS (Interactive Policy Analysis Simulation System) has been developed to analyze the long-term economic and demographic effects of alternative forest resource management policies (Olson, Schallau and Maki, 1984). This system is an adaptation and application made of IMPLAN, which is the USDA Forest Service regional analysis database and software system (discussion of IMPLAN will be provided in Chapters 3 and 5).

Private Forestland Public Policy. Boyd and Hyde (1989) use a political economics approach to public intervention in forest management. The theory of public economics breaks policy objectives into three primary categories which include (1) allocation, (2) distribution and (3) stabilization. Allocation is roughly analogous to the previously discussed economic efficiency objective. Distribution and stabilization are analogous to nonefficiency objectives. These two authors (ibid) comprehensively assess various forest policies with regard to social welfare impacts.

Two broad categories of supply-side and demand-side [3], as well as a category for other market interventions, are used to encompass the analysis of specific policies. Supply-side regulations include state forest practice acts, the Forestry Incentives Program/technical assistance in general, and price stabilization policies. Demand-side regulations include the Fair Labor Standards Act and the Jones Act. Other market interventions include non-neutral taxation and the effects of public lands. Using neoclassical welfare economics within a general equilibrium framework and econometric analysis, Boyd and Hyde (ibid, pages 279-280) summarize the impacts of regulation on the operation of the private market. This summary can be found in Table III. Indeed, the effectiveness of public policies to address economic problems of forested regions depends upon the specific problems addressed and the target clientele.

Public policies tend to be directed from bases with roots in *normative* economics due to the fact that politicians are elected on the basis of what they believe *ought to be*. The actual results of policy, however, rely more on a *positive* analysis of *what is, was, or will be*.

The following discussion of approaches to regional development outline theories and analysis methods which focus on actual results of policy and are generally *positive* in nature.

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3. Boyd and Hyde (1989) analyze regulations from the primary standpoint of timber production. They therefore have categorized those regulations affecting the production of timber as "supply-side" and those regulations affecting wood processing as "demand-side".

TABLE III

SUMMARY OF IMPACTS RESULTING FROM REGULATION OF THE PRIVATE MARKET [1]

Regulation	Social welfare effects	Distributive effects	Stumpage price effects	Restrictions on analysis
State forest practice acts	−$150,000/yr or −$.01/acre/yr	Cost effective enforcement suggests burden on nonindustrial landowners, poorer quality lands, lower price markets	Negligible	Virginia, 1985 Supporting evidence: Washington and Oregon, 1985
FIP (cost sharing)	−$947,800/yr, more if some recipients have nontimber objectives causing them to never harvest	Favors larger landowners Some redistribution to intermediate and final consumers	−$6.38/Mbf for future harvests, less if some recipients never harvest	North Carolina, 1980
Technical assistance	−$303,000/yr, more if some recipients have nontimber objectives causing them to never harvest	Negative, but not as negative as FIP	−$8.18/Mbf for future harvests, less if some recipients never harvest Negligible decrease for current harvests	North Carolina, 1980
Timber Mart-South	>$520,000/yr	Increase market information of nonindustrial landowners	Unknown small price increase Decrease price variation	Southwide, 1977 & 1980
Minimum wage	Not estimated	All forest products industries: wage bill −$114,000 or 1%, −6354 employees or <1%, disemployed move to lower wage industries 3 lowest wage forest industries: 2 of 3 wage bills −2%, −6452 employees or −4%, disemployed may drop below poverty level	Very small and statistically insignificant	Hypothetical $.25 increase in minimum wage in 1983 Wage effects statistically reliable, employment effects not
Jones Act	Costs: $5.6–7.1MM in U.S. and Canada combined, $12.2–13.2MM in U.S. alone Benefits: no national security gain	Western WA/OR producers: −$9.1–9.8MM Northeastern consumers: −$10.7–11.4MM Canadian producers: +$7.2–7.4MM Shipments: rail +$30.7–40.6MM sea −$25.3–42.0MM	<$1.09/Mbf in western WA/OR Smaller and of uncertain sign in other regions	U.S. and coastal western Canada, 1977
Tax or public land policy	**Social welfare effects**	**Distributive effects**	**Stumpage price effects**	**Restrictions on analysis**
Current use taxation	Benefits: <$13,000 or <$.05/acre/10 years Costs: potentially large administrative costs	Unknown	Negligible	Forsyth County, North Carolina, 1960–1970, 1970s
Preferential capital gains	−$240.9–368.2MM or 12–18% of all earnings for timber sector of U.S. economy	>180% incidence on capital Negative employment effects	33–49% decrease (potentially substantial decrease)	Federal tax, 1979
Red-cockaded woodpecker	Benefits: unknown Costs: <$221,000 in perpetuity or <$8820 annually for all 52 habitat sites, zero opportunity costs for 36 individual sites	Unknown	Negligible	Croatan National Forest 1982
Developed campground recreation	$610,000–628,000 current policy yields $3,000–18,000 less than optimal policies	Unknown, generally local users	Zero	Seeley-Swan Valley, Lolo National Forest, 1984
Departures from market timber criteria	Perhaps −$13MM	Consumers −$786.8MM (−$689.8MM in western WA/OR) Industrial producers +592.8MM (+398.3MM in wetsern WA/OR) NIPF producers +$217.8MM (mostly in South and western WA/OR) Public treasuries −$1300MM Rocky Mtns: harvest increases, environmental losses	Increase $20/Mbf everywhere except western WA/OR (+$49/Mbf) and Rocky Mountains (−$20/Mbf)	U.S.-wide, 1977
Community stability	Negligible decrease in factor payments remaining in community (annual community generated income) Substantial costs to U.S. Treasury	Increase wood products wage income <17% No effect on community-wide wage or employment	Decrease 12–26%	W. Montana, 1968–1981 Assume: −18% lumber price, no private stumpage response, no inventory substitutions

1. From Boyd and Hyde (1989; Table 9.1).

Approaches to Regional Economic Development

Regional economics has been an active field of economics research for the past 50 years. Its most active period was during the 1960's as interest in regional economic policy at the Federal level provided researchers with current problems and associated research funding (Richardson, 1978). During the 1980's, a resurgence in regional economics research has emerged due to domestic regional migration patterns (for example, the shift in population from the frost-belt to the sun-belt). Regional migration has caused dramatic impacts on individual, corporate, and community welfare in the regions affected. In part, this resurgence is due to the need to answer fundamental development questions such as spatial distribution of populations, resources, and economic activities between core and peripheral regions (ibid, page 2).

Forestry is not immune from spatial economic perturbations. A major shift which is due, in part, to environmentalist pressures is currently underway which will focus attention for timber raw material supply away from the Pacific Northwest to more productive, less conflict-prone regions such as the Southern United States. Discussion of this regional shift can be found in Alig and Wear (1992) and Haynes and Adams (1992).

Alternative Theories Used in Regional Analysis

Theories exist which attempt to explain important economic growth phenomena as well as spatial economic perturbations. Of importance to this study is the use of regional analysis theory to provide explanation of economic structures dependant upon natural resources. The following discussion outlines the primary theories which capture the essence of modern regional economic analysis research. This discussion is adapted from Richardson (1978); Jenson, West and Hewings (1987); Seppala, Row and Morgan (1983) and others. Special mention of individual studies is made where these theories have been used to explain forestry situations.

Spatial Price Theory. In its simplest form, spatial price theory employs the linear programming transportation problem to minimize total transport costs subject to market clearing and trade balance constraints resulting in optimal interregional flows. Post-trade price differentials between markets are equal to or less than the intervening unit transport cost and allocate resources respectively.

Location Theory. Location theory uses trend analysis and is a relative industry cost model. Location theory is the oldest branch of regional economics and is the foundation for industrial location theory (Richardson, 1978; page 5).

Neoclassical (Regional) Growth Theory. The three primary elements determining neoclassical growth theory include capital accumulation, growth of labor supply, and technical progress. Neoclassical growth theory provides theoretical justification for empirically observed interregional per-capita income convergence in the United States. Wages are inversely related to returns to capital. Neoclassical growth theory explains why high income regions import labor and export capital. One of the basic assumptions of neoclassical growth theory is perfect knowledge.

Spatial Diffusion of Innovations. Economic growth is constrained by technology and its implementation. Spatial diffusion of innovations is in direct conflict with the assumption used in neoclassical growth theory regarding perfect knowledge. Emphasis in spatial diffusion of innovation is on innovation waves, communication networks, and technological factors of profitability and risk.

Sequential Stages of Growth. Sequential stages of regional growth looks at regional development as occurring over time in four distinct stages. These include self-sufficiency, specialization in primary activities, development of secondary industries, and industrialization.

Sector Theory. Sector theory breaks down a regional economy into three sectors. These include primary or agricultural, secondary or manufacturing, and tertiary or services. Shifts within and between regions are due to supply and demand relationships.

Export Base Theory. Similar in many respects to sector theory, export base theory is a market-based theory resting on the premise that regional economic growth depends on production of commodities for export. Regions have little control over exogenously determined demand. Export base theory divides a regional economy into two types of activities. These include export activities and residentiary activities. Residentiary activities are those activities whose primary function is to serve export industries. Most timber processing (particularly secondary processing) would be classified as being export based. Numerous forest economists have studied forestry under export base theory; most notably, these include Connaughton, Polzin and Schallau (1985) and Schuster and Medema (1989). Export base theory is particularly important for regions with excess capacity of some raw material or commodity.

Methods Used in Regional Economic Analysis

Various approaches have been used to address the basic regional economic theory previously mentioned. To provide a fundamental perspective on the methodology employed in this study, a survey of the important methodology types is included here. This discussion is adapted from Richardson (1978), Richardson (1985), Smith and Barkley (1990), Doeksen and Schreiner (1972-a); Goode (1982); Dervis, deMelo, and Robinson (1982); and Just, Hueth, and Schmitz (1982).

Economic Base Models. Economic base models forecast future regional activity based on stable relationships between local service sectors and export sectors. Local service is a function of export. These models emphasize the role of external demand as a primary determinant of regional economic performance. Correct specification of exogenous and endogenous sectors is critical. Economic base models necessarily imply *openness* of regions to factor input and output flows. A criticism of these models is that they include a one way causal dependance only. Economic base models have tended to have problems with model application and stability of resulting multipliers.

Regional Econometric Models. These models have tended to be extensions to the subnational level of macroeconomic models of the type used to forecast future levels of the economy as a whole. The obvious flaw of blindly applying national models to subnational regions occurs due to fundamental differences between sub-national regions and national level relationships of *openness* for flow of resources (Richardson, 1978; pages 16-18).

Shift-Share Analysis. Shift-share analysis measures the total change in a region's performance relative to the nation over a given time period. Criticisms of shift-share analysis focus on the fact that analysis of this nature is more a data standardization technique than an actual regional analysis methodology. Applications of shift-share analysis are limited to historical and descriptive documentation.

The Gravity Model. This model represents the *epitome of spatial economics* (Richardson, 1978; page 20). The gravity model assesses the relative strength of *agglomeration forces* (mass variables) and *dispersion forces* (distance frictions).

Regional Input-Output Models. Regional input-output (I/O) models were developed more than 50 years ago. The models present a valuable method of assessing interindustrial linkages. I/O continues to be a very active area for research. Detailed discussion of input-output analysis and its extension to social accounting matrix development can be found in Chapter 3.

General Equilibrium Theory and Welfare Economics

The development of regional economies, in the absence of public intervention, progress according to the general operations of the free-market. This free-market competitive operation can be summarized through the theory of general equilibrium. Pure exchange, Walrasian equilibrium, welfare properties, Pareto optimality and the maximization of welfare are basic to this theory and are thoroughly examined in Varian (1984, Chapters 5 and 6). This theory's primary formulation is that agents trade among themselves in an attempt to maximize individual preferences thus incorporating the interactions between markets as well as the functioning of individual markets. In the general equilibrium model, all prices and quantities are variable. When markets clear, equilibrium is said to exist.

The economic adjustment required to attain equilibrium is of interest to regional neoclassical economic analysis. Factor mobility is important in regional economic adjustments and depends upon the specific factor of production and cultural attitudes within the region under study. However, given mobility of factors, figure 2 summarizes expected causal relationships between selected variables of a regional economy. Variables represented in figure 2 are either exogenous (rectangles) or endogenous (ovals). Causal relationships, or the partial derivative of the select variable with respect to the causal variable, is indicated by the sign.

Policy analysis can be accomplished within the CGE framework through, for example, assessing the change in supply and demand of a tradable commodity given a change in its price as a result of some policy. Income distribution effects, however, are also evident due to inter-industry relationships and interdependencies between factor and commodity markets. A comprehensive summary of general equilibrium models can be found in Dervis, deMelo, and Robinson (1982).

Studies using general equilibrium models have become more common in recent years. A good survey of general equilibrium models used to assess different policy issues in less developed countries (LDC's) is contained in Bandara (1991). A bibliography of literature pertaining to general equilibrium models is contained in Davarahan, Lewis and Robinson (1986). Adelman and Robinson (1987) assessed macroeconomic adjustment and income distribution

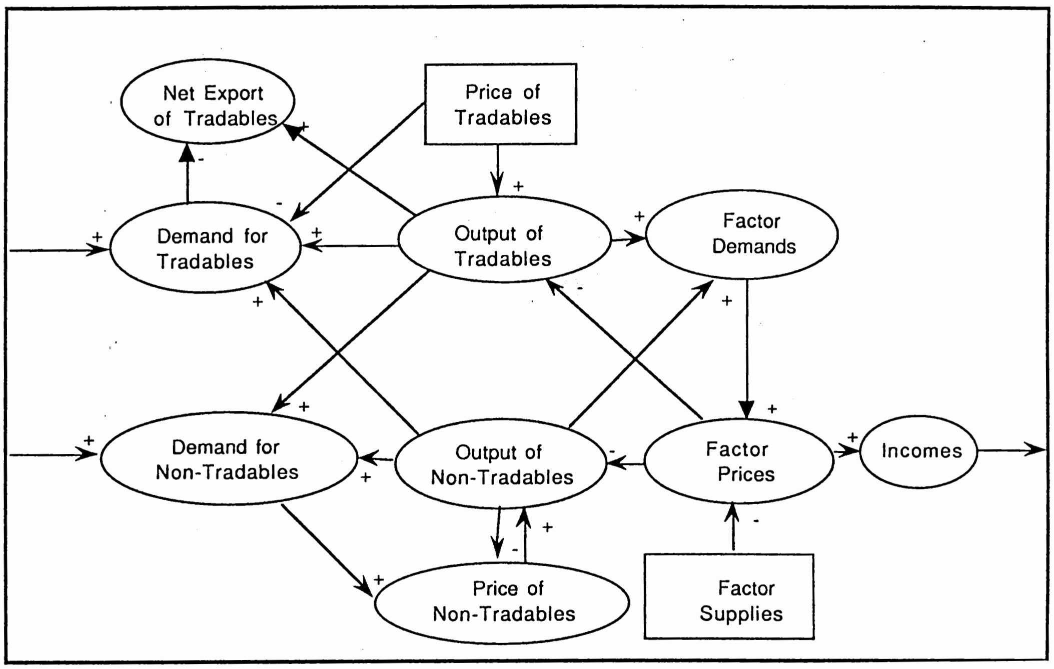

Figure 2. Causal Relationships Between Economic Variables of a Region (from Koh, 1991; page 45).

using a variety of closure rules in a general equilibrium framework for Brazil and Korea. U.S. agriculture has been analyzed using general equilibrium models by Aradhyula, Eswaramoorthy, and Frohberg (1988). Regional general equilibrium models are discussed in Hughes (1991) and Ko (1985). Koh (1990 and 1991) uses a regional general equilibrium model to assess agriculture in Oklahoma.

Microcomputers and appropriate software have enabled researchers to solve general equilibrium problems in an expeditious manner. One software package, referred to as GAMS (General Algebraic Modelling System), has been used regularly. Practical difficulties encountered in constructing general equilibrium programs using GAMS is discussed in Condon, Dahl and Devarajan (1987).

Not until recently has there been literature using general equilibrium analysis pertaining to issues in regional forest economics. Boyd and Hyde (1989) use a general equilibrium framework to assess the impacts of forest regulations on the operation of the private market. Daniels, Hyde, and Wear (1991) apply a three factor, two sector modified general equilibrium model to examine the distributive effects and the community stability objective of the USDA Forest Service constant timber harvest volume policies.

What is Known and What is Not Known

The central theme of this chapter was to identify what is known about regional economic structures dependant, in large part, on natural resources for economic growth and development and to outline areas where research is lacking. The intuitive feeling that forests must have played an integral role in regional economic growth and development through time simply due to their presence and utilization was substantiated through a review of the historical context within which forestry operates. The growth and development of regions are constrained by the conditions within which forestry operates. These include market imperfections, issues of equity, social acceptance of timber production, appropriate valuation of non-market resources, and the ability of public policy to address these issues. This study will assess distributive impacts of timber production thus addressing constraints which are fundamentally equity-based.

Evidence indicates that in certain regions and under certain conditions, forestry operates within the context of oligopolistic raw material markets and oligopsonistic markets for labor. Societal acceptance is an issue and land-use incompatibilities have been shown to exist which provide conditions for appropriate forest management. Non-market goods resulting from forest management have been addressed, albeit only recently. Methodologies which deal with non-market resource valuation exist and have been applied to various situations. Policies targeting forest management tend to be normative. Positive policy analysis based upon facts and empirical estimates show that distributive policy impacts are important. Regional analysis tools exist from which assessment of economic growth and development of natural resource dependant regions can begin.

Research is lacking in the area of income distribution resulting from timber production as well as fundamental econometric analysis of correlations between the extent of forest resources and economic development conditions of regions. Furthermore, statistical analysis of how forest resource dependant regions compare with non forest resource dependant regions is completely lacking.

Income distribution can be assessed using input-output analysis and its extension to social accounting. Discussion of this provides the topic for Chapter III.

CHAPTER III

INTERINDUSTRY ANALYSIS AND SOCIAL ACCOUNTING METHODOLOGY TO ADDRESS DISTRIBUTIONAL ISSUES OF FOREST USE: LITERATURE REVIEW

This chapter reviews the literature which deals specifically with interindustry analysis and social accounting methodology as a means to identify distributional issues of forest use. Input-output analysis will be discussed with attention focused on theoretical foundations and assumptions, empirical accuracy, interregional complexities, and natural resource applications. Caveats of input-output analysis will be discussed. Social accounting methodologies will be detailed as well as applications made to-date. This section will conclude with a focus on recent extensions of the interindustry analysis to regional modeling systems and databases.

Regional Input-Output Analysis

Input-output analysis was originally developed during the 1930's by Wassily Leontief for which he later earned the 1973 Nobel Prize in Economic Science. The fundamental structure of input-output analysis was developed to analyze the interdependence of industries within an economic system. In its fundamental state, it is a system of linear equations which describe industrial distribution within and between sectors of an economy. Discussion of the theory, application, and current forefront of input-output analysis is covered in extensive detail by Miller and Blair (1985) and Miller, Polenske and Rose (1989). Input-output analysis can be extended to regional analysis using data specific to regions. It is the regional application of input-output analysis which provides the focus for the following discussion.

Theory

The basic input-output table is derived from observed economic data for a specific region. This data specifies the activity of industrial groupings that both produce goods (referred to as outputs) and consume goods from other industries (referred to as inputs) in the process of producing each industrial group's own good. The flow of products from each industrial sector considered as a producer to each of the sectors considers as consumers is the essence of interindustry analysis. Construction of this into meaningful form takes place in what is referred to as an interindustry transactions table. Rows of a standard interindustry transactions table track incomes (distribution of producer's output throughout the economy) while columns track expenditures (distribution of inputs required by a particular industry). Additional columns are typically added to the right of the interindustry transactions table which distribute products to their final nonindustrial destination (often referred to as final demand). These often include destinations such as personal consumption, government consumption, investment, and exports. Additional rows are attached below the interindustry transactions table to track inputs of nonindustrial inputs such as land, labor, capital, and taxes required in producing a good (often referred to as value-added) as well as imports which are required as inputs to the production process.

One way that input-output analysis has been tied to regional development theory is its use with export-base theory and the concept that a regional economy must increase its monetary inflows in order to grow. The emphasis is on *basic* or export-based industries which export commodities from the region. If production within basic industries increases, production within the nonbasic or residentiary industries also increases. Disaggregation of a regional economy into basic and nonbasic activities is done through surveying commodity transportation records, location quotients, establishment of minimum export requirements, regression analysis, or by assumption. Total output in a region is simply the sum of all basic and nonbasic activities.

Regional input-output tables are a descriptive set of balanced regional accounts. These balanced regional accounts rest upon data compiled in industry T-accounts. Figure 3 illustrates what an industry T-account might look like and is adapted from Lindahl (1991). Input-output requires data on purchases and expenditures by industrial sectors, institutions, and general economic interindustrial linkages.

Revenue (row)	Expenditure (column)
Sales to industries	Purchases of local goods and services
Sales to institutions	Purchases of imported goods and services
Exports	Investment
	Payroll
	Taxes
	Retained profits
	Distributed profits

Figure 3 Components of an industry T-account

Input-output analysis has the ability to predict impacts of industrial supply or demand change based upon regional accounts. The tracking of impacts through an economy was first developed by Leontief and is contained in numerous textbooks and articles on the topic (Miller and Blair, 1985; Miller, Polenske, and Rose, 1989; Doeksen and Schreiner, 1974; Hamilton and Pongtanakorn, 1982 and others). The specific functional relationship in input-output includes:

$$X = Z + Y \tag{3.1}$$

Where X is total gross output (usually expressed in millions of dollars), Z is a matrix of transactions between sectors, and Y is a vector of sales to final demand. Leontief then extends the relationship that Z is a function of $A\,X$ where A is a matrix of technical (or direct) coefficients specified for input or output orientation and *X*, as stated above is total gross output. Substituting for *Z* results in the following:

$$X = (A\,X) + Y \tag{3.2}$$

Which simplifies to:

$$X - (A\,X) = Y$$

$$X = (I - A)^{-1}\,Y \tag{3.3}$$

This fundamental result includes $(I - A)^{-1}$ which is known as the *Leontief Inverse* or *total requirements table* and is comprised of diagonal elements which act as direct multipliers of economic impact and off-diagonal elements which act as indirect multipliers. Often, this has been expressed in terms of change in output as follows:

$$dX = (I - A)^{-1}\,dY \tag{3.4}$$

Given a change in sales to final demand (or supply given appropriate specification of *A*) to a given or set of regional sectors, change in gross regional output by sector can be assessed.

Predicting Employment Change. Employment creation is often a direct objective of rural economic development initiatives. Employment change can be predicted as a direct proportional change given a change in gross regional output of a single or multiple set of sectors. This is represented by:

$$dE_i = e_i \, dX_i \tag{3.5}$$

Where E is employment (usually measured in number of jobs or full time equivalents) and e is an employment coefficient measured as the ratio of jobs in a given sector to total sector output.

Predicting Value Added change. Value added, or the returns to the factor inputs land, labor, capital, and indirect business taxes accruing to owners of these resources within a region is a common focus of rural economic development. Value added is equivalent to what might be thought of as gross regional product. Value added change resulting from an exogenous shock can also be predicted as the proportional change in value added given a change in regional gross output as follows:

$$dV_i = v_i \, dX_i \tag{3.6}$$

where V is the level of value added or gross regional product (usually measured in millions of dollars) and v is the value added coefficient for each respective sector which is calculated as the ratio of sector value added to total regional sector output.

Critical Assumptions. Input-output analysis rests upon several important caveats which limit the appropriateness of model application. Miller and Blair (1985) discuss the fundamental structure of input-output analysis. An assumption is made that inderindustry flows from sector i to sector j depend entirely on total output of sector j during a specified time period. The limitations of input-output analysis are primarily a function of assumptions behind the technical coefficients used (a_{ij}). These technical coefficients can be represented by:

$$a_{ij} = z_{ij} / X_j \tag{3.7}$$

where a_{ij} denotes the ratio of input to output, z_{ij} denotes the flow of input (measured in dollars of value) from sector i to sector j, and X_j is the total gross output of sector j (measured in dollars of value). In input-output analysis, once a set of observations has provided the result a_{ij}, this technical coefficient is assumed to be unchanging. The a_{ij}'s measure fixed relationships between a sector's outputs and its inputs. This implies that returns to scale are assumed to be constant; economies of scale in production are ignored. This also extends to the inputs required in production. Input-output analysis assumes that inputs to sectors are required in fixed proportions.

In addition, inputs to sectors and outputs produced by sectors are inserted into an input-output table based upon their dollar value in fixed-price terms. If an input-output table is constructed for the base year 1985, the value terms used in construction of the table will be in fixed 1985 prices. This implies that price is exogenously determined even though market-based economic theory is concerned with *price discovery*, or endogenous determination of price.

Furthermore, technological integration in the production process combining factor inputs to produce a good or service is also fixed to the base year in which observations were made. These constraints combine to limit input-output analysis to represent a relatively static analysis pertaining to the economic structure which exists in the base year.

<u>Empirical Accuracy in Input-Output Analysis</u>

Accuracy in empirically estimating input-output tables is directly tied to the methods used in data collection and the model limitations presented above. Jensen (1980) looks at two types of accuracy. The first he terms *A-type accuracy* which is the accuracy of the transactions table. Another term for this type accuracy is *partitive accuracy.* Sources of error within A-type accuracy include data errors and errors from table compilation.

The second accuracy category is *B-type accuracy* which refers to the exactness with which the input-output model reflects the operation of a regional economic structure. Another term for B-type accuracy is *holistic accuracy.* Errors which cause B-type inaccuracy result from a general failure to observe the limitations of the model itself.

<u>Survey vs. Nonsurvey Techniques</u>. Empirical accuracy in input-output is important due to the relevant costs associated with attaining a given level of accuracy. Perhaps a more important question, however, is whether the analytical tool is sufficiently accurate to answer the question at hand. The early I/O tables were constructed from survey data. The costs of developing a survey-based input-output framework for a region are considerable. During the late 1970's and early 1980's, researchers focused attention on nonsurvey techniques for developing input-output tables (Stevens, Treyz, Ehrlich and Bower, 1983; Round, 1983; and others). How well these nonsurvey-based models compare with survey-based models is a function of A-type accuracy.

This specific distinction between two separate model-building techniques neglects to fully illuminate the situation. The truth of the matter is that little distinction is evident in practice. Discussion becomes engrossed in the very significant "gray area" around which input-output databases are developed. Round (1983) summarizes the differences between survey and nonsurvey techniques of I/O model construction as follows (page 190):

> The terms "nonsurvey" and "survey" suggest the existence of two well-defined and mutually exclusive groups, but in practice virtually all input-output tables are hybrid tables constructed by semisurvey techniques, employing primary and secondary sources to a greater or lesser extent. Therefore, there can be few regional input-output tables, if any, that have not relied to some extent on the use of indicators, ad hoc judgment, or some form of data-smoothing technique.

He further clarifies characteristics of nonsurvey-based input-output table construction through the following (page 190):

> These methods are usually referred to as nonsurvey techniques (:) ... any technique used to adjust inconsistent estimates directly based on survey data ... (and) ... short-cut methods used to derive regional sectorial multipliers which bypass the construction of a regional input-output table.

Round (ibid) concludes that the spectrum of perceived usefulness of nonsurvey-based I/O is a continuum from one extreme of severe skepticism to the other extreme of a rather simplistic concept of regional economic interactions (i.e. indicators such as the location quotient are likely to be sufficient to estimate the size and direction of trade flows). Somewhere in between lies the partial-survey techniques which incorporate more and more complexity and time consumption at higher and higher costs.

Empirical Tests. Kuehn, Proctor, and Braschler (1985) compared the multiplier results of nonsurvey, semisurvey, and survey models of statewide Missouri input-output tables with economic base multipliers for nonmetropolitan counties throughout the Midwest. Their findings showed that all three techniques were prone to measurement and/or sampling error. Relative accuracy of the techniques were difficult to establish. They concluded that (1) the economic base model remains a viable choice with several caveats, (2) any single I/O model remained a *snapshot* of a local economy given some historic economic structure, and (3) in the absence of feasibility studies, nonsurvey based I/O models provide reasonable multipliers (usually upper limits) at less cost than survey based I/O.

Stevens, Treyz, Ehrlich, and Bower (1983) discuss and evaluate regional purchase coefficient approaches to nonsurvey-based I/O development. They compare these nonsurvey approaches to corresponding components of survey based models for Washington and West Virginia. Of their two primary nonsurvey approaches (which include location quotient and supply and demand pool methods), the supply and demand pool method explicitly takes into account the actual regional demands for each good and provides results which are better justified theoretically and more closely comparable to the survey approach.

Interregional Complexities

Indeed the specification of interregional transactions is critical to the realistic application of input-output analysis, particularly between regions which are "open" to flows of production factor inputs and commodities. Polenske (1970) has provided a multiregional input-output model for the United States which is often used by nonsurvey-based I/O developers. Her Harvard Economic Research Project team undertook this challenge due to the lack of consistent sets of regional data which inhibited empirical estimation of multiregional I/O models. Polenske's model includes 44 U.S. regions and 78 industries.

Other multiregional models have been developed for various parts of the United States and to assess various problems requiring a multiregion approach. Hwang and Maki (1979) have developed the Minnesota Two-Region Input-Output model. Badger, Schreiner, and Presley (1977) developed a four region, interregional input-output model to analyze expenditures for outdoor recreation of the McClellan-Kerr Arkansas River navigation system. Forest-based economic activity was assessed from an interregional approach by Teeter, Alward, and Flick (1989). Employment linkages were estimated between regions in a multi-county development district by Schreiner, Muncrief and Davis (1972).

From a more global perspective, international trade provides specific challenges due to trade restrictions, rigidity in labor mobility, and other factors leading to relatively *closed* regions. Round (1985) looked at decomposing economic multipliers for economic systems which involved regional and world trade. He developed a methodology which provides insights into the nature of structural interdependence between economic systems involving two or more regions.

Natural Resource Applications

Numerous applications of input-output analysis have been made to address various problems. A comprehensive account for all applications is beyond the scope of this literature review. A thorough review of the renewable resource literature, however, generated numerous interesting applications of input-output analysis. Early forestry applications of input-output analysis include an Oklahoma forest products industry input-output model by Schooley and Jones (1983). The development of a Southern United States forest industry analysis by Flick and Teeter (1988) relies upon numerous input-output models developed individually for Alabama, Florida, Georgia, Mississippi, Oklahoma, Tennessee, Texas, and Virginia. Lake States forestry has been assessed through the development and use of an input-output model by Pedersen, Chappelle and Lothner (1989)

The USDA, Forest Service has been interested in how management of forest resources impacts regional economies. Since the late 1970's, their input-output model generator known as IMPLAN has aided in this endeavor. Primarily developed to generate input-output analysis to county resolution for 528 sectors, the IMPLAN system has considerable potential for assessing regional economies. Its current database and software is for the base year 1985. Operational aspects of IMPLAN can be found in the current technical software manual (IMPLAN Development and Applications Group, 1991). Siverts (1983) and Alward (1986) outline the development of IMPLAN input-output analysis for use in forest planning. An assessment of IMPLAN accuracy can be found in Appendix A. Appendix C contains numerous annotated citations for natural resource applications using IMPLAN.

Siverts (1985 and 1987) discusses the general early analytical opportunities that IMPLAN provides which include developing regional accounts and final demand analysis. Continued effort has focused on improving the social accounting capabilities of IMPLAN. Applications which avail of these opportunities are becoming rather abundant.

The U.S. Forest Service, National Forest System, as part of each individual forest planning process, has used IMPLAN to assess economic impacts of different management strategies on a forest-wide basis. The forest planning process which is typically undertaken for each national forest requires that land management alternatives be explicitly stated and analyzed. The IMPLAN system is used for regional economic analysis of these alternatives. These analyses are incorporated into each respective forest plan.

Other interesting forestry/range production applications of IMPLAN have been made recently. A hybrid econometric input-output model was constructed by Sullivan and Gilless (1990) which uses econometric representations of local wood products industries from published data sources and the IMPLAN I/O model framework. Another article by the same authors (Sullivan and Gilless, 1989) focuses on the cumulative employment effects of timber industries reliant upon National Forest timber harvests. Ferell (1991) evaluates alternatives within a timber sale Environmental Impact Statement (EIS) for the Nantahala National Forest in North Carolina. Beuter (1990) uses IMPLAN to assess the economic impacts of the Northern Spotted Owl conservation strategy in Washington, Oregon, and Northern California. Alward and Sullivan (1984) estimate the impacts of increased Federal grazing fees on income and employment in 13 western states using IMPLAN.

Wildlife and fisheries resources have been assessed using IMPLAN. Alward, Sullivan, and Hoekstra (1985) describe the use of socioeconomic data in assessment of wildlife management activities. Otto (1991) used IMPLAN to identify the economic impacts of creating a wildlife preserve in Iowa. Sah, Schreiner and Schorr assess the economic impacts of bass fishing from a popular Oklahoma border lake on the regional economy using IMPLAN.

Specific policies and programs have been analyzed using IMPLAN. Siegel and Johnson (1991) use IMPLAN to assess impacts of the Conservation Reserve Program (CRP) by developing a "Break Even Approach" to input-output analysis in Virginia. CRP impacts on rural communities are also studied by Hyberg, Dicks and Hebert (1991) using IMPLAN. Dicks, Hyberg, Hebert, Siverts and Wagner (1991) develop and discuss a spreadsheet model for use with IMPLAN to simulate regional inter-sectorial economic impacts of various agricultural policies.

Recreation and tourism development is becoming an important economic development impact discussion topic. Application of I/O to address these issues has also increased. It is, however, not a new endeavor. Mapp and Badger (1970) conducted an early input-output analysis of outdoor recreation which focused on Southeastern Oklahoma. Alward and Lofting (1985) and Alward (1987a) present an overview of recreation and tourism economic impact analysis.

Focus on the important general applications reported in the resource development economics literature specific to Oklahoma generates numerous references. Ghebremendin and Schreiner (1983) use input-output to analyze alternative energy choices which have direct appropriateness to a significant Oklahoma industry. Schreiner, Muncrief and Davis (1973) use input-output to address costs and service requirements for the solid waste management industry in Oklahoma. A from-to interdependence model is used to assist regional planners as a cost-effective alternative to the traditional input-output model for South-Central Oklahoma (Schreiner and Muncrief, 1972). The impact of private investment on employment in Oklahoma has been analyzed over different time frames using a social accounting system and simulation by Doeksen and Schreiner (1972b).

Social Accounting Methodologies

Regional input-output analysis provides data and model frameworks which identify interactions between industrial sectors within a regional economy and specifies the interindustrial manner in which a regional economy can grow. Recent research has led to progress in this area. This analysis, however, has been unsatisfactory in addressing certain issues in socioeconomic development. Socioeconomic development is concerned with raising the living standards of people (Pyatt and Round, 1985; page 1). Data and models which recognize the importance of people and household living standards, not commodities and industrial sector output, are required to address these issues. Pyatt and Round state (ibid):

> Today, while most would agree that output growth is a necessary condition for sustained improvement in living standards, it is also generally recognized that economic policy must simultaneously concern the distribution of benefits arising from growth, to the point where faster growth overall might be sacrificed for the sake of faster growth in the living standards of particular groups, especially poverty groups.

The social accounting matrix provides an approach for assessing how living standards are impacted through the course of economic growth.

A social accounting matrix (SAM) extends input-output analysis to describe the full flow of money and commodities in a base year. This flow of production to factor income to institutional income to commodity demand and savings to further production and investment has been applied to a variety of industrial sectors and regions over the past ten years (Adelman and Robinson, 1986 and others). Whereas input-output models capture a major source of linkages within an economy, they exclude the above mentioned flows. Social accounting expands input-output accounts to include this circular flow within an economy. The concepts were developed for institutionalization through the contributions of Sir Richard Stone (Pyatt and Round, 1985) however the first comprehensive description of the social accounting matrix is generally attributed to a study by Pyatt and Thorbecke in 1976 (Keuning and De Ruijter, 1988). The development and application of social accounting methodologies has arisen primarily due to dissatisfaction with existing practices of national accounting emphasizing economic growth (ibid and Pyatt and Round, 1977). These authors state (ibid; page 339):

> The SAMs were conceived as the initial step towards understanding income distribution as an integral part of the development process and have been developed in parallel with work on planning models.

Pyatt and Round (1985) edited a compilation of papers presented at a 1978 conference in England which focused exclusively on social accounting methodologies and studies. Within this volume are descriptions of nationwide social accounts for Sri Lanka (ibid: Chapter 5), Swaziland (ibid: Chapter 6) and Botswana (ibid: Chapter 7). General nationwide social accounting matrix analysis has also been done for Egypt (Eckaus, McCarthy and Mohic-Eldin, 1981), Greece (Skountzos, 1988), and the Netherlands (Cohen, 1988).

Focus on distributional impacts of industrial sectors using social accounting methodologies is also a common line of application. U.S. agriculture was analyzed using social accounting methodologies by Adelman and Robinson (1986). The agricultural sector of Pakistan was studied by Havinga, Sarmad, Hussain, and Badar (1987). The California defense industry was analyzed using social accounting by Esparza (1989).

Using social accounting to provide information regarding specific social and economic problems is perhaps the methodology's most effective use as a development tool. Adelman, Taylor and Vogel (1988) developed a social accounting matrix for a migrant-sending rural village economy in Mexico to assess policy experiments targeting migration and poverty of landless peasants. Tariff and non-tariff protectionist measures were assessed for an African economy using a social accounting matrix by Ghosh (1987). Impacts of trade sanctions on South Africa was studied by Khan (1988) using a social accounting matrix approach. Income, food consumption, and protein intake of households in Indonesia was assessed using social accounting matrices by Sutomo (1989). Income distribution effects on women and landless groups in Central Java was studied using social accounting methodologies by Budiyanti and Schreiner (1991). Social accounting was used to assess the impact of credit by caste and farm size in Nepal by Sah and Schreiner (1991). Impacts of a large public civil engineering project in Southeastern Oklahoma was analyzed using social accounts by Uwakonye, Schreiner, Badger and Woods (1992).

Rose, Stevens, and Davis (1988) developed a procedure to analyze distributive effects of natural resource policy using social accounting methodologies for a region in West Virginia. Their model, however, did not assess distributive impacts resulting from exogenous resource productivity shocks.

The discussion will now turn to the specific methodological construction of a social accounting framework.

SAM Structure

The structure of a social accounting matrix varies depending upon the study analyzed. A comprehensive discussion of the concept and construction of SAMs is covered by Pyatt and Round (1985). Much of the discussion which follows is adapted from the Pyatt and Round structure.

A social accounting matrix is a completely identified square tableau with row accounts mapping sources of income and column accounts specifying expenditures. Figure 4 conceptually identifies the social accounting matrix used in this study which is composed of an array of accounts which describe the economic structure of the region.

Economic sector accounts represent the traditional input-output tableau which is discussed above. Production sectors are aggregated based on homogeneity of production functions, the objectives of the study and availability of data (Sohn, 1986; Chapter 14). A plausible 6 sector aggregation scheme which addresses forestry problems could focus on timber production, wood processing, agricultural production, food processing, manufacturing, and service/government. Factors of production could include land rent, various skill levels for labor, and capital.

Institutions which highlight timber production in the United States could include the nonindustrial private forest timber production, industrial timber production, public timber production, wood processing industries, agriculture, and all other industries. Households could be categorized as low, medium and high household income levels.

The IMPLAN system has incorporated a social accounting matrix form into it's operation for an earlier (1982) database. It's development is discussed by Alward (1985) and Alward, Lichty, Maki and Westeren (1992). This IMPLAN

	Production Sectors Ag Prod. / Timber Prod. / Mfgr / Food Fiber Proc / Wood Proc / Services and Gov't	Factors 1a 1b 1c 1d 1e 2 3	Institutions a1 a2 a3 a4 b1 b2	Households Low Medium High	Government	Capital/ Savings	Rest of World	TOTAL
Production Sectors Ag Production Timber Prod & Serv Manufacturing Food/Fiber Proc Wood Processing Services & Govt	Interindustry Transactions			Consumption Demand From In-Region Sources	Government Demand From In-Region Sources	Investment Demand From In-Region Sources	Commodity Exports From In-Region Sources	Commodity Demand From In-Region Sources
Factors 1. Labor a. Mgnt/Prof. b. Tech/Sales/Support c. Services d. Farm/Forest/Fish e. Prod/Crafts/Repair 2. Capital 3. Land	Payments to Factors of Production							Factor Income
Institutions a. Forestry Complex 1. NIPF 2. IPF 3. Public 4. Wood Proc b. NonForestry Complex 1. Agric Prod 2. NonAg		Institutional Income Distribution			Transfers to Institutions			Institutional Income
Households Low <15000 Medium 15,000-40,000 High >40,000			Household Income Distribution		Transfers to Households		Unearned Income	Household Income
Government	Indirect Business Taxes	Factor Taxes	Inc. Tax	Household Taxes			Government Transfer	Gov't Revenue
Capital/Savings			Institutional Depreciation	Household Savings				Total Savings
Restof World	Imports of Production Inputs		Institutional Transfer	Imports to Consumption	Gov't Imports	Cap.Form. Imports		Total Exports
TOTAL	Total Industry Outlays	Factor Expenditure	Institutional Expenditure	Household Expenditure	Gov't Expenditure	Total Investment	Total Imports	

Figure 4. Schematic Social Accounting Matrix Which Focuses on Timber Production

social accounting matrix, however, has structural inconsistencies and does not, to the authors' knowledge, allow the user to disaggregate the production sector or specify an institutional disaggregation which is critical to addressing the previously discussed problem.

The IMPLAN system provides an good foundation for generating certain components of a social accounting matrix. These components include the inter-industry transactions matrix, vectors of final demand, and components of value added for a regional sector aggregation. To complete a social accounting matrix, however, requires specific estimated values which fully illustrate the distribution of factor payments among regional institutions. It is this full description of the regional economy which provides conclusive answers to the question of distributional economic impacts.

The specific procedures used in developing the social accounts for this study are introduced in analytical form in the methodology section (Chapter IV) and in empirical form in Chapter V.

CHAPTER IV

THE ANALYTICAL SOCIAL ACCOUNTING MATRIX: MODEL SPECIFICATIONS AND ASSUMPTIONS

The following discussion outlines the social accounting matrix (SAM) in a generic analytical fashion and includes critical components of a SAM, the schematic SAM, and using SAM multipliers to identify distributional impacts of exogenous shocks on sources of regional factor income. The specific construction and empirical estimation of a SAM detailing forestry-related activities will be left for discussion in Chapter V.

Components of a Social Accounting Matrix

A SAM organizes data and develops a modelling framework in the context of stating initial conditions in an economy and focuses on the disaggregation of households into income categories. Those constructing social accounting matrices are often faced with incomplete data of varying quality. SAM's provide an invaluable framework in bringing together available data and assist in quantitatively describing the initial position of an economy (Pyatt and Round, 1985).

King (1985) defines two primary objectives of performing SAM analysis. The first is to organize information about the economic structure of a region in a given year. A SAM provides a static (snapshot) image of a region's economic conditions. More than a static image is required to analyze the operation of an economy or to simulate the effects of policy interventions. The second objective of constructing a SAM is to (ibid, page 17) "provide a statistical basis for the creation of a plausible model".

Taxonomies, or the orderly classification of economic groupings to their presumed natural relationships, within a SAM are critical. The classification system used within the SAM is important in capturing behavioral differences and market imperfections. The model-builder's responsibility is to define and justify his choice of classifications based upon the problem being addressed (Pyatt and Round, 1985). Accounting constraints are important components of a SAM in that they ensure that the system adds up. The ability of an analyst to provide quantitative explanations to phenomena within a regional economy is done through appropriate classification within the confines of a balanced set of regional economic accounts.

A social accounting matrix is a double-entry bookkeeping system within which revenues (or income) must balance with expenditures (or outgoings). SAM's are logical extensions of input-output analyses and are similar in many respects. SAM's, however, contain much more information which focuses on household and institutional disaggregation. Numerous adaptations to the social accounting matrix framework have been made. The following breakdown of SAM components is one plausible taxonomic structuring.

Production of Industrial Sectors

The essence of industrial sector production activities are captured through basic production functions. These individual components differ little from input-output and include interindustry transactions demand, household consumption demand, government demand, investment demand, and commodity exports. Expenditures identify input supply components for the goods and services produced by industrial sectors. Specific components of input supplies include interindustry supply, factor payments to land, labor and capital, indirect business taxes, and commodity imports.

In double entry tabular form, the production of industrial sectors can be summarized as follows:

Revenue (row)	Expenditure (column)
Interindustry demand	Interindustry supply
Household consumption demand	Payments to factors of production
Government demand	Indirect taxes
Investment demand	Commodity imports
Commodity exports	
Total industry revenue	Total industry expenditure

Factors of Production

Factors of production include land, labor and capital and, together, combine to form regional value added. Value added is equivalent to the total inputs to the production process net of intermediate purchased inputs including imports and indirect taxes. In the SAM, factor income includes that which is paid to factors from industrial sectors. Factor expenditure includes payments made to institutional categories and payments made to government in the form of factor taxes.

In double entry tabular form, the factor account can be summarized as:

Revenue (row)	Expenditure (column)
Income from industries	Payments to institutions Factor taxes
Total factor revenue	Total factor expenditure

Institutional Disaggregation

The decomposition of income and expenditure flows to institutional categories captures behavioral differences important to answering the problems being addressed in a specific study. Institutional income is received from factors of production and transfers from government. Institutional expenditures include payments to households, depreciation/retained earnings, and institutional rest-of-world transfers.

In double entry tabular form, the institutional account includes:

Revenue (row)	Expenditure (column)
Income from factors Gov't transfers to institutions	Payments to households Depreciation/retained earnings Institutional ROW transfers
Total institutional revenue	Total institutional expenditure

Households

Households are typically disaggregated by household income categories within a SAM. This allows identification of distributive impacts among various economic groups of changes in economic structure attained through development policy. In a SAM, household income is received from institutions (identified as earned income), government transfer payments, and income from dividends, interest, etc. (identified as unearned income). Households expend income through household consumption, payments to government through taxation, household savings, and imports to consumption.

In double-entry tabular form, the household account is summarized as follows:

Revenue (row)	Expenditure (column)
Earned income	Household consumption demand
Unearned income	Household taxes
Government transfer	Household savings
	Imports to consumption
Total household revenue	Total household expenditure

Government Integration

The government is integrated into regional economies primarily through taxation and transfer payments. Government income is received from productive activity's indirect business taxes, taxes received from factor inputs, household taxes collected, and unearned income taxes. Governments expend funds through direct government commodity demand, transfer payments to institutions, transfer payments to households, and government imports to consumption.

In double-entry tabular form, the government account can be summarized as follows:

Revenue (row)	Expenditure (column)
Indirect business taxes	Government commodity demand
Factor taxes	Transfers to institutions
Household taxes	Transfers to households
Unearned income taxes	Government imports to consumption
Total government revenue	Total government expenditure

Capital Markets

The functioning of capital markets is typically a difficult account to construct for a region due to data unavailability. It can, however, be important in tracing income accruing to economic groupings. A plausible taxonomic structure of a SAM for a region in which capital markets are primarily external can include capital income which is generated from institutional depreciation/retained earnings and household savings. Capital expenditures for a SAM structured in this manner would include investment demand and the net capital flow from the rest-of-world.

In double-entry tabular form, the capital account for a SAM structured in this manner could be summarized as follows:

Revenue (row)	Expenditure (column)
Institutional depreciation/ retained earnings	Investment demand Imports to investment demand Net capital flows
Total capital revenue	Total capital expenditure

Inter-Regional Flows

Regional social accounting matrices are inextricably tied to the outside region by flows in all accounts. Dealt with through residuals, inter-regional income accruing to the region under study would include commodity imports, factor payment outflows, institutional rest of world transfers and net capital flows. Inter-regional expenditures would include commodity exports, unearned income, and government transfers.

In double-entry tabular form, the inter-regional accounts can be summarized as including:

Revenue (row)	Expenditure (column)
Commodity imports Factor payment outflows Institutional transfer Net capital flows	Commodity exports Unearned income Government transfers
Total revenue from ROW	Total expenditure to ROW

Mapping Factor Incomes Through a SAM

The usefulness of a social accounting matrix is a function of its taxonomy and the manner in which factor incomes are traced through an economy. Primarily, this tracing exercise boils down to mapping components of value added through a regional economic structure.

The initial value added matrix which is derived through assessment of the expenditure of productive sector activity includes payments by sectors to the factor inputs of land, labor, and capital used in producing regional output and is distributed throughout the regional economy by initial production sectors.

The structure of this SAM then reaggregates the economy into institutions. Factor payments net of factor taxes are then distributed within the institutional income distribution matrix. Factor taxes are removed from this account to provide consistency with data sources and to provide a net factor income which is then allocated by institutions to households. It is important to note that factor taxes could be removed from institutions (in the household income distribution matrix) if data were available on differential rates of institutional taxation for factors inputs. For this analysis, it is assumed that there does not exist differential rates between institutions. For example, nonindustrial private forest landowners pay the same tax rate on forest land as does industrial private forest landowners.

Income from factor inputs are then distributed among household income groups from institutions. This is accomplished in the household income distribution matrix and is done in accordance with BEA data on personal income by major source specific to McCurtain County during 1985 (USDC, Bureau of Economic Analysis, 1992). Thus, this completely tracks factor income throughout the economic structure from production sectors through households.

A complete description of the specific techniques in constructing the SAM will be found in Chapter V. Attention will now be given to addressing the schematic social accounting matrix with particular attention given to SAM accounting constraints from a generic perspective.

The Schematic Social Accounting Matrix

Recall the fundamental structure of input-output from Chapter III. An endogenous vector of sectoral production expressed as *X* (total gross output) can be predicted from a matrix of coefficients *Z* (which is a matrix of transactions between sectors) and a final demand vector *Y* (sales to final demand). Recall that *Z* is a function of *A X* where *A* is a matrix of technical (or direct) coefficients specified for input or output orientation and *X*, as stated above is total gross output. Substituting for *Z* and simplifying the equation results in the following:

$$X = (I - A)^{-1} Y \qquad (4.1)$$

Social accounting matrices are treated in a similar manner. Using social accounting matrices to predict income distribution resulting from exogenous changes is addressed in the literature. To transform the social accounting matrix into a predictive model requires several procedural steps. Cohen (1988) discusses these as including (1) subdivision of the social accounting matrix into exogenous and endogenous categories, (2) expressing flows as average propensities of their corresponding column totals [1], and (3) progressing through the analysis as outlined below.

Figure 5 presents the SAM in schematic form which distinguishes endogenous and exogenous portions (adapted from Pyatt and Round, 1985; page 190). Note that endogenous accounts appear above and to the left while exogenous accounts appear below and to the right. Equations 4.2 through 4.12 define the accounting relationships which are direct result of the SAM structure. Transactions between endogenous accounts *(N)* can be expressed as the product of the average propensities to consume (the square matrix A_n) and a vector of endogenous incomes (y_n) as specified in (4.2).

$$N = A_n \, y_n \tag{4.2}$$

Note that A_n is the matrix of average endogenous expenditure propensities and is equal to $N \, y_n^{-1}$. Also, N_i is the vector of row sums of $N = A_n \, y_n$.

In a similar fashion, leakages *(L)* are equated to the product of average propensities to leak (non-square matrix) and the endogenous incomes (y_n) as specified in (4.3).

$$L = A_l \, y_n \tag{4.3}$$

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1. Expressing flows as average propensities of their corresponding column totals will allow assessment of demand shifts and assumes that output relationships remain constant through an economic structure. Conventional SAM multiplier analysis is typically done using constant output relationships. Supply-side input-ouput models depart from convention in expressing flows as average propensities of their corresponding row total and allow assessment of raw material supply shifts assuming that input relationships remain constant. The supply-constrained technique applied in this dissertation should not be confused with this supply-side technique. Another manner in which supply can be constrained is through a mixed exogenous/endogenous technique. The supply-constrained analysis referred to in this dissertation follows the mixed exogenous/endogenous technique and will be discussed later in this chapter.

		Expenditures		
		Endogenous Accounts	Exogenous Accounts	Total
Receipts	Endogenous Accounts	$N = A_n\hat{y}_n$ 4.2	X	$y_n = n + x$ 4.4 $= A_n y_n + x$ 4.5
	Exogenous Accounts	$L = A_\ell\hat{y}_n$ 4.3	R	$y_x = \ell + Ri$ 4.6 $= A_\ell y_n + Ri$ 4.7
Total		$y_n' = (i'A_n + i'A_\ell)\hat{y}_n$ 4.8 $\therefore\ i' = i'A_n + i'A_\ell$ 4.9	$y_x' = i'X + i'R$ 4.10 $\therefore\ A_\ell y_n - X'i = (R\text{-}R')i$ 4.11	$\Omega_a' y_n = x'i$ 4.12

Figure 5. Accounting Relationships of the Schematic Social Accounting Matrix (from Pyatt and Round, 1985; Table 9.2, page 190).

Note that A_l is the matrix of average propensities to leak and is equal to $L\ y_n^{-1}$ and L is the vector of row sums of $L = A_l y_n$ and is equal to l. Since N, L, and y_n are directly observable from a constructed SAM, the matrices A_n and A_l can be directly obtained. The accounting relationships by which endogenous incomes are determined are specified in (4.4) and (4.5).

$$y_n = n + x \tag{4.4}$$

$$y_n = A_n\, y_n + x \tag{4.5}$$

Where n are SAM transactions between endogenous accounts (matrix of SAM transactions specified as N) and x are injections from exogenous into endogenous accounts (matrix of injections specified as X). Accounting relationships for incomes in the exogenous accounts (y_x) are specified by (4.6) and (4.7).

$$y_x = l + R\, i \tag{4.6}$$

$$y_x = A_l\, y_n + R\, i \tag{4.7}$$

Note that R is a matrix of SAM transactions between exogenous accounts.

Expenditure summation down the columns of the endogenous accounts (4.8) imply that, for the endogenous accounts, rows and column sums are equal given that (4.9) holds (i.e. that column sums for A_n combined with A_l sum to unity in all cases).

$$y'_n = (i'A_n + i'A_l)\, y_n \tag{4.8}$$

$$i' = i'A_n + i'A_l \tag{4.9}$$

Exogenous accounts are summed down the column in (4.10). The accounting requirement that column sums be equal to row sums provides the logic for (4.11).

$$y'_x = i'X + i'R \tag{4.10}$$

$$A_l y_n - X'i = (R - R')\, i \tag{4.11}$$

Note that X_i is the vector of row sums of X. This, then, provides the implications stated in (4.12) that, in aggregate, inflows into the system must equal leakages.

$$\Omega'_a\, y_n = x'i \tag{4.12}$$

Note that Ω'_a is a vector of column sums of A (aggregate average propensities to leak) and is equal to $i'A_l$. From the definition of $\imath$ combined with equation 4.5, the following result is derived as equation 4.13.

$$y_n = (I - A_n)^{-1}\, x = M_a\, x \tag{4.13}$$

Provided that $(I-A_n)^{-1}$ exists, equation 4.14 also follows.

$$\imath = A_l\, (I - A_n)^{-1}\, x = A_l\, M_a\, x \tag{4.14}$$

M_a is the accounting multiplier matrix. This matrix relates endogenous incomes, y_n, to injections, x. Injection and leakages of the system implied by equation 4.14 satisfy the following requirement, given in equation 4.15.

$$\Phi ' A_l M_a = \Omega '_a M_a = \Phi ' \qquad (4.15)$$

This implies that each injection is accounted for by corresponding leakages.

Endogenous accounts which pertain to the SAM constructed in Chapter V includes production sectors, factors of production, institutions, and households. Exogenous accounts are those accounts specified as government, capital, and rest-of-world. Injections, x, to the system include transfers to institutions and to households from government, and the rest-of-world. In addition, injections occur through demands of production activities from government, investment, and exports to the rest-of-world. Leakages include taxes, savings, and imports.

The Supply-Determined SAM

Wood processing expansion is constrained by the availability of raw material supplies, namely sawtimber and pulpwood generated by IPF, NIPF, and Public timber producers. The ability to specify this constraint is one of the unique characteristics of this analysis.

Mixed Endogenous/Exogenous Accounts. This is done using procedures outlined in Miller and Blair (1985; Chapter 9, pages 325-333). Supply determined mixed exogenous/endogenous account input-output analysis is a departure from standard demand side input-output models. The standard models assume that

Y, or the specification of final demand, is exogenous to the system. Changes in the Y's are derived outside of the model itself. The effects of changes in the Y's on sectoral gross output, then is calculated with the model.

Situations exist, however, where this system is limiting. A more adaptable model is presented with the mixed exogenous/endogenous account input-output methodology where final demands for some sectors and gross outputs of other sectors are exogenously specified. For example, due to limited productive potentials of forest lands and exorbitant hauling costs, the inputs of raw material to wood processors might be fixed with what is currently available for harvest.

Timber production and processing can be viewed as supply-constrained in that rationing by large industrial owners will be accomplished in order to ensure future timber supplies which feed processing facilities. The argument breaks down, however, when prices are no longer fixed. As raw materials become more and more scarce, prices for these production inputs tend to increase. The spatial scope then plays a fundamental role. This analysis is assessing the impacts of timber productivity on a small region (a single county). Demand for processed wood products such as plywood, dimensional timber, and paper are determined in the national marketplace. Processors are viewing demand as relatively elastic. Given generally fixed prices for output, processors are forced to allocate (or ration) raw material supplies to meet this exogenously determined demand. This provides justification for analyzing these sectors in a supply-constrained fashion.

Precedence for using supply determined mixed exogenous/endogenous specification models in social accounting matrices is limited in the literature. Schreiner and Garcia (1992) applied a supply constraint for predetermined output of a commodity account in a recent study on structural adjustment programs in Honduras.

Interpreting SAM Multipliers

Recent literature has provided perspective on decomposing and interpreting SAM multipliers. Pyatt and Round (1985) outline the fundamental SAM multiplier analysis. Cohen (1989) and Round (1988), also comprehensively discuss SAM multiplier analysis. Batey and Weeks (1988) discuss the effects of household disaggregation through SAM multiplier analysis. Rose and Beaumont (1988) discuss interrelational income distribution multipliers. Holland and Wyeth (1989) discuss the decomposition and interpretation of SAM multipliers as well as their relationship to input-output multipliers. Round (1985) decomposes multipliers for economic systems involving regional and world trade. Pyatt and Round (1979) discuss accounting and fixed price SAM multipliers. Robinson and Roland-Holst (1987) discuss SAM multiplier analysis used to sort out direct and indirect links through which macroeconomic shocks affect economic structures. Defourney and Thorbecke (1984) discuss structural path analysis and SAM multiplier decomposition.

Applications of SAM multipliers have become common through the literature. Of noteworthy mention is a study by Adelman, Taylor and Vogel (1988), within which the authors discuss SAM matrix multipliers as applied to a migrant-sending village in Mexico. Also, Esparza (1989) discusses SAM multipliers in an application to defense spending impact analysis. Alward, Lichty, Maki, and Westeren (1992) discuss the framework for using SAM multipliers for analysis of natural resource-base regions.

Actual decomposition of accounting and fixed-price multipliers are of little empirical interest to this study. Results derived through their usage, however, provide plausible stepping stones for analyzing the questions set forth in the problem statements of Chapter I. An excellent discussion of multiplier decomposition can be found in Pyatt and Round (1985; Chapter 9). Discussion of the multiplier analysis used in this study with particular attention to the use of interdependency coefficients is contained in Chapter VI.

CHAPTER V

THE EMPIRICAL SOCIAL ACCOUNTING MATRIX: DATA AND PROCEDURES

Constructing the Regional Social Accounting Matrix

Illustration of a social accounting matrix to address distributional issues of timber production is accomplished by analysis of a region in which forest management and wood processing plays a significant economic role. McCurtain County, in Southeastern Oklahoma, is predominantly rural and forested. McCurtain County is but one example of the current economic structure in the rural south. It should be noted that replication of constructing a social accounting matrix for other regions would be straightforward using procedures discussed in this chapter.

The following discussion will detail the empirical construction of a social accounting matrix, outlined in tabular form in Figure 4. The specification of this SAM is focused on timber production and wood processing, referred to in the following discussion as the forestry complex. The manner in which the forestry complex interacts with returns to factors of production (land, labor, and capital) and distributed throughout economic and industrial groupings is the primary objective of this study. The flow designation of the SAM follows the norm with regional receipts found by reading across rows and regional expenditures found by reading down columns.

Note that factor accounts include five categories for labor, one category for land, and one category for capital. Indirect business taxes are found within the government account. Of primary institutional importance are those sectors which comprise the forestry complex from growing trees through wood processing. Institutions are disaggregated by forestry complex and non-forestry complex. The forestry complex is further disaggregated by timber production and timber processing. Timber production is further disaggregated into three different land ownership patterns including nonindustrial private forest (NIPF) owners, industrial private forest (IPF) owners and public forest owners.

Use of IMPLAN as a Database

IMPLAN, or IMpact analysis for PLANning was developed by the U.S. Department of Agriculture, Forest Service in response to several legislatively mandated planning requirements for economic analyses (Palmer, Siverts and Sullivan; 1985). It consists of (1) a database, (2) software designed to access and analyze the data, and (3) an analysis program allowing planning alternatives and economic impact projections.

IMPLAN functions to aid a user in the development of input-output models and allows the user flexibility in data manipulation and analysis. Initially, the primary IMPLAN applications of the U.S. Forest Service included estimating employment and income impacts resulting from alternative forest management activities such as timber sales and ski area development (USDA, 1984). Other initial users included federal agencies such as the Bureau of Land Management and the Federal Emergency Management Agency. The original system was set up to run on a U.S. Forest Service Univac 1100/80 mainframe computer system around 1980.

The first user's guide details the initial IMPLAN system (Siverts, Palmer, Walters, and Alward; 1983). A good summary of the technical aspects of early IMPLAN operations including the regional database, data reduction procedures, technical coefficients, etc. is included in Alward, Davis, Despotakis, and Lofting (1985) and in Alward and Palmer (1983).

During the mid-1980's, Micro-IMPLAN was developed as an adaptation of the complete system which runs on MS-DOS based microcomputers. Applications of the microcomputer version have steadily risen during the late 1980's. Interim user's guides (Siverts, Alward, Wagner, and Walters; 1987 and Alward, Siverts, Olson, Wagner and Senf; 1989) summarize MicroIMPLAN progress during this period. The current version of Micro-IMPLAN (IMPLAN, 1991) and its respective user's manual (IMPLAN Development and Applications Group, 1991) document the operation of the current software.

<u>The IMPLAN Database and Software System.</u> The IMPLAN database consists of (1) the national-level technology matrix of transactions for goods and services between industries, (2) estimates of gross output, employment, final demand, final payments for sectors by county and (3) social accounts. The current data represent 1985 county-level activity for 528 sectors. Complete database origins and construction procedures in documented form are not yet complete for the 1985 data.

The software which supports the database allows interactive access between users and the various components of the system. IMPLAN allows the user to modify, add or delete data. Specific changes to the database are typically based on available local information. Full operation of the IMPLAN system can be found in the user's manual (ibid).

Social accounting matrix development and application using IMPLAN has seemed somewhat disjoint. Alward (1985) discusses early development of the social accounts. Various versions of IMPLAN have had major problems with the social accounts (an Oklahoma social accounting matrix is only available using the 1982 data) including data omission. Kilkenny (1991) discusses the ability and specific procedures for using IMPLAN to develop social accounting matrices for analyzing farm policies.

The proliferation of primary and secondary user groups are evidence that IMPLAN is increasingly being considered as a valuable interactive tool to develop interindustry analyses and social accounts. Information partnerships are discussed in Siverts and Maki (1990) which detail the current user groups which include the USDA Forest Service, the Federal Emergency Management Agency, the Cooperative Extension Service, the Economic Research Service, the government of Mexico, and a wide variety of individuals, agencies and private entities.

Accuracy of IMPLAN. Numerous attempts have been made to test the accuracy of IMPLAN general results and multipliers. These include studies by Siverts and Chappelle (1989), Borgen and Cooke (1991), Hotvedt, Busby and Jacob (1988), Crihfield and Campbell (1991) and Schuster and Medema (1989). Appendix A discusses an assessment of IMPLAN which focuses on partitive and holistic accuracy with regard to its use for this study. The primary conclusions drawn in Appendix A indicate that IMPLAN reflects published county-level data well and appears to satisfactorily mimic the operation of regional economic structures.

The current data version of IMPLAN uses a base year of 1985. Documentation of this data and data reduction methods used has not yet been published. Earlier data used 1977 and 1982 as base years and documentation does exist (Alward, 1987c; Alward and Despotakis, 1987; and Engineering-Economics Associates, Inc., 1985a, 1985b, 1985c, 1985d, 1985e) which indicates generally satisfactory methodological procedures for development of nonsurvey-based data. Caution is required, however, in using IMPLAN to estimate change; particularly at smaller geographic regional levels such as the single county. Cross referencing the IMPLAN data with published benchmarks and other data retrieval methods and interactively adjusting critical variables such as regional purchase coefficients (RPC's) and components of value added are a must. Further discussion of this can be found in Appendix A.

Developing a Hybrid IMPLAN Model

IMPLAN is used to develop the inter-industry transactions matrix, vectors of final demand as well as components of value added. The 1985 IMPLAN database was edited to more accurately account for timber production in McCurtain County, Oklahoma. Development of a hybrid model uses standard conventions as outlined in the Micro-IMPLAN Users Manual (IMPLAN Development and Applications Group, 1991; section 4). Construction of this hybrid model is accomplished using unaggregated sectors according to IMPLAN industries set forth in this Manual (ibid, Appendix N)

Adjustment of Regional Purchase Coefficients. IMPLAN is a supply-demand pool based input-output modelling system and uses the concept of a regional purchase coefficient specific to each industrial sector to identify inter-regional trade-flows. Comprehensive discussion of the IMPLAN supply-demand pool theory is contained in work done by Kostas A. Despotakis (Engineering-Economics Associates; 1985a, 1985b, 1985d, 1985e). A regional purchase coefficient is defined as representing (IMPLAN Applications and Development Group, 1991; Appendix G, page G-1) "... the proportion of the total supply of a good or service used to fulfill the demands of a region that is supplied by the region to itself."

Errors are evident in the 1985 IMPLAN regional purchase coefficients. Specific RPC errors differ by state database. For instance, the RPC's for retail trade (IMPLAN sectors 462 and 463) and eating and drinking places (IMPLAN sector 491) are zero for Oklahoma. Yet RPC's for IMPLAN sectors 446 through 525 are 1.00 in California, Nevada, North Dakota, and Wisconsin. Given that IMPLAN defines an RPC as stated above, it would appear that zero or one would be unrealistic.

Another problem occurs in applying state-level RPC's to county units in service sectors such as hotels and lodging places (IMPLAN sector 471). Whereas a statewide RPC of 0.8 might appear logical (e.g. most of the hotels and motels operating in a state would be demanded by people from the state itself), a county RPC of 0.8 would seem extraordinarily high (e.g. most of the hotels and motels found in a county are being occupied by people from the same county (?)).

Table IV details the regional purchase coefficients and their adjusted values for specific sectors. The adjustments were made using standard conventions in developing a hybrid model as specified in the user's manual (ibid, pages 4-26 through 4-30).

TABLE IV

MODIFICATIONS MADE TO REGIONAL McCURTAIN COUNTY TRADE FLOWS

IMPLAN Sector	Sector Name	Original RPC	Modified [1] Supply/Gross Demand Pool Ratio	Modified RPC
491	Eating and Drinking Places	.0	.69589	.69589
471	Hotels and Lodging Places	.81763	1.0.	.2
463	Other Retail Trade	.0	.76584	.76584
462	Recreational and Related Retail	.0	.23627	.23627
189	Paperboard Mills [2]	.26543	1.0	.12897
188	Paper Mills, Except Building [2]	.00125	1.0	.00051
187	Pulp Mills [3]	.00018	1.0	1.0
166	Veneer and Plywood [2]	.84623	1.0	.84607
161	Sawmills and Planing Mills [4]	.79086	.0	.79086
160	Logging Camps and Contractors [2]	.798	.82129	.82129
24	Forestry Products [3]	.00018	1.0	.7

1. The net supply/gross demand pool ratio in IMPLAN cannot be exceeded by a regional purchase coefficient. Since a simultaneous hybid model change is made to certain sectors in both gross commodity output and regional trade flow, the original ratio may be violated creating a need to readjust regional purchase coefficients. Those sectors where this applies are denoted by footnote 2.

2. In reallocating components of value-added through gross regional output (see next section on *Adjustment of Timber Production Sector Value-Added*), IMPLAN adjusted supply and demand of these sectors automatically due to linkages imbedded within the system. This, in turn, led to an adjustment to regional purchase coefficient.

3. Both manual readjustment to regional purchase coefficient and internal consistency readjustment were made.

4. Same footnote as 2 except adjustment was not large enough to warrant an adjustment in regional purchase coefficient.

Adjustment of Timber Production Sector Value Added. It appears that values for timber production output (particularly industrial timber production) are often included with non-timber production sectors in which industrial firms are vertically integrated. An example of this is where a forest products firm engaged in the production of paper or plywood relies upon its own forest land for raw material supplies. Employment and output values found in higher levels of vertical integration (manufacturing sectors) typically account for employment and output of lower levels (timber production).

Timber volume estimations for removals were obtained using the reported softwood and hardwood volumes derived through interactive SOFIA (Southern Forest Inventory and Analysis) (USDA Forest Service, 1992b) database usage. This database represents the USDA Forest Service Mid-South United States forest inventory and is maintained in Starkville, MS. The Oklahoma data within SOFIA was collected during 1986. In McCurtain County, Oklahoma, 159 points with 10 plots were measured using standard forest biometry methodologies. These points are distributed throughout the County at corners on a three (3) mile grid. Tree level figures for removals are 10 year annual averages (thus appropriate to assume that 1985 is the same as 1986) and are aggregated to county estimates using standard procedures outlined in the Computer Access to Midsouth Forest Resource Data Manual; USDA Forest Service (1992a). Table V provides aggregate McCurtain County-level volumes for hardwood and softwood removals for 1985.

The timber production sector output was calculated using the standard economic interpretation of value [1], namely the product of price and quantity, using reported prices for Southeastern Oklahoma (Region 1, Oklahoma) found in

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1. This is the standard convention used in national accounting as well as that employed by IMPLAN.

TABLE V

TIMBER REMOVALS [1] FROM McCURTAIN COUNTY
BY OWNERSHIP DURING 1985

Forest Ownership	Removals Volume			
	Softwood		Hardwood	
	Sawtimber[2]	Pulpwood[3]	Sawtimber[2]	Pulpwood[3]
Industrial	103.68	6.840	23.120	3.131
Nonindustrial	2.86	0.596	8.384	0.413
Public	3.50	0.078	0.000	0.000
Total[4]	110.04	7.513	31.504	3.545

1. Obtained through interactive SOFIA database usage based upon USDA Forest Service (1986) Oklahoma inventory. Specific batch file available from author.

2. Sawtimber volume is in million board feet International ¼ Log Rule.

3. Pulpwood volume is in million cubic feet.

4. May not sum to total due to rounding.

Timber-Mart South (Norris, 1985). These average 1985 prices are provided by product in Table VI. It is important to note that differences are specified between industrial timber sales (those sales originating from industrial and nonindustrial private lands) and public timber sales. Lower sales prices for public stumpage are due to the manner in which public timber is sold as well as timber harvesting requirements which tend to be more strict [2]. Table VII combines volume estimates and price with adjustments for appropriate value/volume units to outline the value of timber stumpage for 1985. This is then totaled and taken as industry output for timber production.

The hybrid IMPLAN model used in this study was adjusted to account for timber production sector output. The assumption used here is that annual stumpage value of removals is the most appropriate measure of total industry output. It represents total returns to the landowner. It also includes the intermediate purchased inputs used in growing and managing timber. Value added, for production sectors can be defined as total returns net of intermediate purchased inputs. Total timber production sector industry output was disaggregated using national coefficients for appropriate ratios found in IMPLAN (database ST85-US.ODF and ST85-US.DFD) to identify components of value added.

Following the above-stated assumptions, appropriate values for timber production were shifted from wood processing sector value added to timber production sector value added (total combined value added and total combined industrial output of the wood processing and timber production sectors remaining constant) using standard operating procedures within the interactive capabilities of IMPLAN (IMPLAN Applications and Development Group, 1991;

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2. Personal communication with Frank Norris, Timber-Mart, South, November 9, 1992.

TABLE VI

AVERAGE 1985 TIMBER STUMPAGE PRICES [1]

Type of Sale	Product	1985 Price ($)	Price/Quantity Units
Industrial	Softwood Sawtimber	120.64	Mbf Scribner
	Hardwood Sawtimber	49.80	Mbf Doyle
	Softwood Pulpwood	11.61	Standard Cord
	Hardwood Pulpwood	3.00	Standard Cord
Public	Softwood Sawtimber	82.75	Mbf Scribner
	Hardwood Sawtimber	24.93	Mbf Scribner
	Softwood Pulpwood	8.39	100 cubic feet
	Hardwood Pulpwood	4.95	100 cubic feet

1. From Timber-Mart South (Norris, 1985) for Region 1, Oklahoma. Averages are for monthly reports except November, 1985, which was unavailable.

TABLE VII

TOTAL VALUE OF TIMBER REMOVALS BY OWNERSHIP DURING 1985, McCURTAIN COUNTY, OKLAHOMA

Ownership	Removals Value (1985 $)					
	Softwood		Hardwood			Percentage
	Sawtimber	Pulpwood	Sawtimber	Pulpwood	TOTAL	of TOTAL
Industrial	14,002,352	992,912	1,519,848	117,412	16,632,524	92.39
Non-Industrial	386,813	86,535	551,125	15,505	1,039,978	5.78
Public	323,973	6,557	0	0	330,530	1.84
TOTAL					18,003,031	100.01[1]

1. Does not sum to 100.00 due to rounding.

pages 4-17 through 4-26). Initial non-hybrid data contained in IMPLAN as well as the hybrid adjustments made are outlined in Table VIII

Production Sector Aggregation. Following hybridization of the model, industrial sectors can be aggregated to focus on specific problems. Sectors are typically aggregated based upon study needs and production function similarity. For this study, the aggregation used for industrial sectors is shown in Table IX and applies IMPLAN aggregation techniques following standard convention (as outlined in the user's manual) and corresponding standard industrial classification (SIC) codes. This aggregation is then used for aggregating the hybrid IMPLAN model to determine interindustry transactions, components of value added and components of final demand.

Components of Regional Commodity Demand. Using the aggregation and adjustments described above, the hybrid model was run, social accounts were constructed and aggregated input-output accounts were developed. Aggregated input-output reports were then generated to determine components of commodity supply (Lister Report #403a and #403b) which include regional consumption demand by low, medium, and high income households (household income groups are defined in IMPLAN as annual figures for low ($0 - $14,999), medium ($15,000 - $39,999), and high ($40,000 and above) households in accordance with Bureau of Census convention in 1985). A single regional government consumption demand for each production sector was determined by summing across federal and state/local units. A single regional investment demand was calculated by summing inventory additions and capital formation by production sector. A single rest-of-world trade demand from the region (identified in Figure 4 as commodity exports) was calculated by summing

TABLE VIII

ADJUSTMENTS MADE TO VALUE ADDED COMPONENTS IN IMPLAN HYBRID MODEL

Value-Added Component	Initial Data: Sector 24[1] Forestry Products	Initial Data: Sector 189[1] Paperboard Mills	Hybrid Model Data: Sector 24[1] Forestry Products	Hybrid Model Data: Sector 189[1] Paperboard Mills
Employee Compensation[2]	7,000	22,219,000	1,254,108	18,517,330
Indirect Business Taxes[2]	6,699	787,534	426,073	1,060,551[4]
Proprietary Income[2]	3,384	1,981,762	327,492	20,578[4]
Other Property-Type Income[2]	59,458	9,608,324	6,988,460	7,535,859
Total Value-Added[2]	76,541	34,596,620	8,996,133	27,134,310
Total Employment[3]	4	483	159	444
Total Industry Output[2]	198,585	94,333,210	18,003,030	76,528,760

1. Industrial Sectors as identified in IMPLAN, Appendix N.
2. Values provided in 1985 dollars.
3. Values provided in full-time equivalents (FTE's).
4. Discrepencies with initial data are due to the use of U.S. national coefficients in the hybrid model. An error in the initial IMPLAN database was discovered for Proprietary Income in Sector 189. The national value for total paperboard sector proprietary income was $2,667,507. The calculated national ratio of proprietary income to total value added in this sector was .0007584. When this ratio is applied to the paperboard sector value added in McCurtain County, the result is what is found in the above table. The initial data had proprietary income of $1,981,762 for this sector. This is unlikely since it accounts for almost three-fourths (74.3%) of total U.S. proprietary income for the paperboard sector and the income to Weyerhaeuser, the primary paperboard mill industry operating in McCurtain County, is not classified as proprietary income. The hybrid model adjustments used national ratios for components of value added.

TABLE IX

AGGREGATION TEMPLATE USED FOR PRODUCTION SECTORS

Aggegated Sector Name	IMPLAN Industry Number[1]
Agricultural Production	1,2,3,4,5,7,8,9,11, 12,13,16,18,21,27
Timber Production and Services	24,26
Manufacturing	41,42,45,48,66,67,68,69,70, 71,72,73,74,75,200,205,240, 268,269,285,313
Food/Fiber Processing	84,116,151
Timber and Wood Processing	160,161,166,169,172,189
Services and Government	446,448,449,452,545,456,457,458, 461,462,463,464,465,466,468,469,470, 471,472,473,474,475,477,478,479,482, 484,485,486,488,489,490,491,492,493, 495,501,502,503,505,506,510,511,512, 513,514,515,516,518,521,525,527

1. 100 industrial sectors were active in McCurtain County, Oklahoma during 1985. Cross reference of these IMPLAN sectors with Standard Industrial Classification (SIC) code can be obtained in IMPLAN Applications and Development Group (1992; Appendix N).

domestic and foreign exports by production sector. Total regional commodity demand is calculated as the row sum of interindustry sector transactions, personal consumption demand, government consumption demand, investment demand, and commodity exports.

Components of Regional Commodity Supply. Aggregated input-output reports were also generated to identify components of commodity supply. Final payments to factors of production (Lister Report #404a) include components of value added (categorized by employee compensation, proprietary income, other property income, and indirect business taxes). Discussion of factor shares used to allocate returns to land, labor, and capital are discussed in the following section. Indirect business taxes were extracted from value added and placed in the government row of figure 4. Final payments to trade were identified (Lister Report #404b) and include the sum of foreign and domestic competitive and non-competitive imports by production sector. Total regional commodity supply is the sum of interindustry column totals, returns to factors of production, indirect business taxes, and imports of inputs used by regional production sectors.

Establishing Factor Shares

Referring to figure 4, other components of the regional social accounting matrix include two primary matrices referred to as the institutional income distribution matrix and the household income distribution matrix and numerous secondary matrices. Prior to constructing these matrices, however, further discussion is required in the adjustments made to factor income totals derived from IMPLAN.

Factor Income Distribution. IMPLAN classifies value added following the standard national income accounting framework. This limits the applicability of results and does not allow succinct identification of factor inputs. IMPLAN classifies value added into four primary components. These components include (1) employee compensation, (2) proprietary income, (3) other property income, and (4) indirect business taxes. These, in aggregate, total what is commonly referred to as returns to factor inputs plus indirect business taxes; in other words, total industry output net of intermediate purchased inputs with imports.

This classification, however, departs from convention in that it is very difficult to distinguish returns to the more appropriately identified factor inputs of land, labor and capital. For example, the IMPLAN category employee compensation uses County Business Patterns and other data sources to identify wages paid to individuals. This category does not include returns to entrepreneurial (or self-employed) labor. Entrepreneurial labor is captured in the IMPLAN category of proprietary income. Information from other studies and databases can be used to supplement IMPLAN data which allows a classification of factor income to the categories of land, labor, and capital.

Timber Production Factor Shares. Timber production factor share analysis was done using a proportion of bare land value as land rent, returns to labor calculated using USDL wage data and employment data, and a proportion of residual growing stock liquidation value as a proxy for capital rent. Appendix B outlines the procedural technique used in determining timber production factor shares for land, labor and capital. For the analysis, the factor shares used are 0.419419 for land, 0.341019 for labor, and 0.239562 for capital (see Appendix B).

Factor Shares for Other Industries. Agricultural factor input returns were treated separately and use the factor shares listed for *Other Crops* in Robinson, Kilkenny, and Hanson (1991). These are 0.427 for land, 0.323 for labor, and 0.251 for capital.

Returns to factors of production for manufacturing, food/fiber processing, timber and wood processing, and services and government were adapted from the original IMPLAN value added categories. Initially, labor returns were calculated following the procedure outlined in Koh (1991; pages 84-87). Namely, *employee compensation* and *proprietary income* were added together to form labor returns. *Other property income* was used as a proxy for returns to capital. A fairly clear distinction can be implied which justifies *employee compensation* as labor returns and *other property income* as capital returns. *Proprietary income*, however, is not quite so easily distinguishable.

Koh's procedure was not followed for two reasons. First, his method would appear to overestimate returns to labor and underestimate returns to capital since *proprietary income* is defined as income from self-employment including some proportion to labor and some proportion to capital. Koh (ibid, page 87), however, dealt with the state of Oklahoma data and noted that *proprietary income* accounted for less than 5 percent of total value added. In McCurtain County, *proprietary income* of these sectors accounts for 11.1 percent of total value added and 21.1 percent of total *employee compensation*. More importantly, *proprietary income* of these sectors is 41.7 percent of total *other property income*. Clearly, allocating all *proprietary income* to labor would overestimate labor returns and underestimate capital returns.

The proportion of *proprietary income* accruing to labor and capital was derived in balancing the household income distribution matrix control totals which are based upon firm data from the Personal Income by Major Source

(USDC, Bureau of Economic Analysis, 1992) for McCurtain County, Oklahoma during 1985. For this analysis, 6.4 percent of *proprietary income* accrued to labor and 93.6 percent of *proprietary income* accrued to capital for all sectors except agriculture and timber production.

Using the above-stated procedures, returns to factors of production for each production sector were calculated based upon value added control totals net of indirect business taxes generated from IMPLAN.

Disaggregating Labor Returns. Labor was further disaggregated to assess impacts accruing to various labor skill levels. This is important between production sectors such as timber production and wood processing where differences exist in the amount of technological substitution for labor inputs occurs. Disaggregation of labor into skill categories has been done by sector for the United States by Rose, Stevens, and Davis (1985).

Table X outlines the labor categories used and specific occupations included within each category. Table XI identifies the proportions which apply to each respective category. These proportions represent appropriately weighted aggregate calculations from the initial 41 sector data provided in Rose, Stevens and Davis (ibid; Table 5.1). Minor discrepancies due to rounding were accounted for during calculation to provide consistency with the original total labor return [3].

An obvious improvement over this data set would be data specific to conditions at the subnational, or regional, level. Also, data which focuses solely

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3. This was accomplished by increasing or decreasing the labor return which included a statistical discrepancy until the original total labor return was reached. In effect, this proportionally distributed the statistical discrepancy throughout labor categories. The largest statistical discrepancy was .002 percent of total.

TABLE X

LABOR CATEGORIES AND RESPECTIVE OCCUPATIONS[1]

Labor Category	Occupations
a. Management/Professional	PUBLIC ADMINISTRATORS AND OFFICIALS OTHER ADMINISTRATORS AND OFFICIALS ARCHITECTS ENGINEERS SURVEYORS AND MAPPING SCIENTISTS OTHER SCIENTISTS AND MATHEMATICIANS DOCTORS AND OTHER DIAGNOSTICIANS OTHER HEALTH, INCLUDING NURSES ELEMENTARY AND SECONDARY TEACHERS OTHER EDUCATION RELATED SOCIAL SCIENTISTS AND URBAN PLANNERS SOCIAL, RECREATION AND RELIGIOUS LAWYERS AND JUDGES ARTISTS, ENTERTAINERS, AND ATHLETES
b. Technical/Sales/Administrative Support	HEALTH TECHNOLOGISTS AND TECHNICIANS LICENSED PRACTICAL NURSES OTHER TECHNOLOGISTS AND TECHNICIANS SUPERVISORS AND SALES. SELF-EMPLOYED SUPERVISORS AND SALES, SALARIED SALES, FINANCE, AND BUSINESS SERVICES, SALES REPRESENTATIVES, OTHER SALES, RETAIL AND PERSONAL CASHIERS SALES RELATED SUPERVISORS AND ADMIN. SUPPORT, COMPUTER EQUIPMENT OPERATORS SECRETARIAL RELATED ACCOUNTANTS AND AUDITORS OTHER FINANCIAL RECORDS PROCESSING MAIL AND MESSAGE DISTRIBUTING, SHIPPING, RECEIVING, AND OTHER CLERKS OTHER ADMINISTRATIVE SUPPORT
c. Service	PRIVATE HOUSEHOLD GUARDS OTHER PROTECTIVE SERVICES FOOD PREPARATION AND SERVICE NURSING AND OTHER HEALTH ASSISTANTS CLEANING AND BUILDING SERVICES PERSONAL SERVICES
d. Farm/Forestry/Fishing	FARMING, FORESTRY, AND FISHING
e. Production/Crafts/Repair	AUTO MECHANICS AND REPAIRERS OTHER MECHANICS AND REPAIRERS CARPENTERS OTHER CONSTRUCTION TRADES EXTRACTIVE OCCUPATIONS SUPERVISORS AND PRODUCTION PLANT AND SYSTEM OPERATORS MACHINE OPERATORS FABRICATORS AND ASSEMBLERS PRODUCTION INSPECTORS AND RELATED MOTOR VEHICLE OPERATORS OTHER TRANSPORTATION OPERATORS MATERIAL MOVING EQUIPMENT OPERATORS CRAFT AND PRODUCTION CONSTRUCTION LABOR FREIGHT AND MATERIAL HANDLERS OTHER HANDLERS AND MISCELLANEOUS

1. From Rose, Stevens, and Davis (1985; Table 5.1, pages 50-54).

TABLE XI

LABOR CATEGORIES AND RESPECTIVE PROPORTION OF TOTAL EMPLOYMENT BY PRODUCTION SECTOR OR INSTITUTION, 1985[1]

Labor Category	PRODUCTION SECTOR OR INSTITUTION					
	Agriculture Forestry Fisheries	Manufacturing	Food Processing	Wood Processing	Services Government	Non-Forestry Non-Agriculture
a.	.188156	.236158	.171227	.165075	.376109	.331623
b.	.075389	.158823	.154357	.137995	.338824	.283715
c.	.018219	.009773	.021052	.013500	.115853	.083747
d.	.631668	.000261	.000388	.016146	.001948	.001436
e.	.086568	.594985	.652978	.667280	.167266	.299479
TOTAL	1.000000	1.000000	1.000002	.999997	1.000000	1.000000

1. From Rose, Stevens, and Davis (1985; Table 5.1, pages 50-54).

on the skill levels of labor inputs to the production of timber are non-existent; efforts in this regard would also provide an improvement over this analysis.

Control Total For Factor Income. Row totals for factor incomes are simply the row sums of labor, capital and land return among the production sectors used in this study.

Institutions

The ability of this analysis to focus on distributional impacts of timber production on regional income is directly attributable to the manner in which the economic structure is reaggregated into institutions. Institutions in this social accounting matrix are categorized into forestry complex activities and non-forestry complex activities. Forestry complex activities are disaggregated into four categories. These include timber production activities corresponding to landownerships of (1) nonindustrial private forest (NIPF) landowners, (2) industrial private forest (IPF) landowners, and (3) public forest landowners and a single non-timber management forestry activity category of (4) timber and wood processing which includes logging, log transport, primary wood-based manufacturing, and secondary wood-based manufacturing. Non-forestry complex activities are disaggregated into two categories including (1) agricultural production and (2) non-agricultural/non-forestry activities (including all other manufacturing, service, and government activities). This disaggregation must, in a similar fashion to the value added matrix, fully account for all economic activities within the region net of the above mentioned taxes.

Institutional Income Distribution. The institutional income distribution matrix maps factor expenditures for firm-level production activities to institutions. In many respects, this matrix is similar to the matrix of value added. The exception is that it is net of both indirect business taxes as well as factor taxes such as social security payments.

Institutional Factor Shares. The same hybrid IMPLAN model (MCCURT1) is used to arrive at a control total for each new institutional sector. Total returns to factors of production are allocated to land, labor, and capital following the same procedures as discussed above with the exception that factor shares are now identified for institutions instead of production sectors. Factor shares for timber production forestry complex institutions are determined based upon the extent of ownership within McCurtain County as identified in SOFIA (for discussion of this, refer to previous section on *Adjustment of Timber Production Sector Value Added* and Appendix B).

Factor share analysis for these timber production forestry complex institutions can be thought of as implying a representative timber production enterprise budget of current timber management intensities apparent in 1985. Generalizations regarding these timber management enterprise budgets can be made from the SOFIA inventory data. Industrial private forest (IPF) timber production is typified by short (30 years) rotation even-aged loblolly pine management with at least one intermediate commercial thinning. Active timber management is evident in the SOFIA database for IPF lands. Nonindustrial private forest (NIPF) management is typified by a less intensive management regime which includes a combination of even and uneven-aged management of both hardwoods and softwoods. Little active timber management is evident in the SOFIA database for NIPF lands. Public timber management occurs in a mixture of intensities with emphasis on multiple-use concepts incorporating other resources such as recreation, water and wildlife management. Fundamentally, in McCurtain County, Oklahoma, economic efficiency criteria appear to be nonexistent in the manner in which public timber enterprises are undertaken (for further discussion of factor share analysis of public timber production, see Appendix B).

Annual institutional income from timber production is thus broken into income resulting from respective use of each factor input. With reference to Appendix B, factor shares for nonindustrial private forest landowners are 0.407256 for land, 0.29033 for labor, and 0.302414 for capital. Factor shares for industrial private forest landowners are 0.493549 for land, 0.326761 for labor, and 0.179691 for capital. Factor shares for public forest landowners are -0.20983 for land, 1.217988 for labor, and -0.00816 for capital. These can be rationalized through assessment of land, labor, and growing stock (used as a proxy for capital) ownerships. This assessment can be found in Appendix B.

Factor Taxes. The structure of this social accounting matrix views a portion of the income from factor inputs as accruing to government sectors as direct taxes. Taxes could be removed either in the factor account or in the institution account. Removing taxes from the factor account allows the identification of net returns to factors of production. This account includes social security payments, taxes specific to capital returns, and land taxes. It excludes indirect taxes which are found elsewhere in the social accounting matrix. This convention also agrees with reporting procedures and use of personal income data from the BEA (USDC Bureau of Economic Analysis, 1992) which excludes personal contributions for social security from personal income.

Data for personal contributions for social security specific to McCurtain County in 1985 are obtained from BEA, REIS Personal Income by Major Source data files (ibid). In this data file, personal contributions are 6.3 percent of total earnings by place of work. Under the assumption that employer contributions match personal contributions, a rate of 12.6 percent is applied to total returns to labor found in the institutional income matrix. The procedure used in deriving this rate is the same as the procedure used by Koh (1991; pages 89-91) and also matches closely with the 14.1 percent social security tax rate used in the national USDA ERS study done by Robinson, Kilkenny, and Hanson (1991; page 67).

A tax rate specific to factor returns to capital in Oklahoma was calculated based upon the Koh (1991) study and is 14.25 percent. This rate, taken as a proportion of factor capital tax to total institutional capital column plus factor capital taxes, is calculated from his SAM (ibid; page 104). This also compares favorably to the USDA ERS summed enterprise tax rate and enterprise savings rate of 13.3 percent (Robinson, Kilkenny, and Hanson, 1991; page 67)

All land was taxed at a rate of 15.98 percent in the Koh (1991) study. This would appear to be a high estimate and exact procedures used to derive this rate were unclear. The citation used by Koh (ibid; page 91) to derive a tax rate for land was specific to agricultural real estate in agricultural production. Agricultural production land is typically taxed at a higher rate than the classification of forest land, which comprises the bulk of land taxes in McCurtain County. In McCurtain County, forest land is taxed at the *Agricultural Land: Wasteland and Forestland* category rate. For this analysis, forest land is taxed at a rate of 10 percent [4] regardless of institutional forest ownership.

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4. A specific published tax rate for this land category was not directly available. Information obtained through personal communication with the McCurtain County Tax Assessor's office provided 10 percent as an appropriate rate. The McCurtain County Tax Assessor's office telephone number is (405) 286-5272.

Factor tax rates were used to subtract factor taxes from appropriate factor returns. These net factor returns were then inserted into the SAM in the institutional income distribution matrix. Factor taxes were then placed in the government account. Rounding error is accounted for in the government account thereby leading to slight discrepancies with the above identified tax rates.

Transfers to Institutions. Transfers to institutions are important in nonindustrial private forest timber production as well as agricultural production. County level data on federal forestry cost-share programs, agricultural price supports, and other government programs is contained in USDA documents. The Forestry Incentives Program (FIP) injected a total amount earned of $35,230 to nonindustrial private landowners in McCurtain County during 1985 (Oklahoma Department of Agriculture, Forestry Services, 1992) according to the FIP Progress Report. Total ACP and Projected Price Support Payments in McCurtain County during 1985 was $1,574,322 (USDA ASCS, 1987) according to the ASCS Enrollment Report. These are the values found in the Institutional Transfer account. It is an interesting note that whereas timber production is the dominant land use in McCurtain County, federal and state assistance to forest landowners is relatively insignificant (roughly 2 percent of total institutional transfer payments) compared to assistance given to agricultural landowners.

Control Total for Institutional Income. Institutional income is simply the row sum of net payments from factors of production and institutional transfers from government. This institutional income is then used as a control total for institutional expenditures found at the bottom of the institutional column in the SAM.

Households

The household income distribution matrix maps household income which originates from each institution during the base year (1985). Households are classified as low (annual incomes less than $15,000), medium ($15,000 to $40,000), and high (greater than $40,000). This classification follows national standards for low, medium and high income households during 1985. Income is derived from economic activity aggregated by institutional grouping (i.e.: nonindustrial private forest production, industrial private forest production, public forest production, wood processing, agriculture, non-ag/non-forestry). It should be noted that household income levels in the social accounting matrix are net of FICA payments (FICA payments are accounted for as a factor tax).

Aggregate Income by Income Class. This analysis uses the BEA REIS data on Personal Income by Source for McCurtain County during 1985 (USDC, Bureau of Economic Analysis, 1992) as the control total from which the household income distribution must balance. It assumes that this data source is correct and satisfies those who would argue that its value, when summed with respective values of other counties, adds up to a State total for personal income. Evidence from other sources, however, tend to indicate that these values could, indeed, be underestimations of actual personal incomes for one reason or another. Also, taking state totals for personal income as true does not preclude the possibility that individual counties could be in error. This argument aside, household income is held to the control total for McCurtain County throughout the analysis.

Total personal income reported by the BEA is $281,350,000 for McCurtain County in 1985 (USDA, Bureau of Economic Analysis, 1992). The distribution of this income by household income size is accomplished through use of Summary Tape File Number 3 from the 1990 Census (USDC, Bureau of the Census, 1991) with distribution data specific to McCurtain County. The assumption used here is that the distribution of income in McCurtain County is the same (when adjusted for inflation using the consumer price index) in 1989 as it was in 1985. Table XII outlines the calculations used to determine the income distribution of total personal income for McCurtain County in 1985. First, the 1989 household income ranges were deflated to 1985 household income ranges using the consumer price index (CPI) (Consumer Price Index, 1992). Numbers of households identified in the Summary Tape File (ibid) were then applied to these deflated household income ranges.

Discrete cumulative densities were derived from this data based upon the upper bounds of the ranges. The discrete cumulative densities for $0 to $14,999 (low income households), $15,000 to $39,999 (medium income households), and $40,000 and above (high income households) were then linearly interpolated between the adjusted ranges. By necessity, the upper bound for high income households was arbitrarily set at $200,000. Initially, a midpoint between bounds on ranges was used to calculate total income bills by income groupings. Application of this midpoint to the number of households within each income range did not sum to the control total. The actual point between range bounds was calculated by holding the total personal income constant at $281,350,000. This calculated actual point between range bounds was 0.983 of upper bound on each respective range. Using this actual point, a total income bill by each household income range was calculated which matched with the number of households in each group and the total personal income reported by the BEA (USDC, Bureau of Economic Analysis, 1992). These are the values found in the control totals for total household income.

TABLE XII

INCOME DISTRIBUTION FOR MCCURTAIN COUNTY, 1985

					Income Bill by 1985 Range		Accumulated Income Bill by Low (0-15000), Medium (15000-40000) and High (40000 and above)		
1989 Range[1]	1985 Range[2]	Number of Households[3]	Midpoint of Range	Percentage of Households by 1985 Range	Upper Bound[4]	Midpoint	Midpoint[5]	Upper[4]	.983 Upper Bound
5000	4339	1709	2169	0.139135	7414581	3707291			
10000	8677	2388	6508	0.194415	20720913	15540685			
15000	13016	1573	10846	0.128063	20473616	17061346			
	15000	594.361	14008	0.048389	8915413	8325703	44635025	57524523	56,550,692
25000	21693	2004.639	18346	0.163204	43486131	36777859			
35000	30370	1645	26031	0.133925	49958399	42821485			
	40000	975.915	35185	0.079453	39036612	34337506	1.14E+08	1.32E+08	130,238,400
50000	43386	343.085	41693	0.027932	14884900	14304144			
75000	65078	768	54232	0.062525	49980092	41650077			
100000	86771	162	75925	0.013189	14056901	12299788			
150000	130157	82	108464	0.006676	10672832	8894027			
200000	173542	38	151849	0.003094	6594595	5770271	82918307	96189320	94,560,934
TOTAL		12283		1	2.86E+08	2.22E+08			

BEA Reported Income: 281.35 million $
Adjustment Applied to Upper Bound: 0.983071
Adjusted Total: 281.35 million $

1. Value is upper bound of range
2. Upper bound adjusted by CPI (.89770993 1989 range = 1985 range)
3. Number of households listed in Summary Tape File No. 3 1990 CPH-L-81, Table 3 (USDC, Bureau of Census, 1991)
4. Number of households multiplied by upper bound 1985 range
5. Number of households multiplied by midpoint 1985 ranges

Unearned Household Income. Total household income includes earned income from institutions, unearned income from dividends and interest, and transfer payments from government. The BEA reports unearned income (dividends, interest and capital consumption adjustment for rental income for persons) for McCurtain County in 1985 as $34,414,000 (ibid). This value does not include transfer income.

This value is used as a control total for unearned income and is distributed among household income groups using data from Rose, Stevens, and Davis (1985; Table 6.5, page 66). Table XIII identifies the calculations used to distribute unearned income among household income groups. The assumption used here is that the distribution of dividends among household income groups in McCurtain County during 1985 does not differ from that of the U.S. in 1982 (adjusted for inflation using the CPI). Calculations follow procedures outlined above except that income ranges must be inflated using the consumer price index from 1982 to 1985. Proportions attributable to each respective range are used to distribute total unearned income. These values can be found in the unearned household income account in the SAM.

Household Transfer Income. Transfer payments are identified by the BEA for McCurtain County during 1985 in their data on Transfer Payments by Type (USDC, Bureau of Economic Analysis, 1992) as $76,520,000. These payments include retirement, disability and health insurance benefit payments, medical payments, income maintenance benefit payments, and unemployment insurance payments. Only payments made to individuals (not transfer payments made to non-profit institutions or businesses) are used in identifying components of household income. Total government payments to individuals in McCurtain County during 1985 is reported to be $72,365,000 (ibid).

TABLE XIII

U.S. DIVIDEND COEFFICIENTS AND MCCURTAIN COUNTY DISTRIBUTION [1]

1982 Range[2]	1985 Range[3]	Distribution[4]	Accumulated Distribution[5]	Distributed Amount[6]
5000	5574			
10000	11147			
	15000	0.091506	0.091506	3.149083
15000	16721	0.031494		
20000	22295	0.052		
25000	27868	0.049		
35000	39015	0.103		
	40000	0.007891	0.243385	8.375843
50000	55736	0.126109		
75000	83604			
100000	111473	0.21		
200000	222945	0.329	0.665109	22.88907
		TOTAL 1	1	$34.414

1. From Rose, Stevens, and Davis (1985; Table 6.5, page 66)
2. Upper bound
3. Upper bound adjusted for CPI (1.114725389 1982 Range = 1985 Range)
4. Arbitrarily sets lower bound at $10,000
5. Accumulated to low, medium, and high household income ranges
6. In million 1985 dollars distributing a known total of $34.414 million

These transfer payments to individuals are then distributed among household income groups using data found in Peterson (1991; Table 2-6, page 46) for the nation as a whole. The assumption used here is that transfer payments in McCurtain County during 1985 are distributed among household income groups in a manner which does not differ from the national average in 1983 (after adjustments are made for inflation using the CPI). Table XIV details the computations made to distribute transfer income to household income groups in McCurtain County. It should be noted that this analysis, following Peterson (ibid), differentiates between social security payments, which are not *means dependent*, being distributed in a different fashion than public assistance payments, which are *means dependent*. This is evidenced by the respective distributions in Table XIV. The distribution of transfer payments by household income group is then inserted into the SAM in the transfer payment account.

Row Totals: Household Income Distribution. Once transfer payments to individuals and unearned income are accounted for from total household income by income group, a value which is attributable as earned household income from institutions is calculated. This value matches with the BEA data (USDC, Bureau of Economic Analysis, 1992) accounting for both farm and nonfarm earnings by place of residence. Thus, a row control total is identified for the household income distribution matrix and is used to identify, in sum, the column total.

Institutional Savings. Depreciation on capital assets are accounted for in the institutional savings account. Koh (1991) refers to the USDA ERS rate of 38.5 percent for use in his SAM. This is the rate applied in this study. It is applied only to those industries with large capital investments in equipment. Specifically, this rate is applied to wood processing, industrial timber production, and non-

TABLE XIV

DISTRIBUTION OF TRANSFER PAYMENTS TO McCURTAIN COUNTY (1985)

Socioeconomic Class	Upper bound of 1983 Income Rng.[1]	Upper bound of 1985 Income Rng.[1]	Social Security			Public Assistance		
			% of Payments[2]	Payments distributed[3]	Accum. payments[3]	% of payments[2]	Payments distributed[3]	Accum. payments[3]
Poor	10000	10800.3	0.158	6.251744		0.688	22.56434	
Near Poor	12500	13500.38	0.109	4.312912		0.09	2.95173	
		15000	0.039275	1.554024	12.11868	0.008569	0.281039	25.7971
Working class	30000	32400.9	0.455725	18.03214		0.0999431	3.261037	
		40000	0.060158	2.380325	20.41246	0.017825	0.584592	3.845629
Middle class	50000	54001.51	0.110842	4.385803			0	
Upper mid class	75000	81002.26	0.051	2.017968		0.096175	3.154266	
Affluent	200000	216006	0.016	0.633088	7.036859	______	0	3.154266
TOTAL			1	39.568	39.568	1	32.797	32.797

Total Social Security and Public Assistance:

Income Range:	MM$
below $15,000	37.91578
$15,000-$40,000	24.25809
$40,000 and above	10.19113

1. Originally in 1983 dollars. Converted to 1985 dollars uning the CPI. (1.08003 1983 range = 1985 range).
2. From Peterson (1992; Table 2-6, page 46).
3. In Million 1985 dollars.

forestry/non-agricultural institution. Due to the nonintensive nature of management and the manner in which capital returns were dealt with in nonindustrial and public timber production, this is justifiable. A problem existed with the agricultural institution in that application of this rate would have allocated a large amount of capital inflow into the region from the rest-of-world when, in reality, most of the agricultural producers operating in McCurtain County appear to reside within the county. Therefore, rest-of-world transfers from this institution should be zero, if not close to zero. Depreciation was calculated as a residual for agriculture based upon specifying rest-of-world institutional transfer to zero.

Institutional Rest-of-World Transfers. Factor payment outflows are made to owners of land, labor, and capital who reside outside of McCurtain County. This is significant for returns to capital and absentee owners of land. Statistics on absentee nonindustrial private forest landowners is contained in Donovan (1987). In this study, 22.8 percent of landowners in McCurtain County were absentee landowners. There is very little evidence from other sectors to indicate the actual extent of rest-of-world flows. Industrial private and public timber production could be assumed to fully integrate labor returns into the McCurtain County labor returns. Capital and land factor returns could be treated the same as if industrial private and public forest landowners were absentee landowners. All returns to capital and land within the IPF and public timber production institutions could be allocated as transfers to the rest-of-world. As an alternative to guessing at these amounts, values for rest-of-world transfers were simply calculated as residuals after other elements in the column were specified except for agricultural production which was specified (see discussion above) to have no rest-of-world institutional transfers. The result of this can be found in the institutional rest-of-world account in the SAM.

To reiterate, statistics which identify these flows for McCurtain County for 1985 are not available. Further efforts to substantiate these flow would improve the estimates.

Column Totals: Household Income Distribution. Accounting for rest-of-world institutional transfers and holding institutional expenditures to institutional income results in balancing the household income distribution column totals with the household income distribution row totals. Logically, these must balance with net household income equalling net household expenditures.

Problems were encountered at this step in that the column total (fundamentally determined using IMPLAN return to factor inputs) was larger than the row total (determined using independent data from the BEA). This discrepancy is the result of using IMPLAN to generate returns to factor inputs and comparing IMPLAN results with independent published data from various sources. Recall that household income is based upon firm data from the BEA Personal Income by Major Source and is specific to McCurtain County during 1985 (USDC, Bureau of Economic Analysis, 1992). Since these County incomes aggregate to State totals for personal income, this analysis assumes that they are correct. In fact, they appear to be conservative estimates when compared to other data sources. IMPLAN, on the other hand calculates returns to factors of production using regional and national coefficients, which could also lead to results which agree with the discrepancy found here. Namely IMPLAN appears to overestimate returns to factors of production in McCurtain County during 1985. This discussion aside, the values obtained from the BEA for personal income by major source are used; control totals are held to these values.

Household Income Distribution. This matrix is derived through the use of the Total Income Distribution Matrix for the United States found in Rose, Stevens and Davis (1985; Table 7.6, page 77). It assumes that the distribution of income in McCurtain County derived from total institutional category income during 1985 does not differ from the distribution of income derived from total institutional category income of the United States during 1982 after adjusting for inflation using the consumer price index and constraining net household income totals by income group to published Department of Commerce data for McCurtain County, Oklahoma [5].

Initial use of the Total Income Distribution matrix, found in Table XV, using the control totals [6] resulted in a complete distribution which did not agree with the row totals by income group. The row control totals for low, medium, and high income households are $15,485,830, $97,604,470, and $61,480,730 respectively. Using the above coefficients for low, medium, and high income households resulted in $25,132,010, $83,874,830, and $65,564,200 respectively. Discrepancies were proportionally allocated throughout the household income distribution matrix to ensure that row control totals matched. The result of this procedure can be found in the household income distribution matrix in the SAM.

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5. This is the same database used to distribute total household income found in the U.S. Department of Commerce's Summary Tape File 3, STF 3A, 1990 CPH-L-81, Table 3, McCurtain County, Oklahoma (USDC, Bureau of the Census, 1991).
6. Control totals were derived by proportionally allocating the $15,747,001 discrepancy between row total ($174,571,000) and column total ($190,318,001) to the institutional savings account.

TABLE XV

TOTAL INCOME DISTRIBUTION COEFFICIENTS[1]

Household Income Range (in 1985$)	Institution			
	Timber[2] Production	Agricultural[3] Production	Wood[4] Processing	Non Agric/[5] Non Forestry
Less than 15,000	.043165	.042683	.195469	.151496
15,000-40,000	.628199	.628355	.500102	.443579
more than 40,000	.328636	.328962	.304428	.404925

1. Adapted from Rose, Stevens, and Davis (1985; Table 7.6, page 77) by aggregating sectors, weighting by total sector group income, adjusting 1982 income ranges to 1985 income ranges (using the appropriate CPI), linearly interpolating and accumulating to above listed low, medium, and high income ranges.

2. Includes forestry products and agricultural services.

3. Includes livestock products and other agricultural products.

4. Includes lumber and wood products, wood containers, household furniture, other furniture, paper and allied products, and paper containers and boxes.

5. Includes all other sectors.

Government, Financial Markets, and the Rest-of-World

Household Taxes. Household taxes are calculated as a constant ratio of average income tax by household grouping. These taxes include personal income tax on a household basis. This study uses the published household tax rate published in the USDA ERS study by Robinson, Kilkenny, and Hanson (1991; page 67) of 12.6 percent. This rate is applied to the earned household income by income grouping found as row totals of the household income distribution matrix. Income derived from interest and dividends is taxed at a different rate than earned income. Robinson, Kilkenny, and Hanson (1985; page 67) use a 35 percent tax rate for capital in the USDA-ERS CGE model. This rate is applied to unearned income to derive the unearned income tax by household. Earned income tax is added to unearned income tax by household income group to derive the total household tax found in the SAM.

Household Savings. The household savings matrix includes an account for low, medium, and high income levels. A determination of marginal propensities to save at various income levels is taken from the Robinson, Kilkenny, and Hanson work (ibid; page 67). This marginal propensity is 6.2 percent of earned income and 17.4 percent of unearned household income (capital earnings). These rates are applied to the distributions of household earned income from institution and distributions of household unearned income which ensures consistency regarding total income by income groupings.

Government Expenditure. Government expenditures are comprised of government demand for domestically produced commodities, transfers to institutions, transfers to households, and government demand for commodities produced by the rest-of-world. Firm data on government demand for domestically produced commodities (IMPLAN), transfers to institutions (USDA-ASCS, 1987 and Oklahoma Department of Agriculture - Forestry Services, 1992), transfers to households (USDC-BEA, 1992), and government demand for commodity imports (IMPLAN) provides the total government expenditure for McCurtain County during 1985 as $151,358,000.

Government Revenue. Total government revenue is made up of indirect business taxes, factor taxes, household earned income tax, and household unearned income tax receipts. In McCurtain County, total government revenue generated within the region during 1985 was $92,095,400. There exists a discrepancy between government revenue and government expenditures for McCurtain County during 1985.

Rest-of-World Government Transfer. The social accounting matrix is set-up to reflect the ability of a regional government account to be in surplus or deficit. Savings can be positive or negative accordingly. Realize that the government account is aggregated to include federal, state, and local/county government. This account acknowledges inflow or outflow of funds to government units. Government rest-of-world transfers of $59,262,600 are required for government expenditures to equal government revenues.

Financial Markets: Capital Flows. This account represents annual net capital flow to the region. A data source for this flow at the county level is non-existent. This flow, however, can be inferred from the social accounting matrix (an elegant example of social accounting matrix usefulness). Capital expenditures include investment demand from within the region (identified in

IMPLAN) as well as a rest-of-world flow (data unavailable). Total savings and debt service within the region, however, includes institutional depreciation, and household savings of both earned and unearned income. Total savings within McCurtain County during 1985 has been identified (see discussions of components above) to be $75,701,800. The double counting elegancy of the social accounting matrix would therefore indicate that total investment must equal total savings. Therefore, solving for rest-of-world flows results in a net financial resource outflow of $36,535,700.

Balance Within the Social Accounting Matrix

The social accounting matrix balances. This means that factor expenditure equals factor income, institutional expenditure equals institutional income, household expenditure equals household income, government expenditure equals government revenue, total investment equals total savings, and total financial inflow equals total financial outflow. This allows the social accounting matrix to be contained within a finite boundary and be completely specified. Given control totals, all respective components can thus provide internal consistency. Following the above recipe for constructing a social accounting matrix, balance does occur.

The Social Accounting Matrix for McCurtain County, Oklahoma

Table XVI presents the McCurtain County social accounting matrix for the base year 1985.

Table XVI.

Social Accounting Matrix for McCurtain County, Oklahoma (in thousands of 1985 dollars)

	PRODUCTION SECTORS 1	2.	3.	4.	5.	6.	FACTOR ACCOUNTS 1a	1b.	1c.	1d.	1e.	2	3
PRODUCTION SECTORS	(interindustry transactions)												
1. Agricultural Prod	12227	2240	238	30965	264	361							
2. Timber Prod and Serv	228	547	0	47	7502	0							
3. Manufacturing	282	698	243	331	897	5531							
4. Food/fiber process	3	13	4	2877	16	159							
5. Wood processing	19	1	1009	157	31660	78							
6. Services and gov't	7161	692	5098	3412	12630	20681							
FACTOR ACCOUNTS	(matrix of value added)												
1. Labor (total)													
a. Mgmt/Professional	1532	559	3410	3167	6412	39649							
b. Tech/Sales/Admin Supp	614	224	2294	2855	5360	35719							
c. Service	148	54	141	389	524	12213							
d. Farm/Forest/Fish	5143	1878	4	7	627	205							
e. Prod/Crafts/Repair	705	257	8592	12078	25918	17633							
2. Capital	6347	2088	12399	5622	16153	82156							
3. Land	10797	3656											
INSTITUTIONS							(institutional income distribution)						
a. Forestry Complex													
1. NIPF							24	10	2	81	11	131	185
2. IPF							433	173	42	1453	199	1241	3578
3. Public							32	13	3	108	15	-18	-13
4. Wood processing							5604	4685	458	548	22652	13851	
b. Non-Forestry Complex													
1. Agriculture							1339	536	130	4495	616	5442	9071
2. Non-Agriculture							40101	34308	10127	174	36214	85901	
HOUSEHOLDS													
1. Low (<15,000)													
2. Medium (15-40)													
3. High (>40,000)													
GOVERNMENT	(indirect business taxes)						(factor taxes)						
Government Revenue Sources	1324	432	312	244	1393	10774	7197	7340	2708	1006	5476	18216	1632
CAPITAL													
Savings													
REST OF WORLD	(imports)												
	66957	4992	28442	75335	51473	51958							
TOTAL	(total industry outlays)						(factor expenditure)						
	113487	18332	62186	137486	160829	277117	54730	47065	13471	7864	65183	124764	14453

Table XVI. (Continued)
Social Accounting Matrix for McCurtain County, Oklahoma (in thousands of 1985 dollars)

	INSTITUTIONS						HOUSEHOLDS			GOVERNMENT	CAPITAL	REST OF WORLD	TOTAL
	a1.	a2.	a3.	a4.	b1.	b2.	1. low	2. med	3. high				
PRODUCTION SECTORS							(household consumption demand)			(government demand)	(investment demand)	(commodity exports)	(commodity demand)
1. Agricultural Prod							670	624	295	419	343	64842	113487
2. Timber Prod and Serv							80	54	16	0	0	9857	18332
3. Manufacturing							117	101	38	8408	34714	10826	62186
4. Food/fiber process							1921	2051	1106	36	558	128742	137486
5. Wood processing							44	37	14	123	765	126921	160829
6. Services and gov't							43057	36190	14838	37799	2787	92772	277117
FACTOR ACCOUNTS													(factor income)
1. Labor (total)													
a. Mgmt/Professional													54730
b. Tech/Sales/Admin Supp													47065
c. Service													13471
d. Farm/Forest/Fish													7864
e. Prod/Crafts/Repair													65183
2. Capital													124764
3. Land													14453
TOTAL													
INSTITUTIONS										(transfers to institutions)			(institutional income)
a. Forestry Complex													
1. NIPF										35			478
2. IPF										0			7119
3. Public										0			140
4. Wood processing										0			47798
b. Non-Forestry Complex													
1. Agriculture										1574			23204
2. Non-Agriculture										0			206825
HOUSEHOLDS	(household income distribution)									(transfers to households)		(unearned income0	(household income)
1. Low (<15,000)	-5	-23	-2	4494	-284	11306				37916		3149	56551
2. Medium (15-40)	267	1343	109	18548	15987	61350				24258		8376	130238
3. High (>40,000)	115	580	47	9007	6910	44822				10191		22889	94561
GOVERNMENT							(Household taxes)					(ROW Gov't transfers)	(government revenue)
Government Revenue Sources							3053	15230	15758			59263	151358
CAPITAL	(institutional depreciation)						(household savings)						(total savings)
Savings	0	731	0	12339	592	45229	1508	7509	7795				75702
REST OF WORLD	(institutional ROW transfer)						(imports to consumption)			(gov't impt dmd)	(resource flows)		(total outflows)
	100	4488	-15	3411	0	44118	6101	68442	54702	30598	36538		527636
TOTAL	(institutional expenditures)						(household expenditure)			(government expenditure)	(total investment)	(total inflows)	
	478	7119	140	47798	23204	206826	56551	130238	94561	151358	75702	527636	

CHAPTER VI

DISTRIBUTIVE INCOME EFFECTS OF IMPROVED FOREST PRODUCTIVITY: ANALYSIS OF MODEL RESULTS

Analysis of the McCurtain County social accounting matrix is now addressed. Discussion begins with a qualitative assessment of the McCurtain County social accounting matrix constructed in Chapter V. Quantitative analysis then proceeds by outlining the productive timber potentials of McCurtain County forests. These potentials are then applied to the base year social accounting matrix using two methods. The first method uses the fixed-price SAM multipliers to assess interdependencies of timber volume effects and the resulting wood processing output effect on the distribution of factor income. A real timber stumpage price increase is also assessed in this manner. The second method applies a mixed exogenous/endogenous technique to supply-determine timber production and wood processing which allows assessment of timber productivity on the distribution of regional factor income throughout the regional economy.

Qualitative Assessment of the McCurtain County Social Accounting Matrix

Without further analysis, structural characteristics of the regional economic structure of McCurtain County can be inferred. Table XVII summarizes the social accounting matrix in condensed form. In and of itself, the social accounting matrix can be used to identify phenomena which characterize the McCurtain County economy. These will now be discussed.

The Forestry Complex in McCurtain County

The activities related to producing and processing timber account for a significant portion of the McCurtain County economy. Noting from the production account of Table XVI, over 23 percent of regional industrial output is directly attributable to these activities. Of this percentage, it can be observed that roughly 90 percent consists of wood processing output and 10 percent timber production output. From the factor account of the same table, roughly 19.5 percent of regional factor inputs are used in timber production and processing. Roughly 14 percent of this factor input goes to timber production and 86 percent to wood processing.

These activities could realistically be defined as *primary* in nature, contributing to McCurtain County's export base and generating rest-of-world transfers. Noting from the commodity exports account of Table XVI, roughly 31.5 percent of McCurtain County exports take the form of timber and processed wood products. Imported inputs into the production of these commodities,

Table XVII. The Condensed McCurtain County SAM, Base Year 1985

	Production Sectors	Factors	Institutions	Households	Government	Capital	Rest of World	Total
Production Sectors	(interid. transactions) 148,274			(household demand 101,253	(government demand) 46,786	(investment demand) 39,166	(commodity export) 433,959	(commodity demand) 769,438
Factor Accounts	(factor returns) 327,530							(factor income) 327,530
Institutions		(institutional income) 283,955			(transfer to inst.) 1,609			(institutional income) 285,564
Households			(household income) 174,571		transfers to HH) 72,365		unearned Y 34,414	(household income) 281,350
Government	(indirect business taxes) 14,479	(factor taxes) 43,576		(household taxes) 34,041			(gov't transfer) 59,263	(government revenue) 151,358
Capital			(institutional deprec.) 58,890	(household taxes) 16,811				(total savings) 75,702
Rest of World	(imports) 279,157		(institution ROW transfer) 52,103	(imports to consumption) 129,245	(gov't impt dmd) 30,598	(resource flow) 36,536		(total financial outflow) 527,636
Total	(industry outlays) 769,438	(factor expenditure) 327,530	(institutional expend.) 285,564	(household expenditure) 281,350	(gov't expenditure) 151,358	(total investment) 75,702	(total financial inflow) 527,636	

however, account for only 20 percent (see imports account of same table) of total production imports.

Household Income Distribution

Roughly $175 million (see household income distribution account of Table XVI), or 62 percent of total household income, was earned income accruing to households through the use of wage and self-employed labor resources. These labor resources were used by institutions to produce institutional income. Approximately 1.4 percent of this total McCurtain County earned household income was derived from producing timber and 18.4 percent from wood processing (forestry complex institutions). The remainder was derived from non-forestry complex institutions.

In assessing the distribution of earned income resulting from forestry complex activities, it becomes apparent that low income households are positively impacted by wood processing institutions. Roughly 14 percent of total earned labor resource compensation from wood processing is distributed to low income households, 58 percent to medium income households, and 28 percent to high income households. Timber production, on the other hand, is neutral (actually slightly negative [1]) in its impact on low income households. Most of the impact that timber production has on households is found in the medium income levels (roughly 71 percent) and high income levels (roughly 30 percent). To

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1. This accounts for roughly 1 percent of total earned resource compensation from timber production. From a statistical sense, this number is small enough to be concealed in an error term. Rose, Stevens, and Davis (1985; page 72) identify these negative payments as resulting from net capital usage losses rather than profits in agriculture, forestry, and mining activities. Potential underaccounting for home consumption of commodities produced could be considerable.

more fully understand this distribution and the implications that more intensive timber management have on regional economic development, further analysis is required.

Government Transfers

Government revenues and government expenditures in McCurtain County do not balance without large transfers from outside of the region (refer to goverment row and column from both Tables XVI and XVII). Almost 40 percent of total government revenue (balanced with expenditure) was transferred into the county. This category for government includes local, county, state, and federal governmental units. Governmental interaction in the regional economy (through demand for both domestically produced goods/services and import demand) accounts for slightly more than 51 percent of total government expenditures. The remaining 49 percent, or roughly $75 million dollars, are transfer payments. Indeed, a large proportion of McCurtain County households depend upon government transfer payments for sustenance.

Tables XII and XIII indicate that, during 1985, roughly 51 percent of McCurtain County households were categorized as low income (less than $15,000 annual income). Furthermore, 68 percent of this low income group's income was derived through government transfer payments, namely $12 million in social security and $26 million in public assistance. Social security is primarily impacting a large retired population residing in McCurtain County. Of the total $72 million in government transfer payments to individuals in McCurtain County, roughly 55 percent is in social security payments and 45 percent in public assistance payments.

Sources of Government Revenue

Revenue is generated for governmental units through indirect business taxes, factor use taxes, household taxes, and rest-of-world transfers. Of government revenue generated within McCurtain County, roughly 16 percent was derived through indirect business taxes, 47 percent through factor taxes, and 37 percent through household taxes. Factor taxes consist of roughly 54 percent generated from labor, 42 percent from capital, and 4 percent from land. Household taxes include both earned and unearned income taxes. Roughly 9 percent of household taxes were collected from low income households, 45 percent from medium income households, and 46 percent from high income households.

Forestry and Non-Forestry Complex Institutions

The combined institutional aggregations expended roughly $286 million dollars during 1985. Forestry complex institutions accounted for almost 20 percent of this expenditure. Of the total forestry complex expenditure, roughly 62 percent accrued to households. This compares with 61 percent from non-forestry complex institutions. The remaining institutional expenditure not accruing to households is either put away into depreciated assets or flows out of the region. Roughly 22 percent of institutional depreciation comes from forestry complex institutions. Roughly 15 percent of total institutional rest-of-world transfers were made from forestry complex activities. Combined, this indicates that relatively more forestry complex institutional expenditure is attributable to depreciation as compared to non-forestry complex institutional expenditure.

Gross Resource Status of McCurtain County

The social accounting matrix indicates that McCurtain County has a net resource outflow of roughly $36.5 million during 1985. This is roughly 48 percent of total investment and savings and 7 percent of total financial flow. The reasons for this are not directly evident from this analysis. It can be speculated, however, that this is partly due to current outflows of returns to investment accruing to timber production and wood processing as a result of earlier investments in establishing plantations and capital costs associated with plant development.

Timber Productivity

Distributional economic impact analysis is accomplished through shocking the base year regional economy with timber production potentials. Specification of these potentials is the topic of this section.

Identification of the Exogenous Change

Silvicultural treatment opportunities of McCurtain County forests are identified in the plot-level SOFIA database. These treatments, as specified in USDA Forest Service (1992a; page H-184-85) include the following (exact specification of inventory criteria can be found in the manual):

1. Regeneration without Site Preparation: Inadequate stocking of growing stock trees; little or no site preparation required for artificial regeneration.

2. Regeneration with Site Preparation: Inadequate stocking of growing stock trees; either natural or artificial regeneration will require site preparation.

3. Stand Conversion: High amount of chronically diseased or off-site species; conversion to different forest type or species desirable.

4. Thinning Seedlings or Saplings: Stand has dense stocking of growing stock trees.

5. Thinning Poletimber: Poletimber stand has dense stocking of growing stock trees.

6. Other Stocking Control: Stand has adequate stocking of seedlings, saplings, and/or poletimber growing stock mixed with competing vegetation either overtopping or otherwise inhibiting the development of crop trees.

7. Other Intermediate Treatments.

8. Clearcut Harvest: Mature or overmature sawtimber stand with sufficient volume to justify a commercial harvest followed by regeneration.

9. Partial Cut Harvest.

10. Salvage Harvest: Excessive damage to merchantable timber due to fire, insects, disease, wind, ice, or other destructive agents; regeneration should follow timber removal.

11. No Treatment: Stand has an adequate amount of growing stock trees in reasonably good condition.

McCurtain County treatment opportunity data in SOFIA (USDA Forest Service, 1992b) is first analyzed for number of total plots requiring treatment by ownership. These plots are then expanded to McCurtain County acreages using the specified expansion factor. McCurtain County treatment opportunity acreage is summarized in Table XVIII.

Vasievich (1987) has taken these treatment opportunities and analyzed them for investment opportunities using treatment costs and returns. This analysis was specific to the 18 eastern counties of Oklahoma which are included

TABLE XVIII

ANNUAL TIMBER PRODUCTION IMPROVEMENTS WHICH HAVE BEEN IDENTIFIED AS FEASIBLE AT FOUR PERCENT LEVEL[1], McCURTAIN COUNTY

	Ownership					
	NIPF		IPF		Public	
Treatment	Acreage[2]	Net Growth Increment[3]	Acreage[2]	Net Growth Increment[3]	Acreage[2]	Net Growth Increment[3]
Regeneration with site prep.	174,570	48				
Regeneration without site prep.	56,313	40				
Convert stand	16,894	40	28,156	20	5631	40
Commercial thinning	11,263	43				
Stocking control	33,788	38	140,782	39	11,263	60
Clearcut mature stand	5,631	50	16,894	45		
Salvage harvest	22,525	30	11,263	20		

1. As identified by Vasievich (1987; Table 5) for all forest types.

2. Acreage identified through interactive SOFIA (USDA, Forest Service, 1992b) usage by multiplying number of plots identified (by treatment opportunity) by the expansion factor (EXP = 5631.28).

3. Net annual growth increment in cubic feet per acre.

in the USDA Forest Service's FIA (Forest Inventory and Analysis) region. The assumption used in applying Vasievich's values in this analysis is that McCurtain County forest productivity is the same as the average Eastern Oklahoma forest productivity. This is, most probably, a conservative assumption due to the fact that McCurtain County experiences the highest rainfall of any Eastern Oklahoma County and site productivities are highest on the flat, alluvial Gulf-Coastal plains of southern McCurtain County. An improvement on using these conservative averages would include investment opportunities specific to McCurtain County. Conservative averages for Eastern Oklahoma investment opportunities will be used in identifying productive potentials of Eastern Oklahoma timberlands.

The net growth increment by treatment opportunity is specified by Vasievich (ibid) for Eastern Oklahoma in cubic feet. This is then calculated on a per acre basis using specified total acreages. This represents an estimate of the potential increase in timber growth resulting from applying respective silvicultural treatments. The per-acre net growth increment (in cubic feet) by treatment is multiplied by McCurtain County treatment opportunity acreage to identify the potential of silvicultural treatments to increase the productivity of McCurtain County timberlands.

The Productive Potential of McCurtain County Forests. The current status of timber removals, timber growth, and potential timber growth are summarized in Table XIX. It is important to note that discrepancies exist between current harvest levels and current growth of the McCurtain County forest. With a current (1985) growth to current removals ratio of 0.36, industrial timber managers are harvesting roughly three times the sustainable harvest levels from their own lands. This can be put into perspective, however, by assessing the timber-shed from which industrial wood processors draw from and realizing that this timber-

TABLE XIX

CURRENT TIMBER REMOVALS, CURRENT AND POTENTIAL TIMBER GROWTH, McCURTAIN COUNTY, ANNUAL BASIS

McMurtain County Forest Status	Ownership			
	NIPF	IPF	PUBLIC	TOTAL
Current Removals[1]	3,007	34,280	1,098	38,385
Current Growth[1]	5,280	12,493	4,071	21,844
Removals : Current Growth Ratio	1.76	0.36	3.71	0.57
Current Growth Plus Potential Growth[1,2]	9,485	28,368	5,957	43,810
Current Removals : Potential Growth Ratio	3.15	0.83	5.42	1.14

1. In thousand cubic feet units.
2. Potential growth achieved through investments in timber productivity as identified by Vasievich (1987; Table 5, all forest types) at the 4% level.

shed is larger than McCurtain County. This timber-shed also draws significant volumes from other ownerships within McCurtain County including nonindustrial private forest lands and public forest lands.

Both nonindustrial private forest and public forest current growth to current removals ratios (1.76 and 3.71 respectively) significantly exceed one. Overall, however, the ratio for all ownerships in McCurtain County is 0.57 which implies that a draw-down of timber inventories in McCurtain County is underway. Age class distribution of the McCurtain County forest is an important determinant of impact that this draw-down will have on processing as fully stocked younger forest stands mature.

Analysis of productive potentials departs from this problem and will rely on the sustainability of timber removals equal to current growth plus potential growth increases that implementation of treatment opportunities provide. This simplification is necessary to provide realistic sustainability for continued timber output and processing through time.

Table XX summarizes commodity output potentials as well as specification of a real timber stumpage price change which is predicted to occur over the next 35 years. Volume change effect using current prices and real price increase effect will be analyzed separately in the next section. Current 1985 prices listed in Table XX are the same as those listed in Table VI after conversion to cubic foot units. Furthermore, these prices were adjusted to reflect a combined value for softwoods and hardwoods [2]. The literature (USDA, Forest Service, 1988; page 218 and Lewis and Goodier, 1991; page 96) has identified expected real price increases in stumpage which will also be analyzed. The real price change is calculated from 1985 price using the indexes specified in Lewis and Goodier

2. The need to combine softwood and hardwood commodities is due to provide consistency with data sources. The assumption is made that sawtimber and pulpwood price is equal to 0.7 softwood plus 0.3 hardwood by commodity.

TABLE XX

COMMODITY OUTPUT AND PRICE CHANGES IN TIMBER PRODUCTION FROM 1985-2020, McCURTAIN COUNTY, OKLAHOMA

Commodity	Current Annual Growth 1985[1] (thousand ft^3)	Output Price 1985[2] ($\$/ft^3$)	Annual Potential Growth 1985-2020[3] (thousand ft^3)	Annual Potential Output 1985-2020[4] (thousand $)	Real Price Change 1985-2020[5] ($\$/ft^3$)	Real Income Change 1985-2020[6] (thousand $)	Gross Revenue Change 1985-2020[7] (thousand $)
NIPF							
Sawtimber	3,424	1.19	6,150	7,335	2.29	6,767	14,102
Pulpwood	1,856	0.11	3,334	376	0.16	178	554
IPF							
Sawtimber	8,144	1.19	18,492	22,054	2.29	20,343	42,397
Pulpwood	4,349	0.11	9,876	1,114	0.16	507	1,621
Public							
Sawtimber	2,830	0.78	4,141	3,250	1.51	2,998	6,248
Pulpwood	1,241	0.09	1,816	167	0.13	76	243

1. Identified in SOFIA (USDA, Forest Service, 1992b) in thousand cubic feet units.
2. Table VI adjusted to cubic foot units.
3. Using net annual increment from Vasievich (1987, Table 5; all forest types) plus current growth.
4. Using 1985 prices.
5. Indexed real price change as identified in Lewis and Goodier (1991, Table 3.3) for private timberland economic opportunity projected to 2020 and adjusted to commodity by 0.7 softwood, 0.3 hardwood in cubic feet.
6. Difference between total gross revenue change and annual potential output change in thousand dollar units.
7. Using annual potential output change and real price change in thousand dollar units.

(1991; page 96). It should be noted that this increase in real price is predicted to occur as a gradual trend during the period leading up to the year 2020 (35 years from the 1985 SAM base year). Results of applying this real price shock can be thought of as providing trend values only and should be used with appropriate caution.

The actual extent of productive potentials which are applied in the following analysis are of less importance as compared to the relative proportional results which are generated from the model. The impact of *any* change in timber production and wood processing is accounted for in a relative sense through the following analysis. Discussion, implications, and conclusions will focus on the relative differential impacts on regional sources and destinations of factor income resulting from change in timber production and wood processing. Given this context, the previously discussed assumptions used in identifying an actual value for timber production potential and this value's accuracy thus become less important.

Interdependencies of Institutional Output: Analysis Method One

Technical coefficients of the endogenized McCurtain County SAM (Table XVI from production sectors through household accounts) were calculated using the standard input-output procedures discussed in Chapters 3 and 4. Namely, these technical coefficients are of the a_{ij} form where a_{ij} is a technical coefficient and is calculated as z_{ij} / X_j and denotes the ratio of input to output, z_{ij} denotes the flow of input (measured in dollars of value) from sector i to sector j, and X_j is the total gross output of sector j (measured in dollars of value).

In matrix form, these technical coefficients combine to form A^*. These are then manipulated following the standard fixed-price SAM multiplier analysis as outlined in Pyatt and Round (1985, Chapter 9). This includes:

$$M = (I - A^*)^{-1} \tag{6.1}$$

Where M is a (22 X 22) matrix of SAM-based multipliers, I is a (22 X 22) identity matrix, and A^* is the endogenized technical coefficient matrix of the SAM. This SAM multiplier matrix (M) is provided in Appendix F.

Table XXI organizes the exogenous shock which is applied to the various production sector and institutional columns of the multiplier matrix found in Appendix F. Analysis of the accounts entails care in the usage of appropriate units. Those accounts falling within production sectors (timber production and wood processing) and factors (capital) are analyzed using the total output change. Institutions, however, are analyzed using only that portion of total output attributable to factor income change. Factor income change is calculated using a factor income level to output level ratio for each institution. These ratios are derived by summing across factor incomes of the institutional income distribution matrix (see Table XVI) and dividing by institutional output. This ratio is then applied to the total institutional output change to obtain the factor income level change. Since there exists a small intra-sector and intra-institution (self) interdependence, an adjustment is made to ensure that the shock consists of exactly that which is specified. This adjusted shock is then multiplied by the respective interdependence coefficient to obtain the impacts which are summarized in Table XXII.

Government, savings/investment and rest-of-world are important accounts but are exogenous to this system. These accounts require special treatment to

TABLE XXI

SUMMARY OF EXOGENOUS SHOCKS[1]

Exogenous Shock	Account: Nonindustrial Private Timber (thousand $)	Industrial Private Timber (thousand $)	Public Timber (thousand $)	Wood Processing (thousand $)
Volume Effect:				
Output Level Change	6671	6535	3086	145552
Factor Income Change	2841	2797	1306	43258
Adjustment[2]	2841	2796	1306	42301
Real Price Effect:				
Output Level Change	6945	20850	3074	0

1. Respective column of interdependence coefficients found in Appendix F.

2. Adjustment required to ensure non-self-intendependence (e.g. adjustment required to provide specified change in shocked row).

TABLE XXII

IMPACT OF VOLUME CHANGES IN PRODUCTION AND INSTITUTIONAL ACCOUNTS ON ROWS OF THE McCURTAIN COUNTY SOCIAL AND ACCOUNTING MATRIX

Row Account	Production Account		Institutional Account			
	Timber (thousand $)	Wood-Processing (thousand $)	NIPF (thousand $)	IPF (thousand $)	Public (thousand $)	Wood-Processing (thousand $)
Households						
Low	222	3626	-5	-2	-3	4350
Medium	3956	20869	1716	569	1103	18532
High	2041	13211	770	256	495	9370
Government[2]	2663	15955				
Savings/Investment[3]	1594	15700				
Rest-of-World[4]	11542	85199				

1. Labor skill levels were aggregated to one labor category.

2. Government impact calculated by premultiplying column impact vectors with row vector of government technical coefficients.

3. Savings/investment impact calculated by premultiplying column impact vectors with row vector of savings/investment technical coefficients.

4. Rest-of-world impact calculated by premultiplying column impact vectors with row vector of rest-of-world technical coefficients.

analyze volume and real price increases. These accounts are first analyzed by calculating their respective technical coefficients (*a_{ij}'s*). The respective column vector of endogenized impact is premultiplied with this row vector of government, investment/savings, and rest-of-world technical coefficients. The result is found in Table XXII.

Timber Production Volume Change: Production Account Impact

The total effect (direct plus indirect plus induced) of household income impact resulting from timber production sector volume change is $6.2 million (households account in first column of Table XXII). This is roughly 38 percent of the exogenous shock for total timber production output. Four percent of this is distributed to low income households, 64 percent to medium income households, and 33 percent to high income households.

Impact on governmental units of a volume increase in timber production accounts for 16 percent of total timber production output change. Savings/investment accounts for 10 percent of total output change, and rest-of-world accounts for 71 percent of output change. Significant rest-of-world transfers from timber production (primarily returns to capital and land which flow out of the region) as specified in the social accounting matrix are the cause of this large impact to the rest-of-world account.

Wood Processing Output Change: Production Account Impact

The total household effect of output change in wood processing is just over $37.7 million (households account found in the second column of Table XXII). This is roughly 26 percent of the total exogenous shock of $146 million. Assessing the distribution of this impact shows that low income households are impacted to a larger extent by wood processing than by timber production. Ten (10) percent of the total impact accrues to low income households, 55 percent to medium income households, and 35 percent to high income households.

Governmental unit impact accounts for 11 percent of total output change. Roughly 11 percent of total output change is accounted for in savings/investment impact and almost 60 percent of total output change impacts the rest-of-world account.

Real Timber Stumpage Price Change: Factor Account Impact

The identified real price change in timber stumpage is analyzed in a similar fashion as volume change. It is important to note that the SAM, as constructed, is not well-equipped to handle changes in prices. As a matter of fact, the SAM should be viewed as fixed-price in nature and does not allow for changes in factor or commodity input prices. If a real price change is analyzed using the interdependencies identified through this fixed-price SAM, it must be recognized that this is a return to owners of timber assets who hold the assets for the period under analysis. This will be dealt with in method 2 as an exogenous shock to the capital factor input return of timber production. Method 1, however, assesses this real price change in a similar fashion as timber production volume change.

This change is strictly net of volume changes and specifies impact resulting from an increase in price only. Realize also that real price changes are specified for timber stumpage prices only. Although these real price changes in timber stumpage will presumably be passed on to the wood processing sectors, there is no additional real price effect in those sectors.

Method 1 assesses real stumpage price increases in 2 separate ways; (1) a real price shock applied to capital factor interdependencies, and (2) a real price shock directly applied to the originating institutional accounts. Table XXIII identifies the impacts using the real price shock applied to capital factor interdependencies (method 1, submethod 1). This submethod is applied now with the latter saved for discussion with institutional analysis. For now, the identified real price increase will be applied to the capital factor account interdependency coefficients. When this is done, it can be shown that of the roughly $31 million total real price exogenous shock, about 57 percent finds its way to household accounts. Distributionally, of the total household impact, roughly 9 percent impacts low income households, 55 percent impacts medium income households, and 36 percent impacts high income households.

Timber Production Volume Change: Institutional Account Impact

Attention now turns to identifying impacts resulting from volume changes on forestry complex institutional accounts. A summary of these impacts as well as comparisons between production accounts and institutional accounts can be found in Table XXII. It is interesting to include institutional analysis due to its ability to focus on different land ownership categories of timber production. Focusing attention on the total effect (direct plus indirect plus induced) of

TABLE XXIII

IMPACT OF REAL STUMPAGE PRICE CHANGE ON CAPITAL FACTOR ACCOUNT

Row Account	Factor Account Capital
Factor	
Labor	
Mgmt/Professional	787
Tech/Sales/Admin Support	706
Services	239
Farm/Forestry/Fishing	13
Prod/Crafts/Repair	388
Capital	32514
Land	19
Households	
Low (0-$15,000)	1653
Medium ($15,600-$40,000)	9691
High ($40,000 and above)	6382
Government[1]	7544
Savings/Investment[2]	7430
Rest-of-World[3]	15895

1. Government impact calculated by premultiplying column vectors with row vector of government technical coefficients.

2. Savings/investment impact calculated by premultiplying column impact vectors with row vector of savings/investment technical coefficients.

3. Rest-of-world impact calculated by premultiplying column impact vector with row vector of rest-of-world technical coefficients.

household income impact resulting from volume change, it should be noted that household income impacts include 87 percent of total nonindustrial private forest factor income change, 29 percent of industrial private forest factor income change, and 122 percent of public forest factor income change (recall that public timber production labor inputs exceeded the generation of factor income). Only slight differences exist in the distribution of household income resulting from institutional factor income change in timber production. This is due to the assumption that production technologies applied to timber production are the same across ownership categories. In terms of the silvicultural treatments applied for timber production potentials, this assumption probably holds true. Further research which differentiates production technologies among ownership categories would provide an improvement on this analysis and will be left as a research need. Roughly 69 percent of total household income change accrues to medium ($15,000 - $40,000) income households, 31 percent to high (above $40,000) income households, and zero percent to low (under $15,000) income households [3]. The following impacts result from analysis and are due to the fact that household income impacts of institutions are a function of factor input ownership (land, labor, and capital) and the extent of factor input usage in production of industrial output.

Assessing income distribution with total factor income change by institutions, however, allows differential impacts on household income to become more apparent. Roughly 60 percent of total NIPF factor income change accrues to medium income households and 27 percent accrues to high income

---

3. Very small negative values are associated with low income households due to the nature of total income distribution as identified by Rose, Stevens, and Davis (1985, Table 7.6). They identify this phenomena in forestry, agriculture, and mining as attributable to capital losses rather than profits.

households. There is zero percent impact on low income households resulting from NIPF timber production change.

Whereas the extent of industrial private timber production impacts are large, the proportion of total factor income change accruing to households is smaller due to significant rest-of-world flows. Roughly 20 percent of total factor income change accrues to medium income household groups and 9 percent to high income groups. In a similar fashion to NIPF timber production, IPF exhibits zero percent impact on low income groups.

Public timber production change results in almost all (97 percent) total factor income change accruing to households. Distributionally, 84 percent accrues to medium income household groups and 38 percent accrues to high income groups. This value exceeds one due to the manner in which factor shares were calculated for public timber production. Discussion of what could be termed a subsidization effect of government timber production (i.e. labor payments exceed potential generation of government factor income) can be found in Appendix B.

Wood Processing Output Change: Institutional Account Impact.

Included in Table XXI is the exogenously determined shock of wood processing. This is calculated by assuming that wood processing output would change proportionally to timber production volume change [4]. This wood processing output change is then assessed for factor income change using the factor income level : output level ratio for wood processing (obtained from the

4. This strict proportional increase in wood processing assumes that there are no constraints on increasing production of wood products and simply reflects an increase in raw material supplies.

institutional income distribution matrix). Applying this shock to the interdependence column for wood processing shows the distributional effects of wood processing output change.

Roughly 76 percent of total factor income change resulting from increased wood processing output accrues as household income. Distributionally, this breaks down as 10 percent to low income households, 44 percent to medium income households, and 22 percent to high income households. Given the employment opportunities in wood processing industries, low income households benefit from increased output. This contrasts with the production of timber.

Real Timber Stumpage Price Change: Institutional Account Impact.

Real price increase will now be discussed in the second manner as identified previously. The same caveats apply to this real price impact analysis. To reiterate, a real price increase should be viewed as return to owners of timber holding the asset for the period under examination. Also, this change is strictly net of volume changes and specifies impact resulting from an increase in price only. This real price change is assessed for timber stumpage only; wood product real price change is, again, assumed to be zero.

Table XXIV summarizes impacts of real stumpage price changes. Roughly 87 percent of the real price factor income change resulting from NIPF stumpage accrues to households. IPF real stumpage price increase factor income change results in 29 percent accrual to households. Roughly 122 percent of public factor income change resulting from real stumpage price increases accrue to

TABLE XXIV

IMPACT OF REAL PRICE CHANGES IN ACCOUNTS[1] ON ROWS OF THE McCURTAIN COUNTY SOCIAL ACCOUNTING MATRIX

Row Account	Institutional Account NIPF (thousand $)	IPF (thousand $)	Public (thousand $)
Households			
Low	-12	-12	-7
Medium	4194	4244	2595
High	1882	1905	1165
Government[2]	1024	1036	634
Savings/Investment[3]	603	2751	373
Rest-of-World[4]	5317	17053	2067

1. Forestry complex institutional accounts.

2. Government impact calculated by premultiplying column impact vectors with row vector of government technical coefficients.

3. Savings/investment impact calculated by premultiplying column impact vectors with row vector of savings/investment technical coefficients.

4. Rest-of-world impact calculated by premultiplying column impact vectors with row vector of rest-of-world technical coefficients.

households (once again, due to the subsidization effect; see Appendix B). These changes occur in the same proportion as the volume change.

Assessing the distributional impacts on household income provides an understanding of how real stumpage price changes are distributed among regional populations. These are the same distributions as the volume change. Roughly 60 percent of NIPF real stumpage price factor income change accrues to medium income households and 27 percent accrues to high income households. There is no impact on low income households (account for zero percent change). IPF factor income change resulting from real stumpage price increases are distributed as zero percent to low income households, 20 percent to medium income households and 9 percent to high income households. Real price factor income change in public timber production is distributed as zero percent to low income households, 84 percent to medium income households, and 38 percent to high income households.

The above analysis suffers from minor double counting due to the fact that the framework is essentially supply and not demand determined. Each time a shock is identified and applied to the system, it automatically calls for additional resources which subsequently change other relationships. This leads to a need to specify relationships explicitly within a modeling framework. The following supply-determined analysis accomplishes this more exact specification.

Supply-Determined Production Sector Change: Analysis Method Two

Mixed Exogenous/Endogenous Specification

Imbedded within the constructed SAM are the respective social accounting equations. The mixed exogenous/endogenous account analysis can be referenced in Miller and Blair (1985; pages 325-333). In essence, this analysis allows prespecification of timber production output and wood processing output. The analysis then solves for timber production and wood processing final demands as well as the output of all other accounts. The equational specification used in this analysis is outlined in equations 6.1 through 6.3. Equational set 6.1 is of the standard input-output form $(I - A)\,X = Y$ and summarizes the relationships imbedded within the social accounting matrix. The technical coefficient, a_{ij} is calculated as z_{ij} / X_j and denotes the ratio of input to output, z_{ij} denotes the flow of input (measured in dollars of value) from sector i to sector j, and X_j is the total gross output of sector j (measured in dollars of value). Y_i indicates components of final demand and are disaggregated as government consumption, capital formation, and exports.

The sectors of supply-constrained output include timber production and wood processing; $X2$ and $X5$ respectively. These equations will be dealt with differently than the equations for all other accounts. Equations for timber production and wood processing will fix both $X2$ and $X5$ with analysis solving for the level of final demand (export). The other equations fix $X2$ and $X5$ and exogenously specify levels for final demand (Yi). Bars above components found in the equation set 6.1 indicate that these are fixed values.

$$
\begin{array}{llllllllllllll}
(1-a_{1,1}) & X_1 & -a_{1,2} & \bar{X}_2 & -a_{1,3} & X_3 & -a_{1,4} & X_4 & -a_{1,5} & \bar{X}_5 & -a_{1,6} & X_6 & - \cdots & -a_{1,22} X_{22} = \bar{Y}_1 \\
-a_{2,1} & X_1 & +(1-a_{2,2}) & \bar{X}_2 & -a_{2,3} & X_3 & -a_{2,4} & X_4 & -a_{2,5} & \bar{X}_5 & -a_{2,6} & X_6 & - \cdots & -a_{2,22} X_{22} = Y_2 \\
\vdots & & & & & & & & & & & & & \vdots \qquad \vdots \\
-a_{5,1} & X_1 & -a_{5,2} & \bar{X}_2 & -a_{5,3} & X_3 & -a_{5,4} & X_4 & (-a_{5,5}) & \bar{X}_5 & -a_{5,6} & X_6 & - \cdots & -a_{5,22} X_{22} = Y_5 \\
\vdots & & & & & & & & & & & & & \vdots \qquad \vdots \\
-a_{22,1} & X_1 & -a_{22,2} & \bar{X}_2 & -a_{22,3} & X_3 & -a_{22,4} & X_4 & -a_{22,5} & \bar{X}_5 & -a_{22,6} & X_6 & - \cdots & +(1-a_{22,22}) X_{22} = \bar{Y}_{22}
\end{array}
\qquad (6.1)
$$

$$
\begin{array}{llllllllllllllll}
(1-a_{1,1}) & X_1 & 0Y_2 & -a_{1,3} & X_3 & -a_{1,4} & X_4 & -0Y_5 & -a_{1,6} & X_6 - \cdots & -a_{1,22} & X_{22} = & \bar{Y}_1 & +a_{1,2} \; \bar{X}_2 & +a_{1,5} \; \bar{X}_5 \\
-a_{2,1} & X_1 & Y_2 & -a_{2,3} & X_3 & -a_{2,4} & X_4 & -0Y_5 & -a_{2,6} & X_6 - \cdots & -a_{2,22} & X_{22} = & & (1-a_{2,2}) \; \bar{X}_2 & +a_{2,5} \; \bar{X}_5 \\
\vdots & & & & & & & & & & \vdots & & \vdots & & \\
-a_{5,1} & X_1 & -0Y_2 & -a_{5,3} & X_3 & -a_{5,4} & X_4 & -Y_5 & -a_{5,6} & X_6 - \cdots & -a_{5,22} & X_{22} = & & a_{5,2} \; \bar{X}_2 & -(1-a_{5,5}) \; \bar{X}_5 \\
\vdots & & & & & & & & & & \vdots & & \vdots & & \\
-a_{22,1} & X_1 & -0Y_2 & -a_{22,3} & X_3 & -a_{22,4} & X_4 & -0Y_5 & -a_{22,6} & X_6 - \cdots & +(1-a_{22,22}) & X_{22} = & \bar{Y}_{22} & +a_{22,2} \; \bar{X}_2 & +a_{22,5} \; \bar{X}_5
\end{array}
\qquad (6.2)
$$

$$\begin{bmatrix} (1-a_{1,1}) & 0 & -a_{1,3} & -a_{1,4} & 0 & -a_{1,6} & \cdots & -a_{1,22} \\ -a_{2,1} & -1 & -a_{2,3} & -a_{2,4} & 0 & -a_{2,6} & \cdots & -a_{2,22} \\ -a_{3,1} & 0 & (1-a_{3,3}) & -a_{3,4} & 0 & -a_{2,6} & \cdots & -a_{3,22} \\ \vdots \\ -a_{5,1} & 0 & -a_{5,3} & -a_{5,4} & -1 & -a_{5,6} & \cdots & -a_{5,22} \\ \\ \vdots \\ -a_{22,1} & 0 & -a_{22,3} & -a_{22,4} & -1 & -a_{22,6} & \cdots & (1-a_{22,22}) \end{bmatrix} \begin{bmatrix} \Delta X_1 \\ \Delta Y_2 \\ \Delta X_3 \\ \vdots \\ \Delta Y_5 \\ \Delta X_6 \\ \vdots \\ \Delta X_{22} \end{bmatrix} = \begin{bmatrix} \Delta\bar{Y}_1 + a_{1,2}\Delta\bar{X}_2 + a_{1,5}\Delta\bar{X}_5 \\ -(1+a_{2,2})\Delta\bar{X}_2 + a_{2,5}\Delta\bar{X}_5 \\ \Delta\bar{Y}_3 + a_{3,2}\Delta\bar{X}_2 + a_{3,5}\Delta\bar{X}_5 \\ \vdots \\ a_{5,2}\Delta\bar{X}_2 - (1-a_{5,5})\Delta\bar{X}_5 \\ \Delta\bar{Y}_6 + a_{6,2}\Delta\bar{X}_2 + a_{6,5}\Delta\bar{X}_5 \\ \vdots \\ \Delta\bar{Y}_{22} + a_{22,2}\Delta\bar{X}_2 + a_{22,5}\Delta\bar{X}_5 \end{bmatrix} \quad (6.3)$$

where $\Delta\bar{X}_2 = 16.29$ $\Delta\bar{Y}_1 = 0$

$\Delta\bar{X}_5 = 145.55$ $\Delta\bar{Y}_3 = 0$

$\Delta\bar{Y}_4 = 0$

$\Delta\bar{Y}_6 = 0$

$\Delta\bar{Y}_7 = 0$

$\vdots$

$\Delta\bar{Y}_{22} = 0$

Rearranging these equations for exogenously specified values (*Y1, X2, Y3, Y4, X5, Y6, Y7, ... , Y22*) on the right and endogenously specified values (*X1, Y2, X3, X4, Y5, X6, X7, ... X22*) on the left yields the equational set 6.2. The specification of exogenous values takes the form of the identified Table XXI exogenous shock to timber production output (sum of timber production output change = \$16,263,000) and wood processing output (\$145,552,000). All other exogenous specifications are zero. These are summarized in matrix form in equation 6.3.

This new *supply-determined* (to be read *mixed exogenous/endogenous*) model will then be manipulated in the standard fashion by inverting the new $(I - A^{supply\text{-}determined})$ found on the left hand side of equation 6.3 and post-multiplying it by the supply-determined exogenous shock found on the right hand side of equation 6.3. The result thus solves for the change in *X1, Y2, X3, X4, Y5, X6, X7, ... , X22*. The vector of supply-determined exogenous shock as well as the resulting impact vector are summarized in Table XXV. The $(I - A^{supply\text{-}determined})^{-1}$ can be found in Appendix F.

The Volume Effect.

Table XXV summarizes the supply-determined exogenous shock which is calculated using the right hand side of equation 6.3 with prespecified timber production output change (delta X2) of \$16,293,000, wood processing change (delta X5) of \$145,552,200, and change of all other final demands (delta Y1, Y3, Y4, Y6, Y7, ... , Y22) of zero. These result solely from timber production volume change using 1985 prices as specified in Table XXI. Premultiplying this column

TABLE XXV

SUPPLY-CONSTRAINED EXOGENOUS SHOCK OF PRESPECIFIED TIMBER PRODUCTION AND WOOD PROCESSING OUTPUT CHANGE AND RESULTING IMPACT

Account	Direct Exogenous Shock (thousand $)	Resulting Impact (thousand $)
Production Sector		
Agricultural Production	2,230	2,951
Timber Production/Services	-9,018	8,994
Manufacturing	1,432	1,997
Food/Fiber Processing	26	716
Wood Processing	-116,898	116,846
Services and Government	12,045	25,881
Factor Accounts		
Labor		
Mgmt/Professional	6,300	10,169
Tech/Sales/Admin Support	5,050	8,490
Services	523	1,674
Farm/Forestry/Fishing	2,237	2,390
Prod/Crafts/Repair	23,685	25,689
Capital	16,475	24,740
Land	3,250	3,530
Institutions		
Forestry Complex		
NIPF	0	106
IPF	0	1,757
Public	0	41
Wood Processing	0	13,783
Non-Forestry Complex		
Agriculture	0	5,265
Non-Ag/Non-Forestry	0	46,257
Households		
Low (0-$15,000)	0	3,753
Medium ($15,000-$40,000)	0	23,120
High ($40,000 and above)	0	14,372

vector of exogenous shock by the $(I - A^{supply\text{-}determined})^{-1}$ results in the column impact vector found in Table XXV.

This total shock sums to $161,845,200. The sum of impacts throughout the system is $342,519,900 resulting in a total (direct, indirect, and induced) output multiplier of 2.12. The impact on household incomes include a total direct, indirect and induced impact of $41,245,000, or roughly 25 percent of the total impact. Distributionally, low income households receive 9 percent of total household income impact, medium income households receive 56 percent, and high income households receive 35 percent.

Another interesting multiplier is generated by summing the impacts of this shock on components of the factor account. This would be comparable to an aggregate value added multiplier of total effects. In this analysis (reference Table XXV), the value added multiplier is calculated to be 1.33.

Comparing results of this analysis with the results obtained using method one (Table XXIV) shows slightly higher impacts but general comparability exists. Method 2, however, eliminates any problems which existed with method 1 in the area of double-counting due to the prespecified nature of timber production output and its respective tie with wood processing (also prespecified).

The Real Price Effect.

Table XXVI summarizes the supply-determined exogenous shock which is calculated using the right hand side of equation 6.3 with prespecified real stumpage price change of $30,869,000. This shock is applied directly to the capital factor input (delta X12) and change of all other final demands (delta Y1, Y2, ... , Y11, Y13, Y14, ... ,Y22) of zero. This results solely from the real price

TABLE XXVI

SUPPLY-CONSTRAINED EXOGENOUS SHOCK OF PRESPECIFIED REAL STUMPAGE PRICE CHANGE AND RESULTING IMPACT

Account	Direct Exogenous Shock (thousand $)	Resulting Impact (thousand $)
Production Sector		
Agricultural Production	0	179
Timber Production/Services	0	-8
Manufacturing	0	122
Food/Fiber Processing	0	293
Wood Processing	0	-9
Services and Government	0	5,381
Factor Accounts		
Labor		
Mgmt/Professional	0	786
Tech/Sales/Admin Support	0	705
Services	0	239
Farm/Forestry/Fishing	0	12
Prod/Crafts/Repair	0	386
Capital	30,869	32,511
Land	0	17
Institutions		
Forestry Complex		
NIPF	0	35
IPF	0	340
Public	0	-4
Wood Processing	0	3,903
Non-Forestry Complex		
Agriculture	0	1,469
Non-Ag/Non-Forestry	0	23,868
Households		
Low (0-$15,000)	0	1,652
Medium ($15,000-$40,000)	0	9,687
High ($40,000 and above)	0	6,380

effect on output of timber production sectors using prices as specified in Table XXI. Premultiplying this column vector of exogenous shock by the $(I - A^{supply\text{-}determined})^{-1}$ results in the column impact vector found in Table XXVI.

This total shock, once again, is $30,869,000. The sum of impacts throughout the system is $87,944,91 resulting in a total (direct, indirect, and induced) output multiplier of 2.85. The impact on household incomes include a total direct, indirect and induced impact of $17,719,000 or roughly 57 percent of the total impact. Distributionally, low income households receive 9 percent of total household income impact, medium income households receive 55 percent, and high income households receive 36 percent.

The value added multiplier for a real price shock is generated by summing the impacts of this shock on components of the factor account. In this analysis (reference Table XXVI), the value added multiplier is calculated to be 1.12.

Assessing the supply-determined analysis real price results with method one results show quite comparable findings. This is perhaps most dramatic when comparing the capital factor account impact of real price changes in timber stumpage with the real price effect from method 2. Results are, for all practical purposes, identical. This is due to the fixed proportion nature of capital income among institutions and the fact that differences between timber production functions were not distinguished. Setting aside the argument that the silvicultural treatments applied to increase timber production are the same, one may endeavor to distinguish capital input usage between NIPF, IPF, and Public forest landowners. This could provide an improvement on this analysis.

Reiteration of General Caveats of Analysis

The results of an analysis of this nature are constrained by important caveats which warrant reiteration at this time. These include (1) production functions which exhibit fixed input-output coefficients and constant returns to scale (i.e.: proportional changes in inputs imply the same proportional change in output), (2) sectoral productivity and technology determined by a base year, (3) no input substitution (inputs required in fixed proportions), (4) no supply constraints, and (5) constant prices (technical coefficients are fixed ratios of value).

Caveats withstanding, the analysis does have appropriate applications, particularly in providing quantifiable comparisons between various institutions as they interact with various household income levels within a region. These comparisons provide truly new information to decision-makers in addressing equity issues of various policy instruments.

General Model Limitations and Topics for Further Research

This dissertation has provided a rational model and analysis method of addressing income distribution resulting from the use of factor inputs in producing timber. Whereas this approach provides results which are important for addressing questions of economic development of forested regions, it only scratches the surface of potential areas requiring further research. Two of the primary areas requiring further research are the topics for this Chapter. Namely, these include elaboration of market equilibrating mechanisms and the incorporation of land use compatibilities.

Market Equilibrating Mechanisms

In an effort to provide consistency with economic theory, addressing factor input price change, particularly labor, which results from increasing production of timber commodities within a region is a research need area. The problem begins with the fixed-price nature of a social accounting matrix. In effect, the analysis presumes that all prices are fixed in the base year. Economic theory, particularly neoclassical equilibrium theory, casts a significant shadow on this assumption.

Figure 6 outlines the assumption from a supply-demand perspective in the market for factor inputs. In an effort to predict impacts on factor input use from the social accounting matrix, the analysis uses an exogenous shock which shifts a downward sloping demand curve to the right. Supply, on the other hand, is assumed to be perfectly elastic. The resulting change in quantity of input would be the full shift in demand. This fixed price relationship overestimates quantity change and underestimates (assumes to be zero) price change.

Endogenizing Price. Standard supply-demand relationships are theoretically different. Figure 7 provides a realistic perspective of supply-demand relationships in the market for factor inputs. Once again, demand shifts to the right due to an exogenous change, but now the supply of factor inputs has positive slope; in other words, supply is less elastic. This results in a quantity of input change which is less than the fixed price analysis and provides a positive impact on factor price. Individual factor input markets could be assessed for change in marginal value product which results from an increase in wage structure.

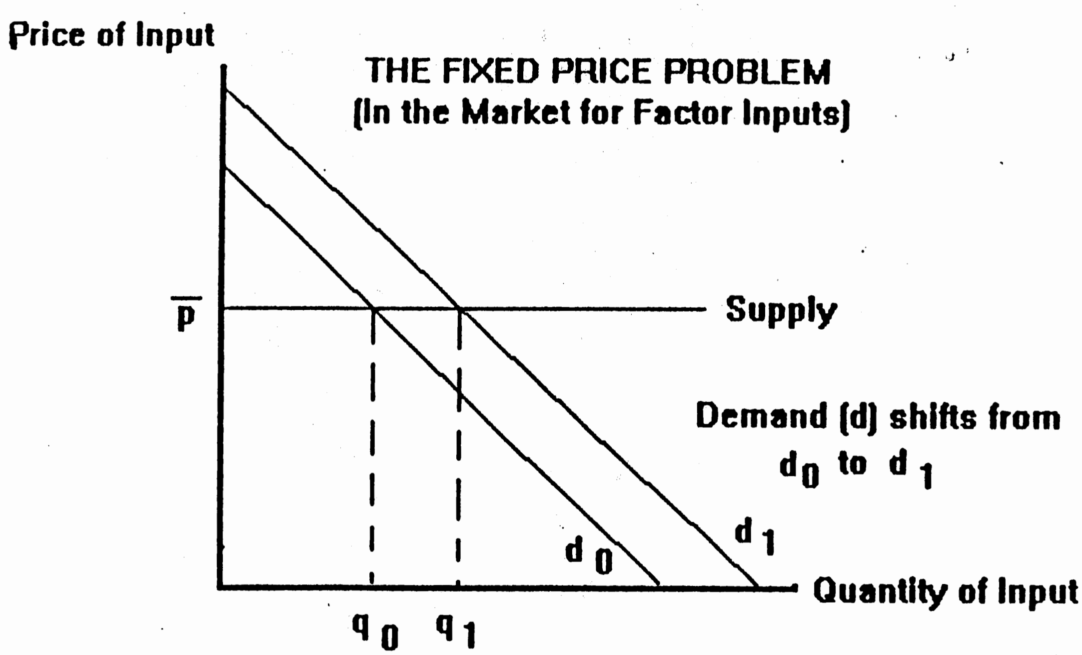

Figure 6. Supply-Demand Relationships Assumed for this Study

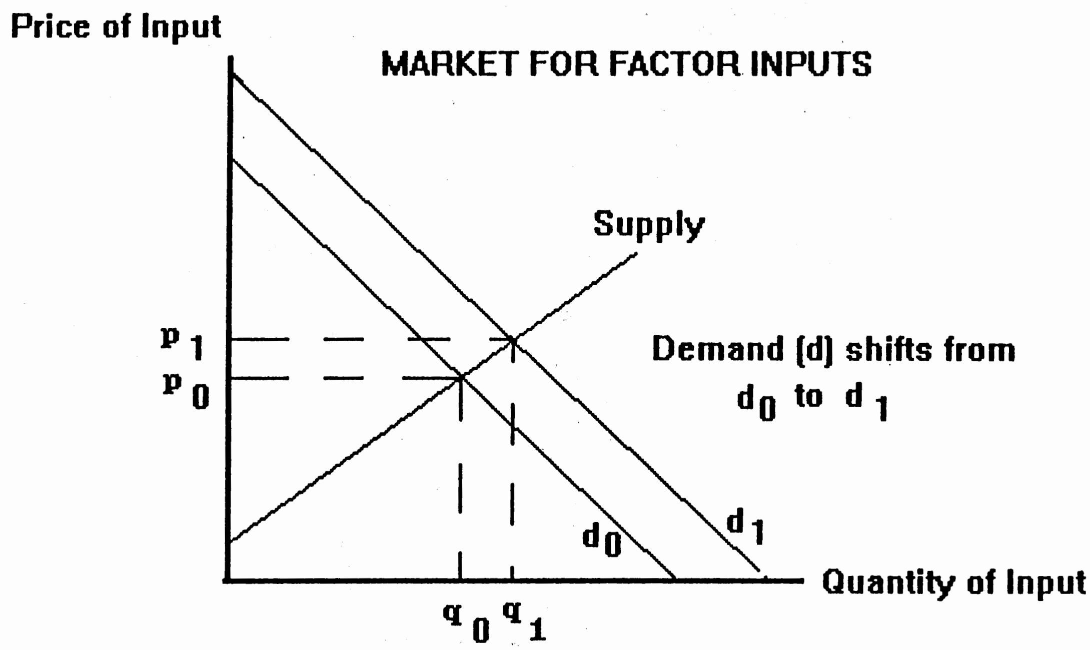

Figure 7. Supply-Demand Relationships Consistent with Economic Theory

The general equilibrium technique allows an assessment of price and quantity change for factor inputs. This was discussed in Chapter 2. Further research in developing a regional equilibrium model using the social accounting matrix as a basis would be the logical next-step of this dissertation. Solution procedures can be found in Koh (1991) and others.

Allowing factor prices to be endogenous to the model and making assumptions regarding supply elasticities would provide results consistent with general neoclassical theory. This leads to another area of research need which is particularly evident in forested regions; that of providing estimates of supply elasticities for labor and land resources involved in the production of timber and wood products.

Estimating Supply Elasticities for Forestry Factor Inputs. Chapter 2 discusses conditions associated with labor markets in rural forested regions. Rigidities in factor mobility are alluded to which are due to fundamentally non-market oriented benefits associated with residing in forested regions. How do cultural and amenities related rigidities in labor mobility affect the supply elasticity of labor in forested regions? These may tend to support the usage of fixed-price analysis. The point made here is that research in this area is lacking. To fully understand economic equilibriums which exist in forested regions, rigidities in labor mobility leading to more elastic supply functions require specification. Factor input analysis is rather incomplete without assessing supply-demand relationships which cause both price and quantity effects.

Compatibility of Forest Uses

Usage of forest lands for the production of timber is one of many uses for which forest land can be put. Other uses include wildlife production, recreational opportunities, wilderness, natural watersheds and livestock production. This dissertation deals specifically with timber production without assessment of other uses put to forest lands. The timber production increases called for to generate the exogenous shock specified in this chapter assumes that other land uses on these acres are fully compatible with intensive, short rotation, loblolly pine plantation management. This type of focus could well be unrealistic. Particularly on lands whose owners provide balanced multiple-use mandates, intensive forestry practices are unlikely to occur even though a four percent (or higher) rate of return on investment may exist. Most probably, this is due to the perceptions of incompatible forest land uses.

Measurement of Compatibility. To what degree does intensive forest management interact with compatible usage of lands for recreation (?) ... for wilderness (?) ... for natural watersheds (?) ... for aesthetic pleasure? Table II, derived from Marion Clawson (1974), outlines the degree of compatibility among various forest uses but quantification of these compatibilities is left to the imagination of the reader.

Furthermore, are there different compatibility indices for different household income groups? Is wilderness valued the same for low income households as it is for high income households? Is squirrel hunting valued the same for low income households as it is for high income households? Where does timber production enter the picture? Based upon this analysis, timber production does not appear to benefit low income household groups significantly. It would appear that many more questions exist than there are suitable answers.

Research in this area would also be a logical next-step for the problem statement identified in this dissertation. Surveys of household income groups would provide empirical estimation of distributional differentials which exist in the assessment of land use compatibilities. The procedures for valuation of non-market natural resources such as contingent valuation and travel cost techniques provide a challenging starting point for further research.

Potential SAM Incorporations. What opportunity exists for incorporation of a land-use compatibility matrix within a social accounting framework? It would certainly be an interesting research pursuit to identify impacts of timber production potentials on distributional factor input returns to both market transactions as well as non-market transactions dealing with forestry activities. Nonindustrial private landowners have objectives which extend beyond strict market transactions. Particularly those NIPF owners of smaller acreages value aesthetics, wildlife production, and the perception of wilderness differently than those who own larger acreages. An example of this would be an owner of 40 acres of forest land which are considered as a "back yard" compared to owners of 1000 mixed forest/pasture acres who are involved with agricultural production and gas exploration. Larger acreage landowners may indeed be more interested in strict market transactions in the management and usage of forest land. These two NIPF owners are also, most probably, in different income categories.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Dissertation in an Nutshell

The Problem

Over the past 25 years, a significant increase in timber management intensity has occurred in McCurtain County, Oklahoma and throughout the southern United States. The structure of timber supply and demand has led to predictions of continued real price increases for timber stumpage. Forecasted real stumpage price increases will provide market incentives for further intensification of timber management, particularly on nonindustrial private forest landownerships throughout the south. The core question addressed in this dissertation deals with how intensification of timber management affects income distribution among groups of people in a regional economy.

The primary objective of this work was to develop a model which could predict impacts of timber production potentials on the distribution of factor income accruing to various groups of people within a region. An extensive literature review revealed that very little is known about factor income distribution resulting from timber production.

The Literature

There exists considerable literature, however, which pertains to the historical and current context within which forestry interacts in regional economic growth as well as the general topic of regional economic analysis. These studies imply that forests have played an integral role in regional economic growth through time due to direct employment of factor inputs as well as extensive forward linkages through wood processing and other industrial sectors. Forestry's role in the economic growth of regions is constrained by the conditions within which forestry operates. These include market imperfections, equity of resource returns, social acceptance of timber production, appropriate valuation of non-market resources, and effective public policy.

Timber production and wood processing are shown to operate within the context of oligopolistic raw material markets and oligopsonistic markets for labor. Implications of these market imperfections on lower income households has not been addressed. Issues of societal acceptance result in land-use incompatibilities. Techniques of non-market forest resource valuation exist and have been applied to various situations but have not addressed distributional attributes of benefits. Policies targeting forest management tend to be normative. Positive policy analysis based upon facts and empirical estimates show that distributive policy impacts are important. Previous work has dealt with policy benefit distribution limited to land ownership categories, not income group. Regional analysis tools exist from which assessment of economic growth and development of natural resource dependant regions can begin.

Research is lacking in the area of income distribution resulting from timber production as well as fundamental econometric analysis of correlations between the extent of forest resources and economic conditions of regions. Furthermore, statistical analysis of how forest resource dependant regions compare with non forest resource dependant regions is completely lacking. The social accounting matrix is identified as a regional analysis tool which has the ability to address distributional attributes of factor income generation.

Addressing the Problem

A social accounting matrix was constructed for McCurtain County, Oklahoma for the base year 1985. The county represents one example of economic conditions in the Mid-Southern United States. Data sources used during construction included mid-south forest inventory statistics specific to McCurtain County, Timber-Mart South, a U.S. Department of Agriculture hybrid input-output model, published data from the U.S. Department of Commerce and U.S. Department of Labor, and numerous studies dealing with income distribution and transfer payments. A separate factor share analysis, the first of its kind for timber production, allows for specification by factor resource ownership.

Timber productivity was assessed using a volume effect and a real price effect. The USDA Forest Service Mid-South forest inventory was used to identify treatment opportunities for McCurtain County. A sustainability assumption was applied which constrains annual removals to current annual growth plus potential net annual increment resulting from more intensive timber management by ownership. Prices for 1985 were applied to assess the volume effect and forecasted prices for 2020 were applied to assess real price effect.

Experiments using the constructed social accounting matrix with timber productive potentials included simple interdependency analysis and a mixed exogenous/endogenous account analysis using supply determined timber production which constrains wood processing sectors within McCurtain County. Impacts of these experiments on the regional economic structure were quantified using a fixed-price analysis. The fixed-price nature of factor inputs within the social accounting matrix presents limitations on the analysis of effects resulting from real price increases of commodity output. A better equipped technique such as regional equilibrium analysis could more realistically deal with both price and quantity effects resulting from real price increases of output.

Results

Three types of exogenous shocks are analyzed separately. These shocks consist of (1) a volume effect resulting from forest landowners taking advantage of treatment opportunities which have been identified as returning four percent on investment and (2) a proportional increase in wood processing output, and (3) a real price effect of predicted increases in timber stumpage during the year 2020 over and above general inflation. The first and third shocks are summarized by ownership in figure 8.

A $16 million annual exogenous shock of timber volume output increase was identified through the use of improved timber management on forest lands in McCurtain County. For perspective, total 1985 output of timber production in McCurtain County was slightly over $18 million. The factor income proportion of this shock totaled roughly $7 million. Of the total timber potential which exists in McCurtain County, 41 percent occurs on nonindustrial private forest land, 40 percent on industrial private forest land, and 19 percent on public forest lands.

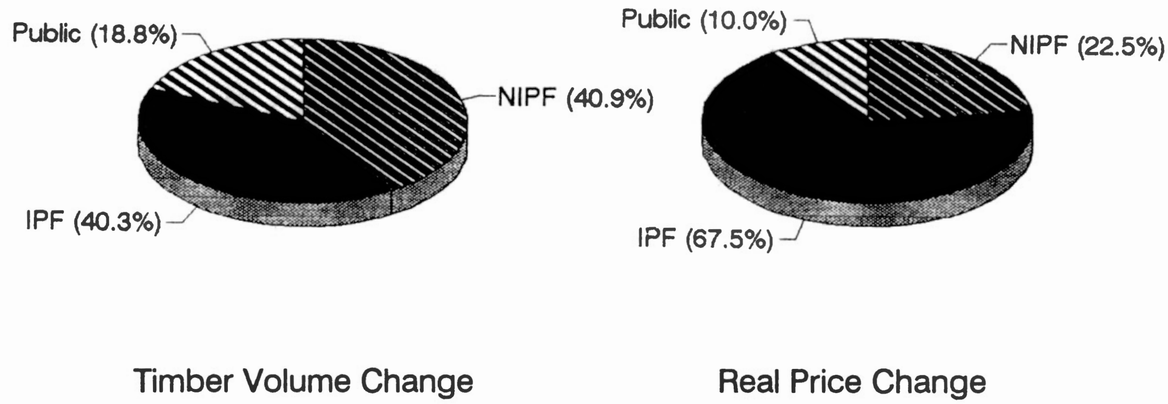

Figure 8. Exogenous Shock Summarized by Ownership, McCurtain County, OK

This increase in timber volume provides raw material increases to regional wood processing industries and thereby allow these industries to expand. Assumption is made that expansion in wood processing is proportional to increased raw material supplies. This assumption leads to the identified $145 million increase in wood processing output which is applied to the social accounting matrix as an identified exogenous shock to the system.

A $31 million exogenous shock of real stumpage price increase was identified. Based upon characteristics of the real price change, roughly 22 percent of this shock accrues to nonindustrial private forest land owners, 68 percent accrues to industrial private forest land owners, and 10 percent accrues to public forest land owners.

These perturbations have different impacts on income distribution within McCurtain County. Timber production volume effects have no factor return impact on low income households (less than $15,000 annual income) in McCurtain County, Oklahoma during 1985. All of the impact was shown to accrue to medium ($15,000 to $40,000) and high (above $40,000) income households. This follows from ownership of factor inputs to timber production. Wood processing output change, on the other hand, had modest impacts on low income households, primarily due to usage of low income household labor resources. These volume impacts are summarized in figure 9.

The real price effect shows various impacts to institutional groupings. Whereas most of the real price change (68 percent) accrues to industrial owners of timber stumpage, most of this real prices change leaks out of the region as return to corporate holding of the asset and does not end up in McCurtain County households. Nonindustrial private owners appear to more fully integrate returns to factor inputs into the regional household structure due to the fact that most NIPF owners are resident in McCurtain County. Timber stumpage real

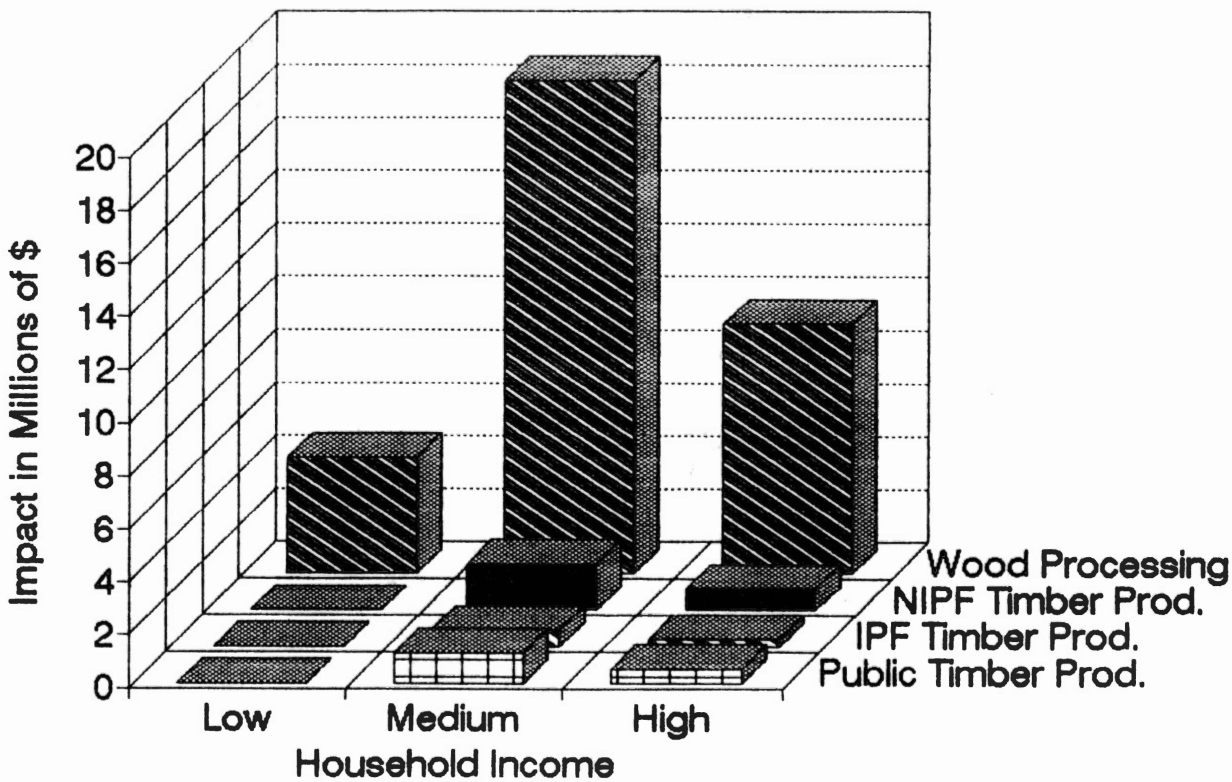

Figure 9. Impact of Volume Shock as a Result of Attaining Timber Productivity Potentials on Household Income Groups Within McCurtain County Using Institutional Interdependencies.

price increases impact regional households in roughly equal amounts between NIPF and IPF institutions even though most of the real price change accrues to industrial private landowners. These impacts are summarized in figure 10.

Results of applying the same real price increase in timber stumpage to the capital factor account is also summarized in figure 10. Note that in total, impact of institutions are roughly additive and compare favorable to the total impact as applied to the capital factor account. The capital factor account is, however, more directly integrated to low income households. This is reflected in figure 10 by the small impact shown on low income households.

Analysis of the social accounting using the two methods discussed in Chapter 6 results in very similar impacts. These two methods included (1) interdependency analysis and (2) supply-determined (mixed exogenous/endogenous) analysis. The problem of double-counting discussed for interdependency analysis (method one) does not appear to seriously hamper the method's effectiveness in distributive analysis. The total impacts using both methods are summarized in figure 11. Note that figure 11 is total volume effect as applied in the two separate ways that method one was analyzed (production sector and institutional analysis) as well as the total volume effect as applied in method two.

This analysis has shown that timber production impacts on household income are minor compared to the impact that increases in timber provide increases in raw materials for forward-linked wood processing sectors. These primary and secondary wood processing industries account for roughly one-fifth of the regions direct employment and are therefore significant players in McCurtain County economic growth and development. Distributionally, wood processing industries primarily contribute to medium income households and to a lesser extent, contribute to low and high income households.

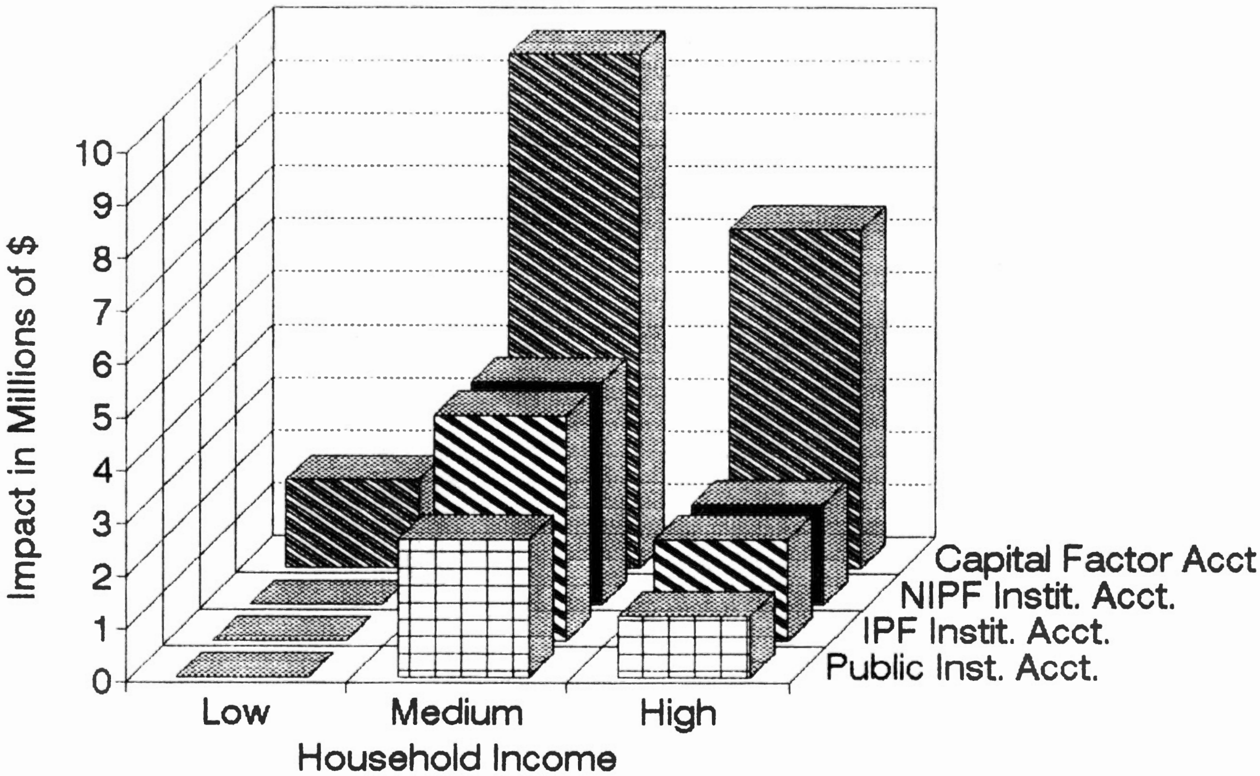

Figure 10. Impact of Timber Stumpage Real Price Shock on Household Income Groups Within McCurtain County Using Institutional Interdependencies.

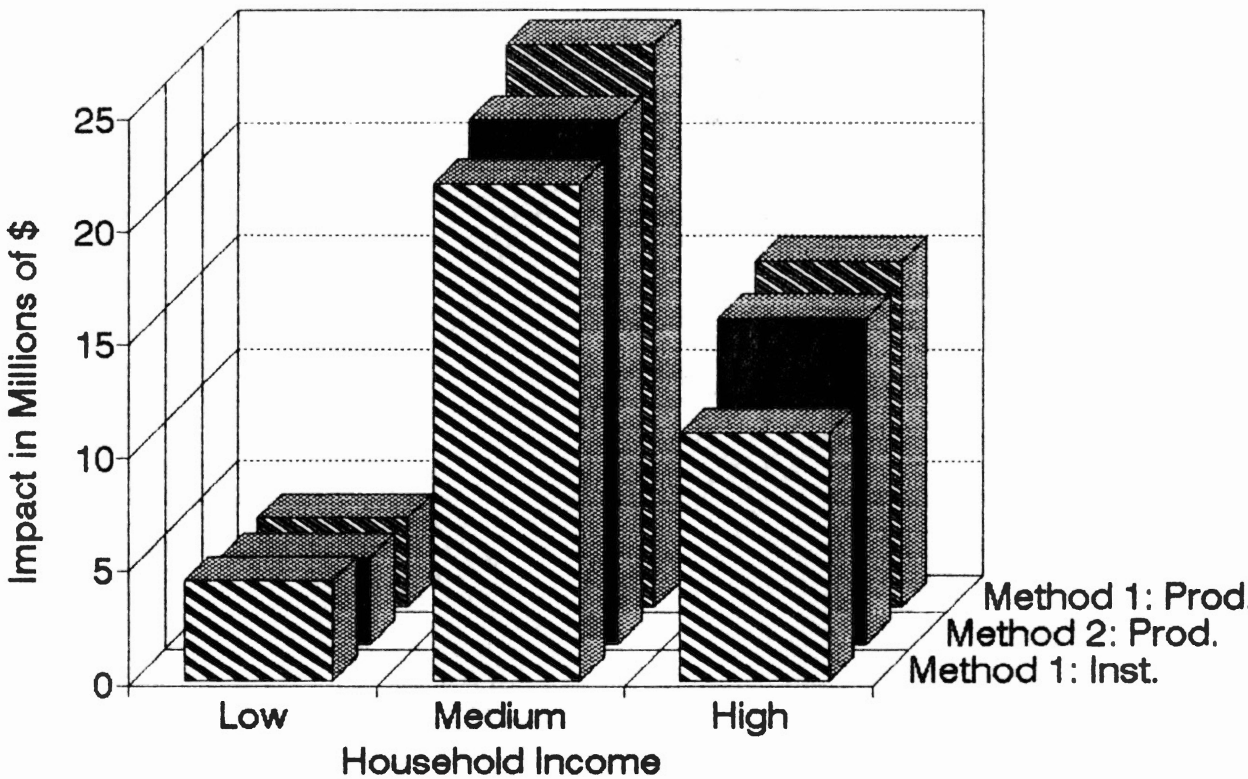

Figure 11. Comparison of Institutional and Production Sector Interdependency Analysis (Method One) and Supply-Determined Analysis (Method Two) for Total Timber Production and Wood Processing Volume Shock by Household Income Group, McCurtain County, Oklahoma.

Policy Implications

It is clear that low income residents of McCurtain County as well as senior citizens are dependant on government transfer payments for basic sustenance. Increases in forestry production could offset this large government inflow of funds to the county. The question then arises, how much increased forestry production would be required to offset government transfers to McCurtain County from the rest-of-world? The analysis indicates that volume change resulting from improved forest management within the county would generate a combined government impact of roughly $18.5 million (Table XXII). If real price increases are experienced, an additional $7.5 million would be generated (Table XXIII). Adding these together, complete accomplishment of achieving timber productivity would impact governments by $26 million. Rest-of-world transfers to the region exceed $50 million (Table XVI).

Efforts to remove able-bodied residents from public assistance by providing employment does not appear to be realistic in timber production due to the types of skills required. Wood processing, perhaps, could absorb a limited number of these low income residents. Human capital development through vocational/technical education would be important to effectively implement employment assistance to people currently on public assistance into wood processing industries.

Timber production appears to be geared toward largest impacts accruing to medium and high income households. This analysis does not provide a clear understanding of potential implications this has on timber management policy. Further research is required prior to developing workable policy measures which address questions regarding investment policy promotion in timber production. It does appear, however, that rates of return are sufficient to provide market incentives which stimulate increased timber production. Real price increases in particular, will continue to generate market-based incentives for landowners to improve management of lands for timber. Problems related to reducing risk and uncertainty associated with timber production are as yet unanswered.

This analysis would assist with public decisionmaking on policies which addresses distributive effects of timber management and wood processing industry policy. Consider the choice of widely varying forest management technologies such as even-aged loblolly pine management versus uneven aged management for oaks and hickory. This analysis has assessed the former technology as per distributive effects. How would impacts on households look if analysis of the latter forest management technology were done? This would provide policymakers with quantitative evidence to support land management choice.

Clearly, more research is required to generate models based on improved primary data sources. There appears to be potential in incorporating modern spatial databases into a regional economic geographical information system (GIS) which would help address these issues. This could take the form of a system similar to IMPLAN which incorporates specific information regarding natural resource inventories, better information of income and its distribution, and information regarding potential industrial expansion areas.

General Conclusions

The above discussion outlines a rational method and empirically estimates a social accounting matrix which can assess distributional impacts of changes in timber production. This methodology is applied to a region typical of the rural Southern United States in which timber and wood processing plays an important role in regional economic structure.

Roughly 51 percent of McCurtain County households are classified as low income (combined household income less than $15,000 in 1985). Government transfer payments are the primary source of this group's income. Growing trees for timber, in and of itself, does not provide financial return to this group because they do not own the land, labor or capital resources (factor inputs) required for production of timber. This does not say, however, that benefits of timber production accrue at the expense of low income groups (an issue of equity). Furthermore, timber production appears to be regionally insignificant to low income households in that total effects (including indirect and induced effects) are not sufficient to allow even "trickle down" impacts to accrue to low income households.

There is a real possibility that low income groups benefit from timber production in a non-market oriented manner. This analysis does not capture non-market transactions. Other benefits that this group enjoys from regional forest resources could take the form of recreational opportunities, hunting wildlife resources, and other less market-oriented activities. Efforts to exclude low income groups from availing themselves of these non-market forest resources could tend to exacerbate any potential social conflict that already exists in intensive management of forests for timber.

It is important to note at this time that timber production refers solely to production of traded and marketable commodities. Evidence exists (Marcouiller, McDowell, Walters, and Anderson, 1991) which indicates that previously ignored secondary products from timber production such as firewood could be an important benefit derived from intensive timber management, particularly stand conversion activities. On a statewide level, roughly one half (ibid; page 16) of the volume removed from Oklahoma woodlands is firewood. This is particularly important in Central and Western Oklahoma. To be sure, McCurtain County proportions would be much smaller due to the significant activity of industrial removals. Nevertheless, firewood resources could be a potential benefit that low income household groups in McCurtain County avail themselves of which are not included in the strict market transactions accounted for from the social accounting matrix.

Processing of timber products which is a significant value added activity, however, does have financial impacts on low income households. Low income household labor resources are evident in the components of wood processing. These components run the spectrum of primary and secondary processing including timber harvesting, log hauling, sawmilling, wood treatments, plywood production, fiberboard production and paperboard manufacture. In that low income households realize the relationship between timber production as a raw material for wood processing industries, an indirect relationship exists.

Understanding the regional economic consequences of shifting resource supplies and their impact on regional welfare is an interesting research pursuit in applied economics and can provide important information to decision-makers for enlightened public policy formation.

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APPENDIXES

APPENDIX A

ON VERIFYING IMPLAN FOR USE IN REGIONAL ECONOMIC IMPACT ANALYSES

The intent of this appendix is to provide a framework to verify important components of IMPLAN for use in regional economic impact analysis. The appendix begins with a general discussion of input-output system accuracy. With this background, discussion then proceeds to the IMPLAN system and its verification within this framework.

Accuracy in I-O

Input-output analysis is a frequently employed technique to assess economic linkages within regions. Abundant literature exists regarding the technical aspects of input-output analysis. A brief introduction is provided in Chapter III of this dissertation. A thorough synopsis can be found in Miller and Blair (1985).

Accuracy in input-output systems is directly tied to the methods used in data collection and model limitations. Input-output accuracy is discussed in Chapter III. Recall the two types of accuracy put forth by Jensen (1980). The first he terms "A-type accuracy" which is the accuracy of the transactions table.

Another term for this type accuracy is "partitive accuracy". Sources of error within A-type accuracy include data errors and errors from table compilation.

The second accuracy category is "B-type accuracy" which refers to the exactness with which the input-output model reflects the operation of a regional economic structure. Another term for B-type accuracy is "holistic accuracy". Errors associated with B-type accuracy result from a general failure to observe the limitations of the model itself (see Chapter III).

IMPLAN is a nonsurvey based supply-demand pool input-output analysis system. Discussion and comparison of survey based input-output models is discussed in Chapter III. Kuehn, Proctor, and Braschler (1985) compared the multiplier results of nonsurvey, semisurvey, and survey models of statewide Missouri input-output tables with economic base multipliers for nonmetropolitan counties throughout the Midwest. Their findings showed that all three techniques were prone to measurement and/or sampling error. Relative accuracy of the techniques were difficult to establish. They concluded that (1) the economic base model remains a viable choice with several caveats, (2) any single I/O model remained a "snapshot" of a local economy given some historic economic structure, and (3) in the absence of feasibility studies, nonsurvey based I/O models provide reasonable multipliers (usually upper limits) at less cost than survey based I/O.

Stevens, Treyz, Ehrlich, and Bower (1980) discuss and evaluate regional purchase coefficient approaches to nonsurvey-based I/O development. They compare these nonsurvey approaches to corresponding components of survey based models for Washington and West Virginia. Of their two primary nonsurvey approaches (which include location quotient and supply and demand pool methods), the supply and demand pool method explicitly takes into account the actual regional demands for each good and provides results which are better justified theoretically and more closely comparable to the survey approach.

Structure of IMPLAN

The following is a terse overview of the IMPLAN structure. Complete description and discussion can be found in the user's manual.

The IMPLAN Database. The IMPLAN database consists of (1) the 1977 national-level technology matrix of transactions for goods and services between industries updated to 1985, (2) estimates of gross output, employment, final demand, final payments for sectors by county and (3) social accounts. The current data represent 1985 county-level activity for 528 sectors. Complete database origins and construction procedures in documented form are not yet complete for the 1985 data.

The IMPLAN System. The software which supports the database allows interactive access between users and the various components of the system. IMPLAN allows the user to modify, add or delete data. Specific changes to the database are typically based on available local information. Full operation of the IMPLAN system can be found in the user's manual (IMPLAN Development and Applications Group, 1991).

Accuracy of IMPLAN

Numerous studies have been done to test the accuracy of IMPLAN general results and multipliers. Siverts and Chappelle (1989) tested the system's holistic accuracy in estimating economic changes in comparison to measured data for employment wage income and population at the county level. Through development and analysis of three different models, they found that no one model emerged as clearly superior, however, the system's Modified Type III multiplier using additional data provides the closest estimate of employment change. The closest estimate of regional wage income is provided using a Type II multiplier. The researchers conclude that county level analysis using IMPLAN provides useful predictions when estimates provided in the database are carefully checked.

Particularly at the county level, problems exist with the IMPLAN Modified Type III multiplier. This is due to relatively weak industrial linkages at the county level. Hence, induced household effects become increasingly important. Borgen and Cooke (1991) argue that these Modified Type III multipliers are not so much traditionally specified Type III multipliers, as defined by Miller and Blair (1985, page 110), but more akin to "non-standard" Type II multipliers.

Hotvedt, Busby and Jacob (1988) assess IMPLAN's usage for regional input-output studies focusing on forestry applications. They found that, in Louisiana, multipliers are sensitive to the resolution of the region being analyzed. Namely, in a holistic sense, the size of multipliers in various sized regions behave according to established theory (i.e. multipliers decrease as economic activity size decreases). These researchers conclude that IMPLAN is, in general, holistically accurate. The researchers, however, question IMPLAN's partitive accuracy for Louisiana.

Crihfield and Campbell (1991) take a different approach to testing IMPLAN's accuracy. They compare IMPLAN forecasts to other leading planning models. The REMI model, developed by Regional Economic Models, Inc. is a conjoined input-output and econometric forecasting model. Despite fundamental model implementation differences, comparison was made between IMPLAN, REMI, and published benchmarks for multipliers, employment changes, output-to-employment ratios and other general results. Even though no unambiguous methodology exists to evaluate true performance, the researchers found that, with minor exception, IMPLAN appears to provide predictions which are less "distorted" than REMI.

Comparison between IMPLAN and survey based input-output models have shown that IMPLAN generates comparable results which are reasonable. In a recent study for Clatsop County, Oregon, Waters and Webers (1991) found that IMPLAN multipliers generated from IMPLAN differ from survey multipliers, on average, by less that 5 percent.

Schuster and Medema (1989) assess National Forest timber harvest levels in Idaho and Montana. They used data from 1973 to 1982 to determine (1) if impact projections were accurate and (2) whether some projection methods were clearly more accurate than others. The researchers compare direct, indirect and induced employment change from an input-output method (using IMPLAN), an economic base method, and a "no change" method (assume that harvest level change does not affect employment). They found inconclusive evidence to suggest that IMPLAN projections and economic base methods consistently improve on the "no change" projection and that geographic and time frame specifications were critical. Furthermore, they found that IMPLAN and economic base were much more accurate at estimating changes given larger regions. The detail at which IMPLAN data was confirmed and updated at smaller geographic units in this study is unclear thereby casting doubt on its general conclusions.

The current data version of IMPLAN uses a base year of 1985. Documentation of this data and data reduction methods used has not yet been published. Earlier data used 1977 and 1982 as base years and documentation does exist (Engineering-Economics Associates, Inc., 1985a through 1985e) which indicates generally satisfactory methodological procedures for development of nonsurvey-based data. Caution is required, however, in using IMPLAN to estimate change; particularly at smaller geographic regional levels such as the single county. Cross referencing the IMPLAN data with published benchmarks and other data retrieval methods and interactively adjusting critical variables such as regional purchase coefficients (RPC's) is a must. A discussion of the various RPC error examples can be found in Chapter V.

Looking at IMPLAN Results for Oklahoma

Comparison of IMPLAN Data to Benchmarks. Comparisons were made using an IMPLAN aggregation which reflects the aggregation used in the Regional Economic Information System (USDC, Bureau of Economic Analysis, 1992) data reporting format for the base year 1985. This aggregation scheme by SIC codes can be found in Table XXVII.

Attention will focus on employment comparisons because employment (namely employee compensation) is (1) a major component of value-added within a region, (2) critical to calculation of industry output, and (3) is a common benchmark available for comparison. Other components of value-added such as

TABLE XXVII

BEA-REIS AGGREGATION USED AS TEMPLATE FOR IMPLAN [1].

Sector Number	Sector Name	SIC 2-digit Codes Included
1	Agriculture	01 - 06
2	Timber/Ag, For, and Fish Services	07 - 09
3	Mining	10 - 14
4	Construction	15 - 17
5	Manufacturing	20 - 39
6	Transport/Utility	40 - 49
7	Wholesale Trade	50 - 51
8	Retail Trade	52 - 59
9	F.I.R.E.	60 - 67
10	Services	70 - 89
11	Federal Gov't	NC
12	State/Local Gov't	NC
13	Household	NA

NC = no code available

NA = not appropriate to compare due to noninclusion of households in BEA-REIS data.

1. IMPLAN aggregation template was constructed by SIC grouping as indicated in the IMPLAN User's Guide (IMPLAN Development and Applications Group, 1991), Appendix N. Data regarding BEA, REIS SIC code convention was obtained from Jeff Wallace of the Oklahoma State Data Center, Oklahoma City, OK (405) 841-5181.

returns to land resources and returns to capital resources are more difficult to compare due to nonstandardized reporting procedures.

An important difference between the BEA-REIS data and the IMPLAN data for employment is that IMPLAN uses the concept of full-time equivalent (FTE) whereas the BEA-REIS is counting total full and part-time employment (total number of jobs). This would logically imply that sectors having a larger proportion of part-time employment would display larger discrepancies between the two databases. Sectors exhibiting part-time employment, in general, would have more total jobs when compared to an FTE counting scheme (i.e. BEA-REIS estimates will be higher than IMPLAN where part-time employment is important).

Comparisons were made between IMPLAN and BEA-REIS data for two regions in Southeastern Oklahoma. Figure 12 details comparison for a single county (McCurtain County) during 1985 and Figure 13 details comparison for a three county (McCurtain, LeFlore, and Pushmataha counties) region in Southeastern Oklahoma.

From these figures, notice that (1) the major components of regional employment are captured in both databases and (2) the estimates from both follow a similar pattern. Sectors which exhibit a large proportion of part-time employment, namely agriculture (#1) and retail trade (#8) exhibit the largest discrepancies. Remaining unexplained is the large discrepancy found in the federal sector (#11).

It can be concluded from this that the regional economic description (using employment as one component) upon which IMPLAN predictions are based relies upon published figures at the county-level. These figures represent fairly good estimates of actual regional economic structures.

This says nothing about the prediction capabilities of the IMPLAN system which include A-type (transactions table accuracy) and B-type (mimicry of actual

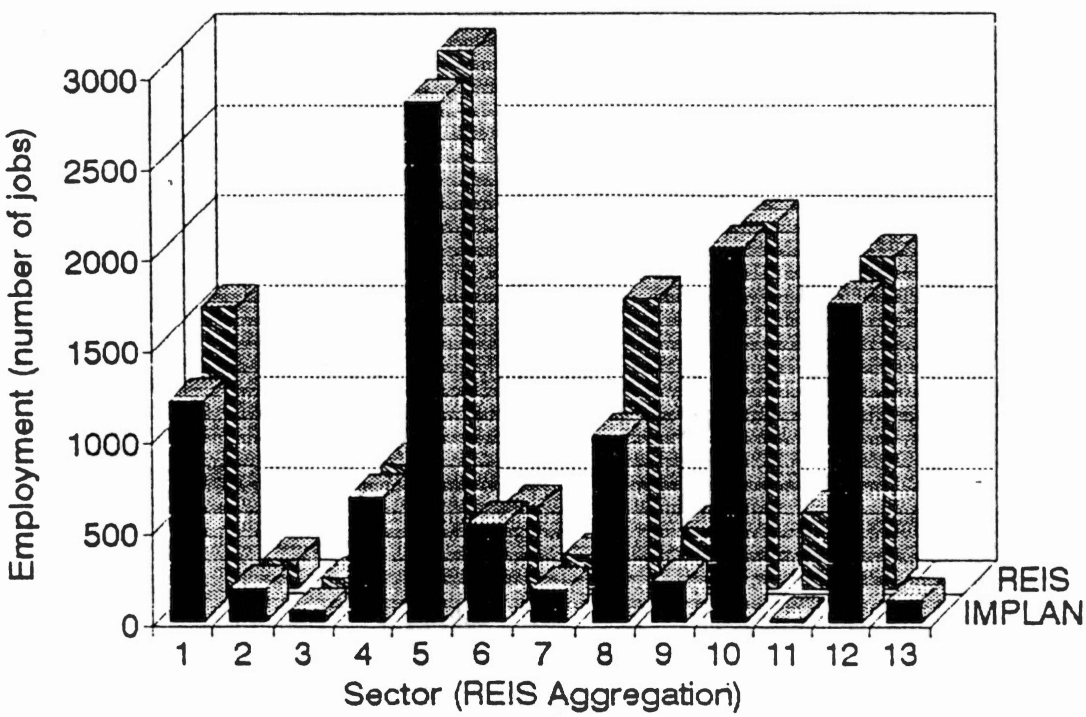

Figure 12. Employment Comparison, USDC-Bureau of Economic Analysis REIS Data and IMPLAN Data for McCurtain County, Oklahoma.

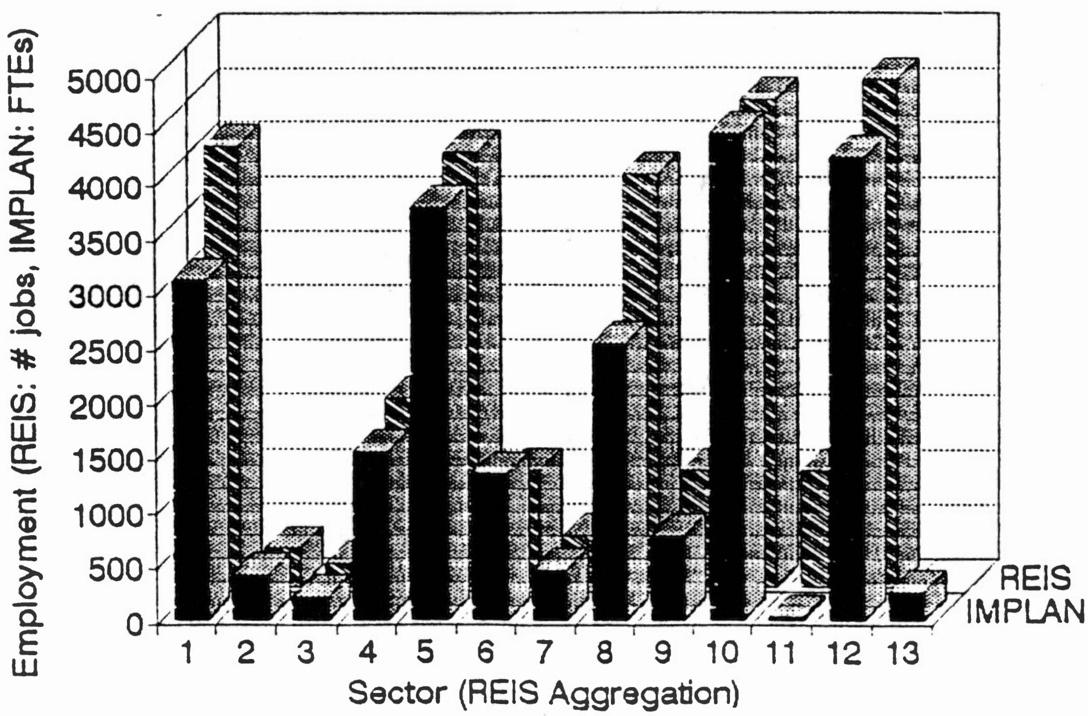

Figure 13. Employment Comparison, USDC-Bureau of Economic Analysis REIS Data and IMPLAN Data for Three County Region in Southeastern Oklahoma, 1985.

regional economic change) accuracies. There exists no standardized benchmark with which to assess transactions between industries at the county level.

An indication of holistic accuracy, however, can be shown by assessing whether multipliers behave according to an acceptable standard. The standard used in this analysis includes successively increasing the size of regions and assessing whether multipliers increase. This follows the assumption that as regions increase in size, the extent of economic activities also respectively increases. This is similar to the test done by Hotvedt, Busby, and Jacob (1988). It is also important to note that Type III employment multipliers vary between 1.2 to 2.2. This is within a reasonable range as compared to other Oklahoma input-output studies (Doeksen, Schreiner, and Barrett, 1978; Schooley and Jones, 1983).

Economic multiplier analysis is an often discussed and criticized aspect of regional economic development. A technical discussion of regional multipliers can be found in Miller and Blair (1985, pages 100-148). The intent of this work is not to advocate the specific usage of multiplier analysis but rather to describe the results of running various IMPLAN models and show the impact of increasing size of economic activity regions.

Holistic Accuracy of IMPLAN. An empirical test was made on the IMPLAN system by generating regional models of various economic activity sizes beginning with a single county and concluding with the state of Oklahoma. Each smaller region modelled using IMPLAN was itself included inside the next sized regional model. Holistically accurate input-output systems would exhibit multipliers which increase in size as the size of the economic activity region increases [1].

Figure 14 illustrates this analysis for the 1985 database IMPLAN Type III employment multipliers generated with the 91-09 version software using the same aggregation template as described earlier. Note that with minor exception, these multipliers do increase in size as the regional size of economic activity grows. Again, unexplained discrepancy occurs in the federal sector with the largest Type III employment multiplier found at the 10 county economic activity size [2]. In general, however, these multipliers behave according to standard convention.

It is important to note that primary data were not incorporated into the models generated for this analysis to assess IMPLAN in its original form. Improvements can be made by incorporating primary data. Of particular importance is the assessment of regional purchase coefficients [3] as well as components of value-added [4] for the region under study.

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1. Literature dealing specifically with this generalization was not found, nor was any rigorous proof of this statement. The generalization, however, does follow fundamental regional economic theory.

2. This may be explained by the generally depressed economic conditions of the 10-county region used. This region is Southeastern Oklahoma which has a large reliance on federal transfer payments.

3. Regional purchase coefficients used in IMPLAN are supply-demand pool adjusted from state coefficients found in Appendix G of IMPLAN Development and Applications Group (1991).

4. Note that factor accounts are those components of value added found in IMPLAN; namely employee compensation, proprietary income, and other property income. The definition of these factor accounts is found below:

    a. Employee Compensation: Wages and salaries paid to employees by industries. This is income accruing to labor.
    b. Proprietary Income: Income of sole proprietorships (includes self-employed income). This is income accruing to labor.
    c. Other Property Income: Dividend, interest and rental income (e.g. interest and corporate profit). This is income accruing to land and capital.

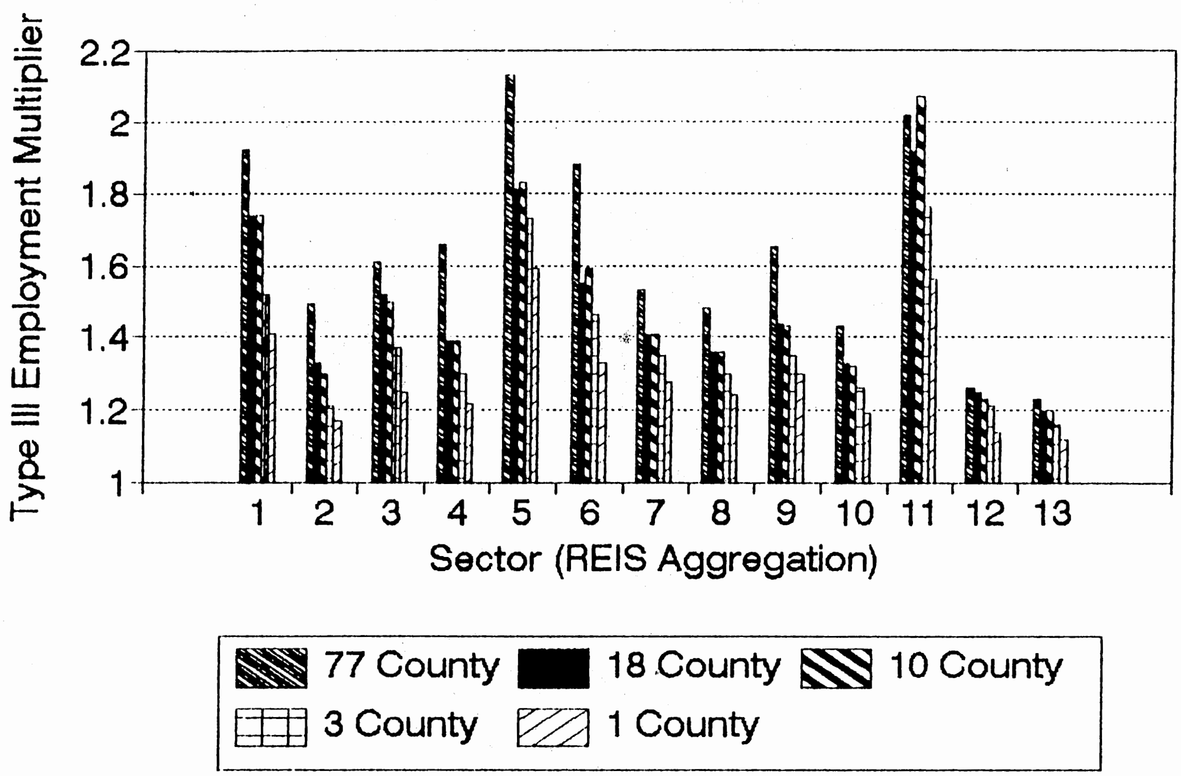

Figure 14. Type III Employment Multipliers Generated from IMPLAN v. 91-08 for 1, 3, 10, 18, and 77 County Inclusive Regions Within Oklahoma for Base Year 1985.

Conclusions

The task of developing a database and software system for county-level resolution over the entire United States is daunting, at best. The IMPLAN group has developed a nonsurvey based system that, based upon benchmarks, is difficult to discredit. The IMPLAN system allows (and encourages) incorporation of better available data which puts a certain amount of responsibility on the user. IMPLAN allows regional input-output analysis to be accomplished in a timely, inexpensive, and relatively accurate manner.

The economic description of regions using IMPLAN captures the important sectors of regional employment. Employment is a key component in regional value-added, hence regional gross product. Employment in IMPLAN is adjusted for FTE's which could be considered a better measure of work-force standard-of-living (critical to analysis focusing on quality employment generation).

The IMPLAN software generates Type III employment multipliers which agree with standard convention. These multipliers are critical to predictions of exogenous change used in economic impact analysis. This prediction accuracy is the B-Type, or holistic, accuracy important to assessing the exactness with which the input-output model reflects the operation of a regional economic structure.

Problems, however, do exist with the IMPLAN database. The state level regional purchase coefficients require careful examination prior to use. Primary data incorporation can improve the ability of IMPLAN to describe regional economic structures as well as prediction impacts of exogenous change.

The extension of IMPLAN to social accounting is interesting. The IMPLAN system has incorporated a social accounting matrix form into it's operation for an earlier (1982) database. It's development is discussed by Alward (1985) and Alward, Lichty, Maki, and Westeren (1992). This IMPLAN social accounting matrix, however, has minor inconsistencies [5] and does not, to the author's knowledge, allow the user to disaggregate the production sector or specify an institutional disaggregation which is critical to focusing attention on industry-specific distributional analysis. Kilkenny (1991) discusses the ability and specific procedures for using IMPLAN to develop social accounting matrices for analyzing farm policies.

IMPLAN is increasingly being considered as a valuable interactive tool to develop nonsurvey-based interindustry analyses and social accounts. Applications have extended from initial Forest Service agency use to a wide variety of clientele groups. Information partnerships are discussed in Siverts and Maki (1990) which detail the current user groups which include the USDA Forest Service, the Federal Emergency Management Agency, the Cooperative Extension Service, the Economic Research Service, the government of Mexico, and a wide variety of individuals, agencies and private entities.

As time progresses, applications of the IMPLAN system will grow along with improvements to the software and database. Usage of IMPLAN for regional economic impact analysis is straightforward and provides relatively good estimates. Improvements in its use, however, will rely upon the professional ethics of individual users to incorporate primary data and understand the full capabilities and limitations of estimates generated.

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5. An IMPLAN SAM was run for the 1982 McCurtain County, Oklahoma region resulting in unequal row - column totals for inventory and capital accumulation. Balance between rows and columns is an important SAM characteristic.

APPENDIX B

ON DETERMINING FACTOR SHARES FOR VARIOUS TIMBER PRODUCTION OWNERSHIPS

Introduction

Standard economic theory outlines the general circular economic flow of the goods market and the factor market within an economy. In the goods market, demand lies within consumers for goods and services which are supplied by producers. In the factor market, roles are reversed and consumers supply the factor inputs while producers demand these factor inputs to produce goods and services. Price discovery occurs in both markets as supply and demand equilibrate.

In the factor market, all production inputs can be summarized as falling within one of three categories. These categories, commonly referred to as factor inputs include (1) land, (2) labor, and (3) capital. Prices paid for these factor inputs include wages for labor, rents for land, and rents in the form of interest for capital. Factor inputs are owned by consumers and payrolls, rents, and interest are paid by producers.

Both theoretical and empirical interest exists in identifying factor shares due [1] to their interpretation as productivity coefficients. Researchers also use factor shares as indicators of change over time and as comparable indicators useful for assessing differences between regions (Ruttan and Stout, 1960). Factor shares analysis is required for this dissertation to disaggregate total value-added in the factor accounts of the social accounting matrix for timber production. Factor shares are also commonly used in general equilibrium analysis.

The intent of this Appendix is to provide detail in determining factor shares for the production of timber used in this dissertation. Literature and research which focuses on factor share analysis for timber production is limited. Boyd and Newman (1991) use factor shares for forestry in aggregate to identify tax reform strategies for land-use in a general equilibrium framework. There is no mention, however, of the manner is which these shares were derived. Empirical factor share analysis used in the allocation process for agriculture has been done by Ruttan and Stout (1960), Tyner and Tweeten (1964 and 1966), and Melichar (1979). Agricultural factor shares are typically determined using current market values for factors under constraining annual values of total gross income. The long-term nature of growing trees and managing forests, however, provide specific challenges to factor share analysis.

Trees will grow naturally with economic inputs limited to land rent, real property taxes, and the opportunity cost embodied in the value of growing stock. Natural regeneration, vegetative competition, natural stand thinning and eventual survival and growth of the fittest trees can generate gross income for landowners without direct landowner production inputs. Statistics show that this type of

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1. Given the situation is characterized by competitive equilibrium and homogeneous production functions.

forest management occurs on the bulk of nonindustrial private lands throughout the South (USDA Forest Service, 1988). More intensive forest management, on the other hand, uses production inputs but, once a stand of trees is established, these trees grow naturally for years prior to requiring further production inputs.

Enterprise budgets for timber frustrate forest economists because of the variability in appropriate discount rates and the extremely long-term nature of the cash flows. A one percent change in discount rate creates very different results in projected gross income. Fundamentally, factor share analysis for the production of timber must be viewed differently than factor share analysis for annual production of agricultural commodities. This appendix provides a theoretical procedure and empirical analysis to determine factor shares for timber production by ownership category.

This analysis uses proportions of bare land value as a proxy for land rents, published wage rates, national *timber production labor : output* ratios and inventory data of past management intensities for labor, and proportions of residual growing stock value for returns to capital goods.

Factor Returns to Land

Ruttan and Stout (1960; page 57) estimate the share of income accruing to land by multiplying the value of land in each region by the average rate of interest charged on farm mortgage debt outstanding in each year [2]. Since statistics on forestland mortgage debt for McCurtain County are not available,

2. It could be hypothesized that forest landowners differ from agricultural landowners in that larger percentages of total forestland acreages are past on through inheritances, paid for with cash, or otherwise owned outright without mortgage payments. Statistics which support this hypothesis are not available and would provide fruitful further research.

this analysis estimates the share of income accruing to land by multiplying the value of bare land in McCurtain County by the total forestland acreage owned by each respective landownership category by an implied rate of interest (or land rental rate). The four McCurtain County landownership categories analyzed here include (1) all forestland ownerships, (2) industrial private forestland (IPF) ownerships, (3) nonindustrial private forestland (NIPF) ownerships, and (4) public forestland ownerships.

Land Resources Used to Produce Timber. Statistics on forestland acreage by ownership in McCurtain County, Oklahoma is contained in the Mid-South Forest Inventory and Analysis (USDA, Forest Service, 1992a and 1992b) database (for further discussion of this database, see Chapter V). In McCurtain County, total forestland acreage is estimated at 878,500 acres of which 596,900 acres are owned by industrial private owners, 174,500 acres are owned by nonindustrial private owners, and 107,000 acres are owned by federal, state and local governments.

Forest Land Values. Forest land values are required for an assessment of returns to land resources. This wealth-based analysis uses the value of existing growing stock (stands of trees) in calculating returns to capital resources. A difficulty exists in identifying these land values because of the simple fact that forestland values include bare land plus growing stock [3]. The instance where

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3. One might ask what differences exist between bare land and bare land classified as forestland. Bare land is simply that, land which is bare of all vegetative growth. A plowed field would provide an example of this. Bare land classified as forestland, however, is land without a forest stand, but with considerable vegetative material remaining. This distinction is important in identifying production costs such as stump-pulling, brush-piling, windrowing, and burning which would be required to produce land capable of agricultural production. Bare land could be directly planted to a row crop. Bare land classified as forestland could not without more production input. The opportunity costs of alternatives are fundamentally different between the two alternative terms thereby leading to a need to distinguish between the two.

forestland is sold just after a clearcut harvest would provide an example of the value of bare land classified as forestland. The value of bare land classified as forestland would logically be a function of its potential productivity in growing trees. This level of sophistication is applied by those land purchasers with a keen sense of forest productivity and silvicultural site relationships. Hard data to distinguish and identify these land purchasers is elusive. Data for land values in McCurtain County was inferred from discussions with those who keep land tax records in McCurtain County. Wide variation exists in purchased acreage sizes and landowner objectives which lead to variations in land value. For this analysis, $100 per acre will be used regardless of ownership or potential productivity. An obvious improvement on this would be to directly survey current land sales by ownership group as well as differentiate by site productivities.

Calculating Land Rental Values. Given acreage of forestland by ownership and multiplying by bare land value yields a total value of bare land forestland. An implied land rental rate is then applied to this total value. The implied land rental rate is determined by fixing total value-added (derived from IMPLAN), accounting for labor (see discussion on labor calculations below), and simultaneously accounting for returns to capital and land (the implied rate is assumed to be the same for returns to capital and returns to land). The implied rate, which is solved for, varies by ownership and depends on each respective ownership's share of total value-added. A discussion of returns to capital resources follows discussion on returns to labor resources.

Factor Returns to Labor

Ruttan and Stout (1960; pages 59-62) use two alternative procedures to determine the factor return to labor. The first procedure uses residuals of gross income after accounting for capital and land. The second procedure used average hourly earnings of hired workers multiplied by the total number of hours worked by all farm workers. An adaptation of the former procedure will be used in this analysis assuming that labor returns are the first payment made from factor income.

Labor Resources Used to Produce Timber. Annual labor used in the production of timber can be identified through the use of labor to output ratios for timber production found at the national level. These have been imbedded in IMPLAN's U.S. datafile (ST85-US.ODF and ST85-US.DFD). Given total timber production output, these ratios provide a control total for annual labor input across all ownerships.

Disaggregating this control total is accomplished through using the Mid-South Forest Inventory and Analysis database (USDA Forest Service, 1992a and 1992b) and identifying management activity and disturbance at the plot level. This collected data describes stand treatments, other than harvesting that have occurred since the last survey. These treatments include codes for *no evidence of stand treatment*, *commercial thinning*, *precommercial thinning*, *stand conversion*, *site preparation*, and *natural disturbance*. It is these treatments which use labor inputs for the sole purpose of producing timber. It should also be noted that these treatments are independent of any timber removals activity. Timber production labor by forest ownership in McCurtain County during 1985 is summarized in Table XXVIII.

TABLE XXVIII

DETERMINING TIMBER PRODUCTION LABOR BY FOREST OWNERSHIP
IN McCURTAIN COUNTY DURING 1985

Ownership	No. of Plots[1] TSI[2]	No. of Total[1] TSI[2] Plots	Proportion of Labor	Total No. of FTE's[3]
IPF	54	61	.885246	140.75
NIPF	3	61	.049180	7.82
PUBLIC	4	61	.065574	10.43
ALL OWNERS	61	61	1.00000	159.0

1. Determined through interactive SOFIA database usage (USDA, Forest Service)
2. T.S.I. (Timber Stand Imvprovement) are identified as "mgt" codes in SOFIA and include commercial thinning, precommercial thinning, stand conversion, and site preparation.
3. FTE (full time equivalent) control is determined using IMPLAN hybrid model McCURT 1.

Labor full time equivalents (FTE's) are distributed proportionally to the acreage treated. This implies that all stand treatments receive equal labor weights. A refinement of this assumption would be to identify different labor input usages by individual stand treatment. The proportion of plots with stand treatments to total plots by respective landownership is identified and calculated. These are then weighted for total treatments so that the ratios sum to one (accounting for all treatments). This ratio is then applied to total employment to identify labor resource used by respective landownership to produce timber.

Labor Wage Values. Information on wages paid in the timber production sector (including SIC codes 0811: timber tracts and 0851: forestry services) is identified for Oklahoma during 1985 by the U.S. Department of Labor (USDL, Bureau of Labor Statistics, 1986; pages 53 and 55). This value ($18,697.69) is an average annual wage weighted by annual average employment. It should be noted here that flaws exist in reporting wage information to the USDL. Also, this value is based on a small sample (only 15 reporting units in Oklahoma account for 105 full-time equivalents). Furthermore, the calculated total employment of the timber production sector in McCurtain County based upon national employment to output ratios was 159 full-time equivalents. If we assume that the reporting units were all originating in McCurtain County, this still only accounts for 66 percent of the total employment. To maintain consistency with IMPLAN operation, this analysis will use the employment figures derived from national coefficients and assume that under-reporting accounts for the discrepancy with USDL data [4].

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4. Certainly, improvements on this procedure can refine the estimates used. A direct survey would provide better statistics on labor input used in timber production.

Calculating Labor Values. The calculation for labor inputs is considerably more staightforward when compared to capital and land. This calculation consists of multiplying the quantity of annual labor by landownership category (described above) by the average annual wage in timber production (also described above). The assumption used here is that a full-time equivalent person employed in producing timber has the same annual wage regardless of the landowner employer [5].

Factor Returns to Capital Goods

Ruttan and Stout (1960; pages 55-57) use current market interest rates on non-real-estate loans, a depreciated value of non-real-estate capital equipment, and a depreciated value of buildings. This procedure is inappropriate for assessment of factor returns to capital goods used in timber production because of the long-term nature of cash flows, the absence of annual building costs, the periodical nature of equipment needs, and the non-annual-input nature of forest stand growth. This analysis uses a proportion of wholesale forest growing stock value net of removals as a proxy for capital rent (or interest). It implies that the capital resources required in producing timber are annual rents taken from the growing stock value of trees themselves.

Wealth-Based Capital Goods Used in Timber Production. The Mid-South Forest Inventory and Analysis (SOFIA) database is used to identify growing stock in McCurtain County during 1985. This growing stock is identified using tree-

5. Returns to labor input into silvicultural stand treatments are the same. The assumption used here is that there exists no quality differences between laborers involved in prescribing and applying silvicultural stand treatments.

level data on sound, acceptable growing stock by hardwoods and softwoods. Sawtimber volumes in board-feet are distinguished from cubic-foot volumes and appropriate conversions are used to identify residual pulpwood volumes in standard cords by softwood and hardwood categories.

Stumpage Values. Prices in 1985 for timber stumpage in Southeastern Oklahoma are reported in Timber-Mart South (Norris, 1985). Keeping units correct, these average prices are applied by product to determine a current market value of growing stock volume. A wholesale rate of .25 is applied to current stumpage prices to determine value of residual growing stock. This is done to recognize that only timber harvested in the current time period has full market value. The remainder has what is known as *wholesale value* (Duerr, 1984; page 58-6). This rate, and the rate at which this wholesale value is discounted (known as the Rothery Factor) are somewhat arbitrarily determined. The concept, however, was valid during the mid-1980's. Where this rate is applied in Western Oregon to determine wholesale values of standing timber for tax purposes, two rates of .25 and .30 may apply depending upon the rate of harvest. This analysis will use the rate applicable to the lower rate of harvest, that being .25.

Calculating Capital Values. A percentage of this total wholesale value of residual growing stock is then calculated based upon a fixed amount of value-added accruing to each respective landownership category. This value could be thought of as the annual capital rent (or interest).

Results for McCurtain County, Oklahoma

Industrial Private Forestland Owners

Table XXIX outlines the calculation of total timber production factor input values for land, labor, and capital on industrial forest ownerships in McCurtain County during 1985. These parameters and calculations for allocating returns to factors of production for timber production are constrained by total returns to factor inputs provided by IMPLAN. For industrial private forests in McCurtain County during 1985, this constraining value is $8,054,144 [6]. This value is determined based upon removals during the base year (discussion of this can be found in Tables V, VI, and VII net of intermediate purchased inputs and indirect business taxes [7]). Since returns to labor are annual payments made through wages, these returns are fully allocated and accounted for prior to allocations to land and allocations to capital.

Once total labor returns are deducted from total returns to factor inputs, returns to capital and land are allocated based upon a fixed percentage. These fixed percentages, which are based upon the residual value after deducting returns to labor, can be thought of as representing an implied capital interest and land rental rate. The residual for industrial timber producers in McCurtain County during 1985 to be allocated to returns to capital and labor is $5,422,368. The

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6. This value is referenced by the proportion (found in Table VII) of total IMPLAN calculated factor income for timber production ($8,717,800).
7. IMPLAN calculates net returns to factor inputs. This net return is total industry output minus intermediate purchased inputs and indirect business taxes. For McCurtain County in 1985, total returns to factor inputs in timber production is $8,717,800. The portion allocated to industrial timber production is found in the far right-hand column of Table VIII.

TABLE XXIX

TOTAL VALUE OF FACTOR INPUTS USED[1] IN PRODUCING TIMBER ON IPF LANDS IN McCURTAIN COUNTY DURING 1985

Factor Input	Quantity Employed	Market Price	Total Value (1985 $)
Land[2]	596,900	100.00	59,690,000
Labor[3]	140.75	18,697.69	2,631,776
Capital[4]			
Softwood Sawtimber[5]	514.749	30,159.10[8]	15,524,373
Softwood Pulpwood[6]	718,807	2.90[8]	2,086,992
Hardwood Sawtimber[7]	273.547	12,450.00[8]	3,405,665
Hardwood Pulpwood[6]	953,125	.75[8]	714,843

1. Obtained through interactive SOFIA database usage USDA, Forest Service, 1992b).
2. Land values are per acre.
3. Labor values are for annual full time equivalent (FTE).
4. Capital factor inputs use growing stock volumes net.
5. Softwood sawtimber volumes were converted from Int ¼ log rule to Scribner using 1.12 Int ¼ (Norris, 1985) and are in million board feet units. Prices are per million bd. ft. Scribner.
6. Pulpwood volumes are converted from cubic foot volumes to standard cords using 80 cubic feet/cord.
7. Hardwood sawtimber volumes were converted from Int. ¼ log rule to Doyle using 1.32 Int. ¼ (Norris, 1985), and are in million board feet units. Prices are per million board feet. Doyle.
8. The wholesale rate of .25 applies to price.

fixed percentage applied to total value of capital and total value of land for industrial timber producers is 0.066596 (or roughly 6.5 percent).

Applying this fixed percentage to total value of capital and labor thus allows a calculation of factor shares. Factor shares for industrial timber producers in McCurtain County during 1985 are 0.493549 for land, 0.326761 for labor, and 0.179691 for capital.

Nonindustrial Private Forestland Owners

The same procedure as outlined above is used to determine factor shares for nonindustrial private forestland (NIPF) owners in McCurtain County during 1985. Table XXX details the calculation of total factor input values. The total amount of factor returns allocated for NIPF owners is $503,600 (see footnote 6). The residual amount, after subtracting out returns to labor, is $357,390, which is then used to determine the implied capital interest and land rental rate. This implied rate of return to capital and land for NIPF landowners in McCurtain County during 1985 is 0.011787 (or slightly more than 1 percent).

Applying this rate to total capital and land value, factor shares can be calculated. Factor shares for NIPF landowners in McCurtain County during 1985 are 0.407256 for land, 0.29033 for labor and 0.302414 for capital.

Public Forestland Owners

Public forestland owners in McCurtain County include the Tiak District of the Ouachita National Forest (managed by the USDA Forest Service), Army

TABLE XXX

TOTAL VALUE OF FACTOR INPUTS USED[1] IN PRODUCING TIMBER ON NIPF LANDS IN McCURTAIN COUNTY DURING 1985

Factor Input	Quantity Employed	Market Price	Total Value (1985 $)
Land[2]	174,500	100	17,450,000
Labor[3]	7.82	18,697.69	146,210
Capital[4]			
Softwood Sawtimber[5]	325.688	30,159.10[8]	9,822,452
Softwood Pulpwood[6]	188,556	2.90[8]	547,456
Hardwood Sawtimber[7]	155.411	12,450.00[8]	1,934,864
Hardwood Pulpwood[6]	821,160	.75[8]	615,870

1. Obtained through interactive SOFIA database usage (USDA, Forest Service, 1992b).

2. Land values are per acre.

3. Labor values are for annual full time equivalent (FTE).

4. Capital factor inputs use growing stock volumes.

5. Softwood sawtimber volumes were converted from log rule to Scribner using 1.12 Int. ¼ (Norris, 1985) and are in million board feet units. Prices are per million board feet Scribner.

6. Pulpwood volumes are converted from cubic foot volumes to standard cords using 80 cubic feet/cord.

7. Hardwood sawtimber volumes were converted from Int. ¼ log rule to Doyle using 1.32 Int. ¼ (Norris, 1985), and are in million board feet units. Prices are per million board feet Doyle.

8. The wholesate rate of .25 applies to price.

Corps of Engineers forest land and State of Oklahoma forest lands. Table XXXI describes the calculations to determine total timber production factor inputs for public land in McCurtain County during 1985. The same procedure as outlined above is used to determine factor shares for these landowners.

It is important to note at this time that the timber on public lands in McCurtain County during 1985 does not appear to be effectively managed using economic efficiency criteria [8]. This conclusion is reached by observing that the portion of returns to factor inputs (based upon timber removals) attributable to public owners is not sufficient to meet the timber production labor wage bill. Other land management criteria are used in managing public lands including non-market goods production such as recreation, wildlife habitat, etc. The assumption is made that federal transfers to the region make up the difference and that the total wage bill for timber production on public lands in McCurtain County during 1985 is paid. This, in part, explains the negative factor shares attributable to capital and land for public ownerships.

The total amount of factor returns to allocate for public owners is $160,056 (see footnote 6). The residual amount, after subtracting out returns to labor, is -$34,890 which is then used to determine the implied capital interest and land rental rate. This implied rate of return to capital and land for public landowners in McCurtain County during 1985 is - 0.00133 (or roughly negative .1 percent).

Applying this rate to total capital and land value, factor shares can be calculated. Factor shares for public landowners in McCurtain County during 1985 are - 0.0889 for land, 1.217988 for labor and - 0.12908 for capital.

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8. This analysis assesses only timber production and therefore is insufficient to draw conclusions regarding total land management economic efficiency which would include implied returns to recreation and wildlife habitat improvement.

TABLE XXXI

TOTAL VALUE OF FACTOR INPUTS USED[1] IN PRODUCING TIMBER ON PUBLIC FOREST LANDS IN McCURTAIN COUNTY DURING 1985

Factor Input	Quality Employed	Market Price	Total Value (1985 $)
Land[2]	107,000	100	10,700,000
Labor[3]	10.43	18,697.69	194,946
Capital[4]			
Softwood Sawtimber[5]	342.127	30,159.10[8]	10,318,243
Softwood Pulpwood[6]	270,335	2.90[8]	784,895
Hardwood Sawtimber[7]	325.797	12,450.00[8]	4,056,176
Hardwood Pulpwood[6]	502,396	.75[8]	376,797

1. Obtained though interactive SOFIA database usage (USDA, Forest Service, 1992b).

2. Land values are per acre.

3. Labor values are for annual full time equivalent (FTE).

4. Capital factor inputs use growing stock volumes net.

5. Softwood sawtimber volumes were converted from Int. ¼ log rule to Scribner using 1.12 Int. ¼ (Norris, 1985) and are in million board feet units. Prices are per million board feet Scribner.

6. Pulpwood volumes are converted from cubic foot volumes to standard cords using 80 cubic feet/cord.

7. Hardwood sawtimber volumes were converted from Int. ¼ log rule to Doyle using 1.32 Int. ¼ (Norris, 1985), and are in million board feet units. Prices are per million board feet. Doyle.

8. The wholesale rate of .25 applies to price.

All Forestland Ownerships

The same procedure as outlined above is used to determine factor shares for all forestland owners in McCurtain County during 1985. This aggregation is necessary for allocations to the timber production sector in the SAM (factor income distribution found in Table XV). Table XXXII details the calculation of total factor input value. Discrepancies with individual ownership totals is attributable to rounding error. The total amount of factor returns to allocate for all forestland owners is $8,717,800. The residual amount, after subtracting out returns to labor, is $5,744,867 which is then used to determine the implied capital interest and land rental rate. This implied rate of return to capital and land for all forest landowners in McCurtain County during 1985 is 0.041621 (or slightly more than 4 percent).

Applying this rate to total capital and land value, factor shares can be calculated. Factor shares for all forestland owners in McCurtain County during 1985 are 0.419419 for land, 0.341019 for labor and 0.239562 for capital.

TABLE XXXII

TOTAL VALUE OF FACTOR INPUTS USED[1] IN PRODUCING TIMBER ON ALL FOREST LANDS IN McCURTAIN COUNTY DURING 1985

Factor Input	Quantity Employed	Market Price	Total Value (1985 $)
Land[2]	878,500	100	87,850,000
Labor[3]	159	18,697.69	2,972,933
Capital[4]			
Softwood Sawtimber[5]	1,182.204	30,159.10[8]	35,654,213
Softwood Pulpwood[6]	1,177,709	2.90[8]	3,419,373
Hardwood Sawtimber[7]	754.755	12,450.00[8]	9,396,705
Hardwood Pulpwood[6]	2,276,681	.75[8]	1,707,511

1. Obtained through interactive SOFIA database usage (USDA, Forest Service, 1992b).

2. Land values are per acre.

3. Labor values are for annual full time equivalent (FTE).

4. Capital factor inputs use growing stock volumes.

5. Softwood sawtimber volumes were converted from Int. ¼ log fule to Scribner using 1.12 Int. ¼ (Norris, 1985) and are in million board feet units. Prices are per million board feet Scribmer.

6. Pulpwood volumes are converted from cubic foot volumes to standard cords using 80 cubic feet/cord.

7. Hardwood sawtimber volumes were converted from Int. ¼ log rule to Doyle using 1.32 Int. ¼ (Norris, 1985), and are in million board feet units. Prices are per million board feet Doyle.

8. The wholesale rate of .25 applies to price.

APPENDIX C

ANNOTATED BIBLIOGRAPHY OF SELECTED REFERENCES

The following literature was compiled during 1990, 1991 and 1992 to determine the status of current research dealing with timber production and its role in regional socioeconomic development.

The literature referred to within this bibliography was determined appropriate based upon relevance to the above topic. Specifically, literature is sought which allows a deeper understanding of the ability of forests to act as tools to regional economic development including economic problems specific to forested regions. Regional analysis literature as it pertains to natural resource management is of interest including input-output analysis, social accounting matrix development and computable general equilibrium. Identification and understanding of operating regional modeling systems such as IMPLAN are also objectives of this literature compilation. Also of interest is a comprehensive listing of current regional modeling system applications focusing on natural resource-based regions. Figure 15 identifies a general outline of research needs and the literature found pertaining to each respective category.

Much of the literature was identified through electronic databases using keywords. A listing of the various databases and the keywords used is found in Appendix D. Literature pertaining to computable general equilibrium models was identified in a bibliography by Devarajan, Lewis and Robinson (1986). Earlier (pre-1980) literature pertaining to spatial and regional analysis methods applied to forestry settings was identified in a bibliography by Obiya, Chappelle and Schallau (1986). Assistance in identifying IMPLAN literature was provided by the IMPLAN Development and Applications Group. Reference sections of identified literature were also valuable in identifying focused works.

Annotations for each reference were written through assessment of the literature as it pertains to this study. If available, use of an abstract or introductory statement from the article or text assisted in writing the annotation and should not be construed as an infringement on copyright. The letter directly preceding each annotation corresponds to the cross-referenced categories found in Figure 15.

Numerous acronyms are used throughout the annotated bibliography. To assist the reader, Appendix E identifies and defines acronyms found within.

A complete listing of all authors can be found at the end of this bibliography (pages 37 and 38). Numbers listed next to authors in the index correspond to the numbers found within the bibliography.

Figure 15. Cross Reference of Literature

The following organizes the literature according to major category for use in the dissertation entitled *Development and Use of a Supply-Determined Social Accounting Matrix to Evaluate Economic Impacts of Forest Productivity on Regional Distribution of Factor Income*. The numbers following each topical heading correspond with the numbered citation in the annotated bibliography.

The reader should realize that the following category listing is broad. There exists a certain amount of reference-crossover depending upon a paper's scope. Literature was classified by the most appropriate broad category. Each reference is listed in only one of the following categories:

a. General forestry statistics and context within which forestry operates:

Includes references of a general nature such as forest statistics, ability of forests to be managed within societally determined constraints, etc.

23, 29, 38, 72, 91, 93, 102, 161, 163, 164

b. Addressing economic problems of forested regions:

Includes references dealing specifically with problems such as economic dependency, non-market resource valuation, investment constraints, imperfect markets for timber production, natural resource policy analysis and general references regarding transfer payments and income distribution.

20, 25, 26, 30, 34, 37, 43, 49, 57, 64, 65, 66, 90, 95, 97, 108, 109, 117, 120, 121, 122, 123, 124, 127, 132, 133, 137, 158, 159, 168, 170, 171, 172, 173, 174

c. Approaches to economic development:

Includes references of a comprehensive rural economic development analysis nature applicable to natural resource based economies.

100, 101, 106, 114, 135, 149, 152, 157, 165

d. Input-output analysis theory and general concepts:

Includes references which outline basic input-output analysis theory and references specific to addressing problems associated with how natural resources can be dealt with.

33, 45, 48, 52, 53, 55, 81, 82, 83, 89, 98, 99, 110, 115, 118, 150, 151, 153, 160

e. Applications of input-output analysis with natural resource focus:

Specific references dealing with input-output analysis extended to natural resource applications.

18, 27, 35, 46, 47, 50, 60, 61, 63, 67, 68, 77, 84, 94, 96, 128, 129, 130, 131, 146

f. Extension of input-output to social accounting matrices (concepts):

Basic literature which deals with the theoretical concepts involved in extending input-output analysis to a social accounting framework.

39, 54, 69, 73, 85, 111, 112, 113, 116, 119

g. Extension of input-output to social accounting matrices (applications):

Includes references of how social accounting matrices have been applied to address various problems in regional analysis.

1, 3, 28, 31, 36, 51, 58, 62, 70, 86, 87, 125, 134, 148, 154, 166

h. Development and operation of IMPLAN:

References outline the development, theoretical construct, and operation of IMPLAN, the U.S.D.A. Forest Service input-output analysis system.

4, 6, 7, 10, 13, 14, 15, 16, 24, 56, 71, 74, 79, 80, 92, 105, 139, 140, 141, 142, 143, 144, 145, 147, 162, 169

i. Applications of IMPLAN:

Literature outlines the various regional analysis applications which have been made using IMPLAN. Primary focus is on references which apply IMPLAN to natural resource-based regional analysis.

5, 8, 9, 11, 12, 21, 22, 44, 59, 75, 78, 103, 104, 107, 126, 136, 138, 155, 156

j. Extensions to computable general equilibrium (CGE) analysis:

References outline the theory and construction of CGE models and applications of CGE models to regional analysis.

2, 17, 19, 32, 40, 41, 42, 76, 88, 167, 175, 176

Development and Use of a Supply Determined Social Accounting Matrix to Evaluate Socioeconomic Impacts of Forest Productivity on Regional Distribution of Factor Income

An Annotated Bibliography

1. Adelman, I. and S. Robinson. 1986. U.S. Agriculture in a General Equilibrium Framework: Analysis with a Social Accounting Matrix. American Journal of Agricultural Economics, 68(5):1196-1207.

   g. *Multisectoral models of the sort used in developing countries and their applicability to address similar problems in the United States are discussed. A U.S. social accounting matrix (SAM) is constructed for 1982 and impacts of various exogenous shocks are analyzed which focus on the links of agricultural and nonagricultural sectors.*

2. Adelman, I, and S. Robinson. 1987. Macroeconomic Adjustment and Income Distribution: Alternative Models Applied to Two Economies. Working Paper No. 385, Dept. of Agricultural and Resource Economics, University of California, Berkeley, CA. 34 pages.

   j. *This paper outlines the construction of a computable general equilibrium (CGE) model that incorporates neoclassical, neo-Keynesian, and a variety of structuralist macro closure rules. This model is then applied to Brazil and Korea. Results indicate that size distribution of income is insensitive to macro closure rules, functional distribution is very sensitive to macro closure rules, and balance-of-trade closure is at least as important in determining distributional outcomes as the savings-investment closure.*

3. Adelman, I., J.E. Taylor, and S. Vogel. 1988. Life in a Mexican Village: A SAM Perspective. Journal of Development Studies, 25(1):5-24

   g. *A 1982 village SAM is employed to analyze economic structure of a migrant-sending rural economy in central Mexico using household survey data. SAM multipliers are derived and utilized in policy experiments on production, value added, income, and investment flows of the village. Results highlight importance of internal and international migration to village economy.*

4. Alward, G. and C. Palmer. 1983. IMPLAN: An Input-Output Analysis System for Forest Service Planning, in: R. Sepalla, C. Row, and A. Morgan (eds.), Forest Sector Models: Proceedings of the First North American Conference on Forest Sector Modeling, Williamsburg, VA, Nov. 30-Dec. 4, 1981; pp. 131-140.

   h. *Contents and procedures used to develop nation-wide IMPLAN database are identified. Analytical capabilities of the system are described in the context of USFS planning efforts.*

5. Alward, G. and B.J. Sullivan. 1984. Estimated Impacts of Increased Federal Grazing Fees on Income and Employment in 13 Western States, Appendix to the 1985 USFS/BLM Grazing Fee Study, October 5, 1984. 125 pages.

   i. *Economic implications of changes in federal grazing fees are analyzed for 13 western states using standard IMPLAN procedures. Interesting causal structure of economic effects diagram used on page 5.*

6. Alward, G., H.C. Davis, K. Despotakis, and E. Lofting. 1985. Regional Non-Survey Input-Output Analysis With IMPLAN, a paper presented at the Southern Regional Science Association Conference, Washington, DC, May 9-10, 1985. 26 pages.

h. *IMPLAN system characteristics and applications are reviewed. Regional I/O is emphasized as well as a discussion of changes and enhancements to IMPLAN circa 1985. Dated work ... interesting IMPLAN history. Good discussion of income distribution (page 14) and early work to incorporate Rose's matrices.*

7. Alward, G. 1985. Extending the IMPLAN I/O System: The Social Accounting Matrix, A paper presented at the Midwest Forest Economist's meeting, Ames, Iowa, May 30-31, 1985.

h. *I/O framework extended to a SAM is detailed. IMPLAN development of a SAM is discussed. Mathematical representations of the IMPLAN SAM are presented as well as a brief discussion of potential applications for USFS policy analysis.*

8. Alward, G., and E. Lofting. 1985. Opportunities for Analyzing the Economic Impacts of Recreation and Tourism expenditures Using IMPLAN, a paper presented at the 13th Annual Meeting of the Regional Science Association, Philadelphia, Pennsylvania. Nov. 14-16, 1985.

i. *Enhancements to both the standard data components of IMPLAN used to construct regional economic accounts and I/O models as well as augmented data on consumption expenditures related to recreation and tourism activities are discussed. Attributes of the system particularly relevant to analyzing recreation and tourism are emphasized.*

9. Alward, G.S., B.J. Sullivan and T. W. Hoekstra. 1985. Using Socioeconomic data in the Management of Fishing and Hunting. Transactions of the 49th North American Wildlife and Natural Resources Conference; pp. 91-103.

i. *Illustrates use of "The National Survey of Fishing, Hunting, and Wildlife-Associated Recreation" data with IMPLAN models to determine the impacts of wildlife management policies upon the supplying industries and income of regional economies.*

10. Alward, G.S. 1986. A Generalized System for Regional Input-Output Analysis of Natural Resource Issues. In Systems Analysis in Forest Resources (R.C. Field and P.E. Drers, eds.) Society of American Foresters Systems Analysis Workshop, Athens, Georgia. December, 1985.

h. *Characteristics of the current and revised versions of the USFS IMPLAN system for generating regional non-survey I/O models are discussed. Enhancements to the system such as the ability to generate a SAM are discussed. Potential extensions of IMPLAN to artificial intelligence and interpretive aides are discussed.*

11. Alward, G. 1987a. Local and Regional Impacts of Outdoor Recreation Development, in: The President's Commission on American Outdoors: A Literature Review, December, 1986; pp. 47-57.

i. *Interactions between recreation activities and economic consequences at the regional level are examined. Spatial and structural aspects are emphasized which focus on the attributes critical to analyzing recreation. Direct and indirect as well as social accounting of recreation benefits are discussed.*

12. Alward, G. 1987b. Assessing the Socioeconomic Implications of Multiple-Use Forestry: Methods and Findings, Proceedings of the VIIIth IUFRO World Congress, Ljubljana, Yugoslavia; pp. 191-202.

i. *Methods for systematically assessing the implications of forest land use decisions such as timber harvesting, livestock grazing, watershed development and wildland recreation are discussed. The incorporation of social accounting into IMPLAN is to assess socioeconomic impacts of multiple-use forestry is outlined.*

13. Alward, G.S. 1987c. IMPLAN Version 2.0: Methods Used to Construct the 1982 Regional Economic Data Base, USDA Forest Service General Technical Report RM-000, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

h. *Methods and procedures used to assemble the IMPLAN version 2.0 database of regional economic statistics for constructing social accounting matrices are discussed. Principle components include a social accounting matrix for the 1982 U.S. economy, total outputs, factor accounts and employment for 528 industries in all states and counties. Text and appendices detail specific adjustments made to derive a consistent and highly dissaggregated system.*

14. Alward, G.S. and K. Despotakis. 1987. IMPLAN Version 2.0: Data Reduction Methods for Constructing Regional Economic Accounts, USDA Forest Service General Technical Report RM-000, Rocky Mountain Forest and Range experiment Station, Fort Collins, CO.

h. *The regional purchase coefficient (RPC) technique for estimating regional trade is described. Analogous to the Armington assumption, the RPC technique approximates gross import and export trade based upon a supply-demand pooling method. Characteristics of the available empirical base are examined, with emphasis on the conventions underlying documentation of trade flows and appropriate data reduction techniques.*

15. Alward, G., E. Siverts, D. Olson, J. Wagner, D. Senf, and S. Lindall. Micro IMPLAN: Software Manual. Colorado State University, 1989.

h. *Outdated IMPLAN manual.*

16. Alward, G., R. Lichty, W. Maki and K. Westeren. 1992. Social Accounting System for a Natural Resource-Based Regional Economy. Paper presented at the Mid-continent Regional Science Association annual meetings, June 4-6, 1992, Stillwater, OK.

h. *Several related applications of the SAM framework within an impact assessment of a natural resource-based region in Northeast Minnesota and another in Central Norway are presented. In rough form, this paper outlines an approach to ecological modeling using the SAM methodology.*

17. Aradhyula, S.V., K. Eswaramoorthy and K. Frohberg. 1988. An Application of the Computable General Equilibrium Model to Analyze U.S. Agriculture. Working Paper 88-WP 26, Center for Agricultural and Rural Development, Iowa State University, Ames, IA. 27 pages.

j. *The effects of exchange rate and capital stock changes are analyzed using a CGE model for the U.S. The model is in the Walrasian tradition and is calibrated to 1982 data. Results indicate that a devaluation of the U.S. dollar has a positive effect on the agricultural sector and balance of trade, but has a negative effect on consumers.*

18. Badger, D.D., D.F. Schreiner, and R.W. Presley. 1977. Analysis of the Impacts of Consumption and Investment Expenditures for Outdoor Recreation at the McClellan-Kerr Arkansas River Multiple Purpose System. IWR Contract Report 77-4, U.S. Army Corps of Engineers, Fort Belvoir, VA.

e. *Data on expenditures for water-related outdoor recreation of the McClellan-Kerr Arkansas River Navigation system are presented as well as detail of the survey work done. An interregional I/O model is discussed to assess economic impacts of recreationist' expenditures.*

19. Bandara, J.S. 1991. Computable General Equilibrium Models for Development Policy Analysis in LDCs. Journal of Economic Surveys, 5(1):3-69.

j. *In this survey article, the advantages of general equilibrium approaches over partial equilibrium approaches in analyzing a wide range of policy issues are highlighted. The evolution of CGE modelling is discussed and more than 60 CGE applications related to different policy issues in less developed countries (LDCs) are surveyed.*

20. Bartels, C.P.A. 1977. Economic Aspects of Regional Welfare, Income Distribution and Unemployment. Martinus Nijhoff Social Sciences Division, Leiden, The Netherlands. 261 pages.

b. *This text outlines statistical characteristics of income inequality measures, welfare functions, intra-regional income distributions, regional unemployment, and the labor market. Young-Kon (1991, citation 176) refers to this author's work in identification of the Weibull distribution as an appropriate selection for a probability density function of income.*

21. Bergstrom, J.C, H.K. Cordell, A.E. Watson and G.A. Ashley. 1990. Economic Impacts of State Parks on State Economies in the South. Southern Journal of Agricultural Economics, 22(2):69-77.

i. *The economic impacts of recreational visits to state parks on the economies of North Carolina, South Carolina, Georgia, and Tennessee were estimated using IMPLAN. Recreational expenditure data was obtained from the Public Area Recreation Visitors Study (PARVS).*

22. Beuter, J.H. 1990. Social and Economic Impacts of Spotted Owl Conservation Strategy. American Forest Resource Alliance Technical Bulletin No. 9003, Washington, D.C.. 37 pages

i. *This report details the findings of an economic, social and forestry science team to study economic impacts and social/cultural implications of implementing the conservation strategy for the Northern Spotted Owl. Use of IMPLAN was made to analyze regional economic impacts.*

23. Birdsey, R.A. and D.M. May. 1988. Timber Resources of East Oklahoma. USDA Forest Service Resource Bulletin SO-135, Southern Forest Experiment Station, New Orleans, LA.

a. *Summary statistics of eastern Oklahoma forests as surveyed by USFS in 1986. Detail found in SOFIA.*

24. Borgen, H.B. and S.C. Cooke. 1991. Income Multipliers for Idaho from IMPLAN Data. In: Proceedings: IMPLAN, May 20-22,1991; Western Rural Development Center, Oregon State University, Corvallis, OR; pp. 5-20.

h. *The IMPLAN Type III multipliers are examined and critiqued. An affirmation of the equations for the type III income multipliers is undertaken with a 35 sector model of the state of Idaho. Serious inconsistencies were identified with the multipliers. Type III multipliers are more akin to nonstandard Type II multipliers. Marginal propensity to consume is contrasted with average propensity to consume in concluding inconsistencies.*

25. Bowker, J.M. and J.R. Stoll. 1988. Use of Dichotomous Choice Nonmarket Methods to Value the Whooping Crane Resource. American Journal or Agricultural Econonomics, 70(2):372-381.

b. *Valuation of the whooping crane is accomplished a utilizing dichotomous choice form of contingent valuation methodology. In effect, this quantifies individuals' economic surplus associated with preservation of the whooping crane resource. Results suggest caution be used in applying dichotomous choice techniques.*

26. Boyd, R.G. and W.F. Hyde. 1989. Forestry Sector Intervention: The Impacts of Public Regulation on Social Welfare. Iowa State University Press, Ames, Iowa. 295 pages.

b. *The effect of public regulation on the natural resource sector in general and the forestry sector in particular are analyzed. Focus is on private forestlands, taxation and public ownership in forestry. The text outlines state forest practice acts, cost sharing, price reporting services, minimum wage/OSHA regulations, the Jones Act, taxation and public ownership and relevant policy implications.*

27. Brucker, S.M., S.E. Hastings and W.R. Latham III. 1987. Regional Input-output Analysis: A Comparison of Five Ready-made Model Systems. Review of Regional Studies, 17(2):1-20.

e. *The evolution of regional I/O over the last 25 years (since 1987) is discussed. Five I/O regional modelling systems are discussed including RIMS II, ADOTMATR, RSRI, IMPLAN, AND SCHAFFER. Evaluation is dated to 1986 (i.e. the current IMPLAN version evaluated was mainframe-based). Provides good discussion of comparable system limitations.*

28. Budiyanti, R. and D.F. Schreiner. 1991. Analysis of Income Distribution for Rural Central Java Emphasizing Women and Landless Groups: An Application of Social Accounting Methodology. Paper presented at the Mid-Continent Regional Science Association Meetings, Chicago, IL; May 31 - June 1, 1991.

g. *Sources of income for women and landless rural laborers in Central Java is traced using a social accounting matrix. Good discussion of income distribution inequity focusing on target populations. Fixed prices and unitary expenditure elasticities are assumed.*

29. Carlisle, A. and L. Chatarpaul. 1984. Intensive Forestry: some socioeconomic and environmental concerns. Petawawa National Forestry Institute, Canadian Forestry Service, Information Report PI-X-43.

a. *Recent changes in society's demands upon forests are outlined. Increasing interaction and potential conflict between forest policy, socioeconomic issues and environmental concerns are documented.*

30. Clawson, M. 1974. Conflicts, strategies, and possibilities for consensus in forest land use and management. In: Forest Policy for the Future, papers and discussions from a forum on forest policy for the future, May 8-9, 1974, Washington, D.C.; pp 101-191.

b. *Primer on fundamentals of conflict management related to natural resource management. Good discussion of increasing societal interaction as well as an excellent systematic portrayal using a land-use compatibility matrix.*

31. Cohen, S.I. 1988. A Social Accounting Matrix Analysis for the Netherlands. De Economist, 136(2):253-272.

g. *The conceptual framework of a SAM for the Netherlands is described. A set of equations is identified, multipliers decomposed and conclusions drawn using fixed price analysis.*

32. Condon, T., H. Dahl and S. Devarajan. 1987. Implementing a Computable General Equilibrium Model on GAMS: The Cameroon Model. Report No. DRD290, Development Research Department, Economics and Research Staff, World Bank. 74 pages.

j. *This paper presents solutions to practical difficulties in applying general equilibrium models. A prototype model of Cameroon is used to describe a framework for implementing numerical general equilibrium models on the General Algebraic Modeling System (GAMS).*

33. Connaughton, K.P., P.E. Polzin, and C. Schallau. 1985. Tests of the Economic Base Model of Growth for a Timber Dependent Region. Forest Science, 31(3):717-725.

d. *The assumption that basic activity affects but is not affected by derivative activity in Flathead County, Montana is tested using Granger causality testing. Granger causality basically states that one variable "causes" another if the second can be better predicted by using past information on the first than by not using that information. Results cast doubt on economic base modelling assumptions thereby signalling caution for usage of static multipliers. Basic sectors, in particular, timber production, appear to be affected by derivative sectors.*

34. Cordell, H.K., L.A. Hartmann, A.E. Watson, J. Fritschen, D.B. Propst, and L.E. Siverts. 1987. The Background and Status of an Interagency Research Effort: The Public Area Recreation Visitors Survey (PARVS), proceedings: 1986 Southeastern Recreation Research Conference, Asheville, NC.

b. *This paper details the current status of PARVS. PARVS was initiated in 1982 to provide data on direct value of recreational visits to users by describing travel, recreational, and demographic profiles. At paper printing, 20,000 visitors have been interviewed.*

35. Crihfield, J.B. and H.S. Campbell, Jr. 1991. Evaluating Alternative Regional Planning Models. Growth and Change, Spring(1991):1-16

e. *This paper evaluated the Regional Economic Models, Inc. (REMI) and IMPLAN economic impact analysis systems. The relative performance of these models in estimating economic impact of opening an automobile manufacturing facility in central Illinois is assessed. Using indirect performance criteria, IMPLAN generated more plausible outcomes compared to REMI.*

36. Crossman, P. 1988. Balancing the Australian National Accounts. Economic Record, 64(184):39-46.

g. *Australian income and expenditure accounts are balanced using a social accounting matrix. The paper discusses the assignment of reliability weights to items in the accounts as well as the balancing method used.*

37. Danziger, S.H. and K.E. Portney (ed.). 1988. The Distributional Impacts of Public Policies. St. Martin's Press, New York, NY. 257 pages.

b. *This compilation of papers submitted to the* Policy Studies Journal *were selected by the editors in response to a call for work dealing with the distributional impacts of public policies. Interesting summary of transfer payment policy.*

38. Davis, L.S. and K.N. Johnson. 1987. Forest Management. McGraw Hill, Inc., New York, NY. 790 pages.

a. *Standard undergraduate text in forest management. Chapter 8 outlines evaluation of project and planning alternatives and briefly describes input/output analysis in the context of regional development. Discussion of evaluation criteria including economic efficiency, equity, regional development, stability and environmental security are specific to forest management.*

39. Defourney, J. and E. Thorbecke. 1984. Structural Path Analysis and Multiplier Decomposition Within a Social Accounting Matrix Framework. The Economic Journal, 94(373):111-136

f. *Structural path analysis is applied to a social accounting matrix to identify the network through which influence is transmitted through the system. This provides a more detailed method to decompose multipliers. The specific multiplier decomposition is discussed for a South Korean SAM.*

40. deMelo, M.H. 1982. A Simulation of Development Strategies in an Economy-wide Model. Economic Development and Cultural Change, 30(2):335-349.

j. *This paper presents a quantitative assessment of the effects of alternative development strategies on GNP growth, employment, income distribution and real income of lowest income group. A representative set of technological, economic and institutional relationships is assumed using a SAM and CGE model applied to Sri Lanka.*

41. Dervis, K, J. deMelo, and S. Robinson. 1982. General Equilibrium Models for Development Policy. The World Bank, Washington, D.C. 526 pages.

j. *This World Bank publication develops and discusses the computable general equilibrium (CGE) models common in development literature. CGE models are detailed for closed economies, with incorporated foreign trade and trade policy, and for open economies. Appendices outline methodological approaches to building a SAM as well as algorithms and solution strategies used.*

42. Devarajan, S., J.D. Lewis, and S. Robinson. 1986. A Bibliography of Computable General Equilibrium (CGE) Models Applied to Developing Countries. Unpublished bibliography.

j. *Bibliography of literature pertaining to CGE models for developing countries.*

43. DeVilbiss, J. 1986. Timber Stumpage Supply and Economic Dependency. Ph.D. dissertation, Michigan State University, East Lansing, Michigan. 106 pages plus appendices.

i. *This dissertation analyzes and evaluates the economic dependency of 8 case study areas throughout the Rocky Mountain Region. IMPLAN is used to develop I/O models for each study area. Analysis focused on export based industries such as timber production and processing. National timber stumpage markets were analyzed for each area. Results showed positive economic dependency on total export bases.*

44. Dicks, M., B. Hyberg, T. Hebert, E. Siverts, and J. Wagner. 1991. Development of a Regional Inter-sectorial Impact Simulator. Oklahoma Agricultural Experiment Station Bulletin B-800, Division of Agricultural Sciences and Natural Resources, Oklahoma State University, Stillwater, OK. 31 pages.

b. *This paper outlines the RISIS modelling systems which is primarily a spreadsheet policy analysis system with IMPLAN at its core. Specifically, this paper details information necessary to construct spreadsheet models that enable users to analyze the local, regional, and national effects of changes in economic policy.*

45. DiPietre, D., R. Walker, and D. Martella. 1980. Developing Regional Input-Output Models from the U.N. Format Adopted by the U.S. in the New 1972 Input-Output Model. Southern Journal of Agricultural Economics, 12(1980):143-149.

d. *This paper presents methodology to develop a regional I/O model from the national I/O model (current when paper was published in 1980) found in "The Input-Output Structure of the U.S. Economy, 1972." (Ritz, Phillips. 1979. Bureau of Economic Analysis. U.S. Dept. of Commerce.). A generalized model conforming the new treatments introduced by the BEA is described.*

46. Doeksen, G.A. and D.F. Schreiner. 1972a. Investments in Agricultural Processing for Rural Development in Oklahoma. American Journal of Agricultural Economics, 54(1972):513-519.

e. *This paper discusses a simulation model which measures impact of investment in agricultural processing industries using an I/O model for Oklahoma. Results showed positive results for encouraging investment.*

47. Doeksen, G.A. and D.F. Schreiner. 1972b. Simulating Short, Intermediate and Long-Run Effects of Private Investment on Employment by Industrial Groupings. Journal of Regional Science, 12(1972):219-232.

e. *This paper expands impact analysis from short run effects to medium and long run effects of private investment in various industrial sectors of the Oklahoma economy. The Oklahoma social accounting system is presented, a state simulation model is outlined, and employment impact is analyzed.*

48. Doeksen, G.A., and D.F. Schreiner. 1974. Interindustry Models for Rural Development Research. Agricultural Experiment Station, Oklahoma State University.

d. *This paper presents four models used in rural development research including input-output (static), from-to (static), dynamic input-output (measure impacts over time), and simulation (extends I/O to long run effects). Each model is discussed as per basic components, assumptions, applications, and mathematical presentations.*

49. Driver, B.L. and G.L. Peterson (compilers). 1990. Forest Resource Value and Benefit Measurement: Some Cross-Cultural Perspectives. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO; General Technical Report RM-197. 85 pages.

b. *This compilation of papers from the IUFRO Forest Landscape, Recreation, and Tourism Management Section and the Social and Economic Aspects of Forestry Section presents a broad view of non-market valuation techniques. Included are papers dealing with identification, measurement and valuation of environmental change focusing on tourism, urban forest sites, and timber harvesting impacts on scenic beauty using various methodologies including logit analysis, MGA methods and others.*

50. D'Sousa, G., M.B. Materu, D.K. Smith, A. Hoque, and G.W. Zin. 1988. The Role of Agriculture in the Economic Development of West Virginia: An Input-Output Analysis. Misc. Publ. 20, Agricultural and Forestry Experiment Station, West Virginia University, Morgantown, WV. 9 pages.

e. *The economic linkages among the agricultural sector, its input supply sources, and the associated manufacturing, processing, marketing, and service sectors in West Virginia are described using I/O analysis. Multipliers are presented as well as discussion of regional economic development implications.*

51. Eckaus, R.S. F.D. McCarthy and A. Mohic-Eldin. 1981. A Social Accounting Matrix for Egypt, 1976. Journal of Development Economics, 9(2):183-203.

g. *A 1976 social accounting matrix for Egypt is presented and the methods of estimation used are described. SAM implications are discussed. This SAM allowed analysts to identify distribution of taxes and subsidies, which led to conclusions regarding distributive progressivisms.*

52. Engineering-Economics Associates. 1985. On the Calculation of Gross Regional Trade Flows. Report EEA-85-01, submitted to the USDA Forest Service; Engineering-Economics Associates, Berkeley, CA. 31 pages.

d. *This paper focuses on the use of econometrically estimated decomposition indices in the form of regional purchase coefficients (RPCs). A method for estimating RPC's at the state and county level using data from a 125 sector interstate study of the U.S. economy is discussed.*

53. Engineering-Economics Associates. 1985. On User-Specific Regional Purchase Coefficients. Technical Note EEA-85-TN-01, submitted to the USDA Forest Service; Engineering-Economics Associates, Berkeley, CA. 13 pages.

d. *User specific Armington functions are discussed in a rigorous framework. These functions, it is argued, better reflect trading and overall economic activity in the region under consideration.*

54. Engineering-Economics Associates. 1985. Economic Impact Analysis. From Input-Output to Social Accounting Matrices. Report EEA-85-TN-02, submitted to the USDA Forest Service; Engineering-Economics Associates, Berkeley, CA. 30 pages.

f. *Related expressions for the standard I/O model are derived and discussed. These include detail of the "Use" and "Make" matrices where distinction is made between commodities and industries, and for the Social Accounting Matrix framework.*

55. Engineering-Economics Associates. 1985. Calculating Gross Regional Trade Flows. The Armington Assumption Extended in an Regional Context. Report EEA-85-03, submitted to the USDA Forest Service; Engineering-Economics Associates, Berkeley, CA. 17 pages.

d. *This paper appears to provide an extension of EEA-85-TN-01 (citation 53) and continues the discussion of regional purchase coefficients.*

56. Engineering-Economics Associates. 1985. IMPLAN Beyond Supply-Demand Pooling. Report EEA-85-05, submitted to the USDA Forest Service; Engineering-Economics Associates, Berkeley, CA. 62 pages.

h. *Previous reports and notes are reviewed regarding trade flow methodology with particular focus to those referred to as STEB (a methodology forwarded by Stevens, Treyz, Ehrlich, and Bower). These are shown to be analogous to the widely accepted Armington assumption. In a regional context, this is then presented as the IMPLAN regional purchase coefficient approach. Characteristics of the available empirical base, appropriate data reduction methods, and issues of econometric methodology are discussed.*

57. Ellefson, P.V., 1992. Forest Resources Policy: Process, Participants, and Programs. McGraw-Hill, Inc. New York, NY. 504 pages.

b. *This contemporary forest policy textbook begins through discussion of general U.S. forestry and forest policies. The policy process is then detailed as are participants. The book finishes with a detailed description of current policies and programs important to forest management. Excellent as an introductory survey text but lacking in any quantitative policy analysis.*

58. Esparza, A. 1989. Defense Impact Analysis Within a Social Accounting Framework. Growth and Change, 20(3):63-79.

g. *A social accounting matrix for the California economy is constructed which focuses on industrial-occupational linkages in the defense industry and the relative impacts of defense expenditures throughout the regional economy. A discussion of SAM multiplier decomposition is included as are general results.*

59. Ferell, R.S. 1991. Coefficients for a Timber Sale Environmental Impact Analysis: A MicroIMPLAN Application. In: Proceedings: IMPLAN, May 20-22, 1991; Western Rural Development Center, Oregon State University, Corvallis, OR; pp. 43-67.

i. *This paper describes the use of IMPLAN in an environmental impact statement development process. An individual timber sale on the Nantahala National Forest in Graham County, North Carolina and an adjoining 2, 7, and 18 county region are used as study areas. Hybrid model adjustments such as verification and update of industry output and regional purchase coefficients were not detailed in the paper. These adjustments are important to the value added components, hence any multipliers, of the sectors detailed.*

60. Flick, W.A. and L.D. Teeter. 1988. Multiplier Effects of the Southern Forest Industries. Forest Products Journal, 38(1988):69-74.

e. *Economic multipliers for forest-based industries are presented for eight southern states. Type II output, income and employment multipliers generated from input-output models are compared. The paper contains good layperson discussion of type I and type II multipliers as well as caveats specific to I/O. Conclusions, however, are based on multiplier comparison which, in itself, is a dubious technique.*

61. Ghebremendhin, T.G. and D.F. Schreiner. 1983. An Input-Output Approach for Analysis of Alternative Energy Choices. The Review of Regional Studies, 13(1):38-44.

e. *A comprehensive energy information system is developed and integrated into a dynamic simulation model for purposes of evaluating alternative energy choices for Oklahoma. The paper concludes with a good discussion of policy implications.*

62. Ghosh, A. 1987. Tariff and Non-Tariff Protection Through a Social Accounting Matrix - Case Study of an African Economy. Indian Economic Review, 22(2):195-211.

g. *The concept of effect rate of protection (ERP) from a single sector formulation to a multi-sector formulation in an input-output model is developed and discussed. Numerous partial problems are combined in a social accounting matrix to develop a single unified model to assess tariff and non-tariff protection measures. Empirical analysis and results are included for Tanzania.*

63. Goode, F. 1982. Comparative Features of Input-Output and Export Base Models as Tools for Extension Programming. In: How Extension Can Help Communities Conduct Impact Analyses, University of Wisconsin Extension Report 1-04-82-IM-E, Madison, WI; pp. 17-23.

e. *This paper focuses on how input-output and export base models can be used by extension specialists to assist communities conduct impact analyses. Good discussion regarding I/O caveats, data requirements, and conclusions.*

64. Gregersen, H.M. and A. Contreras. 1975. U.S. Investment in the Forest-Based Sector in Latin America. Johns Hopkins University Press, Baltimore, MD. 113 pages.

b. *This work provides an analysis of the foreign investment process and experience in a renewable natural resource sector. Principal focus is on Latin America. This qualitative analysis distinguishes foreign investment importance in forest sectors from that in nonrenewable sectors such as petroleum and mining.*

65. Gregersen, H., S. Draper and D. Elz (eds.). 1989. People and Trees: The Role of Social Forestry in Sustainable Development. EDI Seminar Series, The World Bank, Washington, D.C. 273 pages.

b. *This manual outlines development planning, policymaking, investment analyses, and project implementation of social forestry programs throughout the developing world. Good discussion of employment, income, and investment returns to social forestry and further research needs.*

66. Hall, E.J. 1982. Economic efficiency vs. local economic impact: A comparison of National Forest Management programs. Ph.D. dissertation Michigan State University, East Lansing, Michigan.

b. *This dissertation deals with the measurement of forest management policy impact on a local economy and how to compare that impact to the cost of achieving it. National forestland in the Idaho panhandle is used to illustrate the methodology which includes developing a model defining the conditions of maximum present value of timber management. The FORPLAN linear programming model is then used to assess the maximized timber management alternative with three other alternatives, assigning cost as the present value loss compared to the maximum. Impacts of each alternative on local employment and income is determined using an input-output model. Finally, losses in present net value of timber management are compared to gains in present net value of local income produced.*

67. Hamilton, J.R., and C. Pongtanakorn. 1983. The Economic Impact of Irrigation Development in Idaho: An Application of Marginal Input-Output Methods. Annals of Regional Science, 17(1983):60-69.

e. *This paper estimates impacts of expanded irrigation in Idaho using marginal input-output analysis. Focus is given to the effect of new, energy intensive irrigation on the overall demand for electricity, and on limited low-cost hydroelectric sources. Good mathematical representation and discussion of marginal I/O.*

68. Hamilton, J.R. and S. Stanger Quinn. 1989. The Impact of Boise National Forest Outdoor Recreation on the Economics of Local Communities. Paper presented to the 1989 Western Forest Economists Meeting, Wemme OR, May 2, 1989. 13 pages.

e. *A short-cut method of deriving multipliers without a full I/O table (developed by Burford and Katz, 1981, J. of Regional Science 21(2)) was used to assess outdoor recreation opportunities of an Idaho national forest on the local and regional economies. Detailed community specificity was achieved however methodology used was primitive.*

69. Hanson, K.A. and S. Robinson. 1989. Data Linkages, and Models: U.S. National Income and Product Accounts in the Framework of a Social Accounting Matrix, U.S. Department of Agriculture, Economic Research Service, Agriculture and Rural Economy Division, Staff Report No. AGES 89-5.

f. *This paper discusses the use of social accounting methodology. The relationship between a SAM and the existing national economic accounts for the U.S., including the NIPA and the input-output accounts is discussed. The SAM as a basis for CGE and microsimulation models is also discussed.*

70. Havinga, I.C., et al. 1987. A Social Accounting Matrix for the Agricultural Sector of Pakistan. The Pakistan Development Review, 26(4):627-639.

g. *The effect of alternative agricultural policies on production, consumption and income distribution within a social accounting framework is discussed. SAM multiplier analysis on an 1979-80 agricultural SAM for Pakistan is accomplished and discussed. Agricultural production, processing, and food consumption sectors are disaggregated.*

71. Hernandez Diaz, J.C. 1988. Input-Output Analysis of the State of Durango, Mexico. Ph.D. dissertation, Colorado State University, Fort Collins, Colorado.

h. *1980 economic conditions in Durango, Mexico are described using IMPLAN and IMS (developed at Colorado State University). Employment, output, and household income multipliers are derived for 57 intermediate sectors. This dissertation is an example of current extensions of IMPLAN to regional planning in Mexico. Good discussion of regional economic analysis techniques and their applications.*

72. Hines, F.D. and D.F. Bertelson. 1987. Forest Statistics for East Oklahoma Counties - 1986. USDA Forest Service Resource Bulletin SO-121; Southern Forest Experiment Station, New Orleans, LA.

a. *Summary statistics of eastern Oklahoma forests as surveyed by USFS in 1986. Detail found in SOFIA database.*

73. Holland, D. and P. Wyeth. 1989. SAM Multipliers: Their Decomposition, Interpretation and Relationship to Input-Output Multipliers. Paper presented at the Western Regional Science Meetings, San Diego, CA, February 20-23, 1989. 34 pages.

f. *Social accounting matrices and their respective models is the focus of this paper. It presents a good discussion of the flow of income as it is captured in a SAM representative of the U.S. economy. A simple economic model is constructed and SAM multipliers are calculated. Detail of SAM multiplier decomposition is discussed for both Stone (extragroup and closed loop multipliers) and Pyatt and Round (open and closed loop multipliers) techniques. Excellent discussion.*

74. Hotvedt, J.E., R.L. Busby, and R.E. Jacob. 1988. Use of IMPLAN for Regional Input-Output Studies. In: Forest Resource Economics: Past, Present and Future, proceedings of the 1988 southern forest economics workshop; 1988, Univ. of Florida, Gainsville, FL; 241-259.

h. *This paper evaluates IMPLAN for generating regional non-survey input-output models. Good discussion of the IMPLAN system and components as well as partitive vs. holistic accuracy. The industrial output component of the IMPLAN database is compared to the Census of Manufacturers, employment and employee compensation to County Business Patterns and Louisiana Department of Labor. Whereas care was taken to compare appropriate sectors, mention was not made of the significant comparability error due to IMPLAN measuring employment in FTE's. I/O holistic accuracy is assessed by comparison of multipliers generated from various economic activity sized regions. The researchers conclude that IMPLAN may not be partitively accurate for Louisiana (due, in part, to the fact that they were not assessing comparable estimates) but does appear to be holistically accurate.*

75. Hughes, D. and D. Holland. 1991. Constructing Core-Periphery Input-Output Models with IMPLAN: An Example from Washington State. In: Proceedings: IMPLAN, May 20-22, 1991; Western Rural Development Center, Oregon State University, Corvallis, OR; pp. 67-90.

i. *This paper integrates regional economic theory with empirical model building through the construction of a simple interregional core-periphery input-output model using models constructed using IMPLAN. The three models constructed include the Seattle-Tacoma urban core, the rest of Washington state (the periphery) and an aggregate of the two subregion models. The research assesses urban growth, backwash effects, and the spatial structure of economic activity. No mention is made of assessing IMPLAN RPC's or industrial totals prior to running models.*

76. Hughes, M. 1991. General Equilibrium of a Regional Economy with a Financial Sector - Part I: An Accounting Framework with Budget and Balance Sheet Linkages. Journal of Regional Science, 31(4):385-396.

j. *This paper presents an accounting framework used as a basis for regional general equilibrium economic models which incorporates real and financial activity. This framework accounts for the circular flow of payments from regional income to credit base and back to regional income, including the balance of payments identity. Real market transactions and capital stock changes are explicitly recognized.*

77. Hwang, H.H. and W.R. Maki. 1979. Users' Guide to Minnesota Two-Region Input-Output Model. Staff Paper Series P79-34, Department of Agricultural and Applied Economics, University of Minnesota, St. Paul.

e. *This user's guide provides background and outlines the operation of the Minnesota Two-region I/O Computer Model developed by University of Minnesota SIMLAB during the 1970's. This 35 sector model uses the national technical coefficients applied to regions in Minnesota without generally apparent adjustment. Good concise mathematical representation of model.*

78. Hyberg, B.T., M.R. Dicks and T. Hebert. 1991. Economic Impacts of the Conservation Reserve Program on Rural Economies. The Review of Regional Studies, 21(1991):91-105.

i. *This paper details the impacts of the Conservation Reserve Program on 5 industrial sectors at national, regional, and local levels using IMPLAN. Researchers emphasize the importance of measuring distributional impacts of national programs to ensure that rural communities are not inadvertently bearing an unfair portion of the costs of environmental protection.*

79. IMPLAN Development and Applications Group. 1991. IMPLAN User's Guide: Version MI 91-09. Department of Agricultural and Applied Economics, University of Minnesota, St. Paul, MN.

h. *This user's manual details the operation of IMPLAN, a supply/demand pool nonsurvey based input output computer modelling system. It also contains detailed appendices which discuss mathematical notation, regional purchase coefficients, file extension descriptions, deflators used, FIPS codes, industry classification by SIC codes, and related literature.*

80. IMPLAN. 1991. Micro-IMPLAN version MI 91-09 and Oklahoma 1985 County Database. Available from the IMPLAN Development and Applications Group, University of MN, St. Paul, MN.

h. *System software and county-level databases for Oklahoma (revised 1985 data).*

81. Jackson, R.W., P.R. Israilevich, and J.C. Comer. 1992. A Note on the Role of Survey Data and Expert Opinion in Constructing Input-Output Tables. Papers in Regional Science, 71(1):87-93

d. *This paper discusses the role of survey information and expert opinion in the construction of input/output tables. U.S. Bureau of Economic Analysis data on the use of commodities by industries is compared to corresponding Bureau of the Census data on selected use of materials by industry. This is done with regression analysis. Results show that changes in BEA data cannot be explained by corresponding changes in the Census data on which they are founded.*

82. Jensen, R.C. 1980. The Concept of Accuracy in Regional Input-Output Models. International Regional Science Review, 5(2):139-154.

d. *Excellent discussion contrasting partitive accuracy (accuracy of individual cells within an I/O transactions table) with holistic accuracy (overall table portraying actual economic structure of region).*

83. Jensen, R.C., G.R. West, and G.J.D. Hewings. 1988. The Study of Regional Economic Structure Using Input-Output Tables. Regional Studies, 22(3):209-230.

d. *This paper discusses the use of input-output tables to describe regional economic structures. Holistic matrix descriptors are developed and summarized. Further analysis shows that individual cells are individually "predictable" and that patterns of predictability are identifiable. The researchers conclude that it is possible to recognize a group of cells on the tertiary end of the continuum which appear to constitute a predictable fundamental structure.*

84. Johansen, L. 1974. A Multi-Sectoral Study of Economic Growth, Second Enlarged Edition. North-Holland/American Elsevier Publishing Company, Inc, New York, NY. 274 pages.

e. *This text outlines an input-output study examines economic growth in Norway. Development of the model is complete and comprehensive. Interesting mention of special treatment for forest-related sectors.*

85. Keuning, S.J. and W.A. deRuijter. 1988. Guidelines to the Construction of a Social Accounting Matrix. Review of Income and Wealth, 34(1):71-100.

f. *This paper discusses guidelines to construction of a SAM. This construction process begins with the overall design of the system and discussion details various options. Data sources need to be identified; a provisional checklist is provided. Reference year specification and SAM classification are reviewed in detail.*

86. Khan, H.A. 1988. Impact of Trade Sanctions on South Africa: A Social Accounting Matrix Approach. Contemporary Policy Issues, 6(4):130-140.

g. *This paper applies social accounting matrix methodology to studying trade sanctions on South Africa. Output effects and distributional impacts on factors and households are discussed. Results indicate effects of trade sanctions are significant.*

87. Kilkenny, M. 1991. A SAM for Farm Policy Analysis. In: Proceedings: IMPLAN, May 20-22, 1991; Western Rural Development Center, Oregon State University, Corvallis, OR; pp. 91-104.

g. *This paper discusses how data on farm program transactions and transfers is organized, reconciled, and used to construct parts of the Farm Policy in General Equilibrium (FPGE) GAMS computable general equilibrium (CGE) model of the U.S. The researcher focuses on loan program stock accumulation and loan forfeit benefits*

88. Ko, Suknam. 1985. A Regional Computable General Equilibrium Model for Korea. Unpublished Ph.D. Dissertation, University of Illinois, Urbana-Champagne, IL.

j. *This dissertation outlines and analyzes a computable general equilibrium model at the regional level for the Korean economy. Factor and commodity movements among regions are introduced from a "bottom-up" approach using region specific equations and the main structural equations of a previously developed 1978 South Korean SAM.*

89. Kuehn, J.A., M.H. Procter and C.H. Braschler. 1985. Comparisons of Multipliers from Input-Output and Economic Base Models. Land Economics 61(2):129-135.

c. *This article presents empirical comparisons of multipliers for three different models. These models include (1) a nonsurvey, simply constructed I/O model, (2) a semisurvey, intensively developed model, and (3) an economic base multipliers set. Results indicate that relative accuracy of the three models cannot be established. All three models are subject to measurement and/or sampling errors. Provides additional support for nonsurvey I/O models such as IMPLAN.*

90. Ladd, G. and V. Suvannunt. 1976. A Model of Consumer Goods Characteristics. Amererican Journal of Agricultural Economics, 58(1976):504-510.

b. *This paper derives and tests two hypotheses concerning characteristics of purchased consumer goods. These hypotheses include (1) retail price paid is a weighted linear combination of a product's yields of characteristics, each weight being a characteristic's marginal implicit price and (2) that consumer demand for a product is a function of income, product prices, and product's yields of characteristics. These hypotheses form a realistic methodology to assess nonmarket forest products such as aesthetics and recreation.*

91. Lewis, D.K. and J. Goodier. 1990 The South's Fourth Forest - Oklahoma. Oklahoma State University Agricultural Experiment Station Miscellaneous Paper 130. 96 pages.

a. *Summary of current timber value for Oklahoma as well as detailed characteristics. Discussion also includes a comprehensive review of timberland management investment opportunities and productive potentials.*

92. Lindahl, S. 1991. Notes from IMPLAN workshop, September 5 - 7, 1991, University of Minnesota, Department of Agricultural and Applied Economics, St. Paul, MN.

h. *Comprehensive discussion of IMPLAN background including regional economic development theory.*

93. Lustig, T.D. 1983. Resolving conflict: An expert panel in action. Journal of Soil and Water Conservation 38(6):459-461.

a. *This paper details the alternative dispute resolution technique employed for a land management/water quality conflict which occurred over Weyerhaueser land management practices in Southeastern Oklahoma during the early 1980's. Good first-hand discussion detail.*

94. Mapp, H.P. Jr. and D.D. Badger. 1970. Input-Output Analysis of the Economic Impact of Outdoor Recreation in Southeastern Oklahoma. Oklahoma Current Farm Economics, 43(2):23-30.

e. *This paper discusses results of a study to determine the potential impacts of recreation sector expenditures on a local economy's output, income and employment by use of an input-output table. The region assessed for this study is the Kiamichi Economic Development District which encompasses seven counties in southeastern Oklahoma.*

95. Marcin, T.C. 1985. Integrating Social Sciences into Forest Resource Research. In: Discovering New Knowledge About Trees and Forests; Proceedings: IUFRO Subject Group S6.09 meeting; August 19 - 23, 1985, Houghton, MI, USDA FS, North Central Forest Experiment Station General Technical Report NC-135; pp. 55-63.

b. *This paper describes demographic changes in the U.S. and in the world as well as the impact of these changes on forest requirement. Aging, passage of the Baby Boom generation, and world population growth differentials between developed and developing countries are discussed as per critical affects on forest conservation and future markets for timber.*

96. McGregor, P.G. and I.H. McNicoll. 1992. The Impact of Forestry on Output in the UK and its Member Countries. Regional Studies, 26(1992):69-79.

e. *This paper estimates the impact, measured in terms of sectoral output, of domestic forestry activity on the economies of the UK and its constituent countries. Key data sources were the United Kingdom input-output tables for 1984 and a purpose-specific survey of the forestry and timber processing sectors. Forestry's backward and forward linkages are examined. Backward linkages incorporated the concept of critical supply-dependency among certain timber-using sectors.*

97. Mead, W.J. 1966. Competition and Oligopsony in the Douglas Fir Lumber Industry. University of California Press, Berkeley, CA. 276 pages.

b. *The behaviour of buyers in the market for federal timber is determined through thoughtful analysis of supply and demand. Results indicate that, whereas lumber markets appear to be very competitive, markets for timber inputs are characterized by factor supply functions which are relatively inelastic due to the narrowly circumscribed geographical nature of timbersheds. Conclusion point out the oligopsonistic structure of timber markets. Somewhat dated (mid 1960's) but conclusions are probably still valid.*

98. Miller, R.M. and P.D. Blair. 1985. Input-Output Analysis: Foundations and Extensions. Prentice-Hall, Inc. Englewood Cliffs, NJ. 1985.

d. *Textbook in fundamental theory and practice of input-output analysis. Good development of mathematical notation for multipliers and organization of basic data. Detailed discussion of I/O applications including energy input-output, environmental input-output, supply side input-output and others. Nonsurvey and partial-survey I/O development methods are discussed as are balancing methods such as the RAS technique.*

99. Miller, R.M., K.R. Polenske, and A.Z. Rose (eds.). 1989. Frontiers of Input-Output Analysis. Oxford University Press, New York, NY. 335 pages.

d. *Advanced input-output text. Good discussion of multiplier analysis in social accounting frameworks (chapter 7). Also, good discussion of comparative accuracy of regional purchase coefficient (RPC) estimating techniques (chapter 18).*

100. Monke, E.A. and S.R. Pearson. 1989. The Policy Analysis Matrix for Agricultural Development.
Cornell University Press, Ithaca, NY. Chapters 1 through 6.

c *This text advances a new approach to policy evaluation by constructing and analyzing what is known as the policy analysis matrix (PAM). The PAM integrates market determined activities with societally determined activities. The PAM is composed of identities which define profitabilities and differences between private and social values.*

101. Obiya, A., D.E. Chappelle, and C.H. Schallau compilers. 1986. Spatial and Regional Analysis Methods in Forestry Economics: An Annotated Bibliography. USDA Forest Service Pacific Northwest Research Station, General Technical Report PNW-190. 32 pages.

c. *This bibliography provides wide coverage of the relatively recent incorporation of regional economic analysis to forest economics. Entries relate to models, techniques, and information regarding spatial and regional analysis printed before 1981.*

102. Oklahoma Department of Commerce. Statistical Abstracts of Oklahoma. Center for Economic and Management Research, College of Business Administration, University of Oklahoma and Oklahoma Department of Commerce, Oklahoma City, Oklahoma, 1988.

a. *Summary statistics of social and economic characteristics of Oklahoma including per capita income, average household size, etc by county.*

103. Olson, D., C. Schallau, and W. Maki. 1984. IPASS: An Interactive Policy Analysis Simulation System. USDA Forest Service, Pacific Northwest Forest and Range experiment Station, General Technical report, PNW 170. 70 pages.

i. *This report describes the data, their sources, and the calibration procedures used in operating IPASS (interactive policy analysis simulation system) models. It provides generic instructions for analysts preparing databases for various geographical areas.*

104. Otto, D.M. 1991. Economic Impact of Creating a Wildlife Preserve in Emmet and Dickinson Counties. In: Proceedings: IMPLAN, May 20-22, 1991; Western Rural Development Center, Oregon State University, Corvallis, OR; pp. 105-116.

i. *This paper analyzes and presents information on the economic impacts associated with the development of a wildlife preserve for two counties in Iowa. The conceptual benefit-cost framework for evaluating natural resource based projects is discussed. IMPLAN is used for economic impact determination.*

105. Palmer, C., E. Siverts, and J. Sullivan. 1985. IMPLAN Analysis Guide, Version 1.1. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 115 pages.

h. *This analysis guide contains techniques and procedures to assist users in the proper construction of IMPLAN models and their application in the forest planning process. Interesting discussion of IMPLAN's ability to "supply constrain" (4-38) a commodity. It is unclear whether this accomplishes the same calculations that supply-side I/O (as defined by Miller and Blair, 1985) accomplishes.*

106. PARD Project Team. 1990. Agricultural Growth in Kenya: Applications of the Policy Analysis Matrix. Egerton University Policy Analysis for Rural Development Working Paper Series No. 13, Research and Extension Division, Agricultural Resources Centre, P.O. Box 536, Njoro, Kenya. 49 pages.

c. *This paper presents the results of work undertaken by the Research and Training in Agricultural Policy Analysis Project of the Policy Analysis for Rural Development (PARD). The analysis develops and discusses the policy analysis matrix (PAM). This comprehensive matrix uses the concept of economic profit in assessing costs and returns of agricultural development with policy intervention. Methodology illustrates one forefront of economic development policy analysis.*

107. Pederson, L., D.E. Chappelle and D.C. Lothner. 1989. The Economic Impacts of Lake States Forestry: An Input-output Study. USDA, Forest Service General Technical Report NC136.

i. *This paper discusses current (1985) and projected (1995) levels of forest-related economic activity in the three-state region of Michigan, Minnesota, and Wisconsin. Their impacts on other economic sectors are based on a regional I/O model. Direct economic impacts of three forms of forest resource uses (forest products, wood energy, and outdoor recreation) and their economic multiplier effects are analyzed. IMPLAN was used with no primary data input.*

108. Peterson, G.L. and B.L. Driver. 1990. Identification, Measurement, and Valuation of Environmental Change. In: Driver, B.L. and G.L. Peterson (compilers): Forest Resource Value and Benefit Measurement: Some Cross Cultural Perspectives. USDA Forest Service General Technical Report RM-197, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO; pp. 1-14.

b. *This paper identifies and discusses qualitative and quantitative concepts of environmental change valuation. It presents a model that identifies various components of the problem and demonstrates the definitions and measurements needed for different purposes.*

109. Peterson, W.C. 1991. Transfer Spending, Taxes, and the American Welfare State. Kluwer Academic Publishers, Boston, MA. 176 pages.

b. *This recent work outlines the current status of transfer payments and tax structures in the U.S.. Provides perspective on recent trends. Presents numerous statistical analyses of data regarding transfer payments including transfer payment distribution by income class for 1983 (the last year data summarized by Census documents).*

110. Polenske, K.E. 1970. A Multiregional Input-Output Model for the U.S. Report No. 21. Economic Development Administration, U.S. Department of Commerce, Washington, DC.

d. *This report includes a summary description of the multi-region I/O model of the United States. Procedures used to assemble the data and the results of implementing the model for the base-year 1963 with projections to 1970 and 1980 are discussed. Implemented in 1970, the model uses a 78 sector aggregation for regions and identifies trade flows within the U.S. (between identified regions).*

111. Pyatt, G. and J.I. Round. 1977. Social Accounting Matrices for Development Planning. Review of Income and Wealth, 23(4):339-364.

f. *This paper discusses the construction of social accounting matrices for three national economies (Iran, Sri Lanka, Swaziland). These SAM's focus particular attention on the distribution of income through disaggregation of household sector income and outlay accounts consistent with more conventional disaggregation of production, factors, etc.*

112. Pyatt, G. and J.I. Round. 1979. Accounting and Fixed Price Multipliers in a Social Accounting Matrix Framework. Economic Journal, 89(356):850-873.

f. *This paper discusses the relationships between output, factor demands and income and the decomposition of these relationships into separate effects as suggested by the structure of a SAM representation of the flows between them. Decomposition is illustrated using the Sri Lanka SAM. Accounting multipliers are discussed and are then used to identify income effects in a fixed-price model. Implications of income elasticity effects are discussed within a fixed price system. Empirical results illustrate the various components of fixed-price multipliers and alternative methods of deriving them.*

113. Pyatt, G. and J.I. Round (eds.). 1985. Social Accounting Matrices, A Basis for Planning. The World Bank, Washington, DC. 281 pages.

f. *This World Bank summary report outlines and describes the development of social accounting matrices (SAMs). Following a comprehensive review of SAM methodology, case studies are analyzed including the SAM for Sri Lanka, Swaziland, and Botswana. An excellent discussion of fixed-price SAM multiplier analysis is included and conclusions are drawn related to policy implications.*

114. Richardson, H.W. 1978. The State of Regional Economics: A Survey Article. International Regional Science Review, 3(1):1-48.

c. *This article comprehensively summarizes the various methods used in regional economic analysis. These include economic base models, regional econometric models, shift-share analysis, the gravity model, and regional input-output models. Critical evaluation of the theoretical characteristics of these models is discussed in detail.*

115. Richardson, H.W. 1985. Input-Output and Economic Base Multipliers: Looking Backward and Forward. Journal of Regional Science, 25(4):607-661.

d. *Another extremely well written summary of the current (1985) state of regional analysis which focuses on economic base models, regional input-output, and others. Contains a brief, but well explained, supporting statement for the use of supply-constrained input-output models.*

116. Robinson, S and D.W. Roland-Holst. 1987. Modelling Structural Adjustment in the U.S. Economy: Macroeconomics in a Social Accounting Framework. Paper presented at the annual meetings of the American Economic Association, New Orleans, LA, December, 1986. 38 pages.

f. *This paper describes an economywide modeling framework based on a social accounting matrix (SAM) that has been used in developing countries to explore the interactions between macro policy and structural adjustment. Multiplier analysis is used to illustrate how this framework can capture the essential structural features of the economy and sort out the direct and indirect links through which macro-shocks affect the system.*

117. Rose, A., B. Stevens, and G. Davis. 1988. Natural Resource Policy and Income Distribution. The Johns Hopkins Press, Baltimore, MD. 139 pages.

b. *Pathbreaking work dealing with income distribution and natural resource policy. First national breakdown of sectoral labor income by household income level. First national breakdown of stock holdings and dividend income by household income level. Good discussion of integration of data and model application to policy analysis on the Monongahela National Forest for management of natural resources.*

118. Round, J.I. 1983. Nonsurvey Techniques: A Critical Review of the Theory and the Evidence. International Regional Science Review, 8(3):189-212.

d. *This paper presents a critical review of nonsurvey methods including methods of constructing regional input-output tables, reconciling estimates, and deriving sectoral multipliers where no I/O table exists. The continuing claims about accuracy of existing methods are also examined in the context of the efficacy of various test procedures.*

119. Round, J.I. 1985. Decomposing Multipliers for Economic Systems Involving Regional and World Trade. Economic Journal, 95(378):383-399.

f. *This paper analyzes the linkages between economic systems and the spillover and possible feedback effects one system may have on another. A regional SAM for Malaysia is used to derive multipliers for analysis. An extension of the multiplier analysis discussed in Pyatt and Round for the case where interdependent regional systems are involved is included.*

120. Rudis, V.A., J.H. Gramann, E.J. Ruddell, J.M. Westphal. 1988. Forest Inventory and Management-Based Visual Preference Models of Southern Pine Stands. Forest Science, 34(4):846-863.

b. *This paper discusses methodology and results of a study using photographs and student opinion of photographs to identify visual preferences under various forest stand conditions. The authors used several scenic beauty models including predictive models with standard and nonstandard parameters, study-based models, and principal components. Timber management implications of visual preferences are discussed.*

121. Rudis, V.A. 1988a. Nontimber Values of Louisiana's Timberland. USDA FS Resource Bulletin SO-132, Southern Forest Experiment Station, New Orleans, LA. 27 pages.

b. *This summary describes nonmarket forest resources as identified during the 1984 survey of Louisiana timberlands. Measured nonmarket forest resources include water quality, soils, range, wildlife habitat, aesthetic, and dispersed recreation.*

122. Rudis, V.A. 1988b. Nontimber Values of East Texas Timberland. USDA FS Resource Bulletin SO-139, Southern Forest Experiment Station, New Orleans, LA. 35 pages.

b. *This summary describes nonmarket forest resources as identified during the 1986 survey of East Texas timberlands. Measured nonmarket forest resources include water quality, soils, range, wildlife habitat, aesthetic, and dispersed recreation.*

123. Rudis, V.A. 1990. Multiple Value Forest Surveys in the Midsouth States. In: LaBau, V.J. and T. Cunia (eds.); State-of-the-art Methodology of Forest Inventory: A Symposium Proceedings, July 30-August 5, 1989; USDA FS General Technical Report PNW-263, Pacific Northwest Experiment Station, Portland, OR; pp. 495-504.

b. *This paper reviews achievements and limitations in integrating water, range, wildlife, and recreation inventories with forest surveys of the USDA-Forest Service Southern Forest Experiment Station Forest Inventory and Analysis Unit.*

124. Rudis, V.A. and J.B. Tansey. 1991. Placing "Man" in Regional Landscape Classification: Use of Forest Survey Data to Assess Human Influences for Southern U.S. Forest Ecosystems. In: Mengel, D.L. and D.T. Tew (eds.); Ecological Land Classification. USDA FS General Technical Report SE-68, Southeastern Forest Experiment Station, Asheville, NC; pp. 135-136.

b. *This paper describes USDA, FS SOFIA survey information as it provides a basis for classifying human-dominated ecosystems at the regional scale of resolution. Attributes include forest stand measures, evidence of human influence, and other disturbances.*

125. Sah, J. and D.F. Schreiner. 1991. Distribution and Impact of Credit by Caste and Farm Size in Nepal: A Regional Perspective. Paper presented at the Mid-Continent Regional Science Association Meetings, Chicago, IL; May 30 - June 1, 1991.

g. *A primary data SAM is constructed and analyzed for a Nepalese village to understand the relationships between credit and income distribution within the caste hierarchy. Results indicate that resource ownership dominates income distribution and not the caste hierarchy.*

126. Sah, J. and D.F. Schreiner, and M. Schorr. 1991. Regional Economic Impact of Lake Texoma Striped Bass and Non-striped Bass Fishing Activities. Unpublished report submitted to Oklahoma Department of Wildlife Conservation, OKC, OK. 48 pages.

i. *This paper describes the economic effect of fishing activity on a large water-based multi-purpose project in South-Central Oklahoma and North-Central Texas. Aggregate impacts of angler expenditures were determined based on output, income, value added, and employment multipliers estimated using IMPLAN.*

127. Sartorius, P. and H. Henle. 1968. Forestry and Economic Development. Praeger Publishers, New York, NY. 340 pages.

b. *This text discusses the role of forestry in rural economics of both developed and underdeveloped countries. The relationship of forestry to economic development is considered through employment needs, timber markets, and expansion of raw material supply and processing in less developed countries. Conclusions are drawn which are primarily based upon export base theory.*

128. Schooley, D.C. and J.G. Jones. 1983. An Input-Output Model for Measuring the Impact of the Oklahoma Forest Products Industry on the State's Economy. Oklahoma State University Agricultural Experiment Station Report P-939, Stillwater, OK.

e. *This paper presents an input-output model of the Oklahoma economy used to describe the role of the forest products industry and to predict economic impacts of potential changes due to market forces, government regulation, and incentives programs. Primary data on the forest industry was collected by use of a mailed survey instrument. The I/O model uses 1978 as the base-year and consists of 31 endogenous producing sectors, a households sector, several additional exogenous row sectors, and six exogenous consuming sectors.*

129. Schreiner, D.F. and G.E. Muncrief. 1972. Estimating Regional Information Systems with Application to Community Service Planning. Regional Science Perspectives, 2(1972):136-158.

e. *An information system that interrelates area activity in business, households, and governments for a multi-county region in Oklahoma is discussed, constructed, and analyzed. Application of the information system to planning community services is presented by means of estimating the regional requirements for solid waste disposal services.*

130. Schreiner, D.F., G.E. Muncrief, and R.G. Davis. 1972. Estimating Intercounty Employment Linkages in a Multi-County Development District. Southern Journal of Agricultural Economics, 4(1972):53-58.

e. *This paper delineates some of the intercommunity linkages in an economic accounting model, describes a procedure for their estimation, and analyzes the results of estimated intercounty employment linkages for a multi-county planning region in South Central Oklahoma. A two community interregional input-output model is constructed using primary data.*

131. Schreiner, D.F., G.E. Muncrief, and R.G. Davis. 1973. Solid Waste Management for Rural Areas: Analysis of Costs and Service Requirements. American Journal of Agricultural Economics, 55(1973):81-89.

e. *Spatial effects of solid waste collection density and transfer distances to disposal sites are analyzed using an input-output model. This model estimates quantity of solid waste generated and costs per ton of solid waste collected, transferred, and disposed for different service areas and alternative technologies.*

132. Schreiner, D.F., D.D. Badger, and D.A. Willett. 1984. Recreation Benefits for Lakes in the McClellan-Kerr Arkansas River Navigation System with Rural and Urban Benefit Distribution for Two Lakes. Current Farm Economics, September, 1984:17-23.

b. *This study builds on an earlier study by the same authors which identifies linkages of recreational use of a Navigation System to the rest of the economy. This linkage extends the analysis by constructing estimates of the social benefits and their distribution between rural and urban regions. This is done through a travel cost analysis.*

133. Schreiner, D.F. and G.M. Cannock. 1989. The Value of Nonmarket Goods: The Case of Water-Based Recreation in Eastern Oklahoma. Current Farm Economics, September, 1989:34-48.

b. *This study identifies the contribution of water-based recreation in Eastern Oklahoma to regional and state economic development. This impact is analyzed to determine whether the resources allocated to water-based recreation are earning the equivalent return if invested in production of more tangible goods valued by market prices. This is done through benefit-cost analysis using a National Welfare Model and an Oklahoma Welfare Model.*

134. Schreiner, D.F. and M. Garcia U. 1992. Selected Results of Structural Adjustment Programs in Honduras. Unpublished draft report, Department of Agricultural Economics, Oklahoma State University, Stillwater, OK. 172 pages.

g. *This report discusses results of structural adjustment programs in Honduras in terms of output and prices changes in the agricultural sector. Major components of structural adjustment programs include major currency devaluations and market reforms through elimination of controlled prices. A SAM is constructed to analyze the inderdependencies of the agricultural economy.*

135. Schuster, E.G., C.R. Hatch, and W.D. Koss. 1975. Location Quotients, Excess Employment and Short Run Economic Base Multipliers for Idaho's Forest Products Industry. Information Series No. 10, College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow, ID. 25 pages.

c. *This paper focuses on three measures commonly used in the evaluation of alternative land management activities. These measures include location quotients, excess employment, and short run economic base multipliers. Good discussion of basic regional economic analysis (circa 1975) applied to forestry.*

136. Schuster, E.G. and E.L. Medema. 1989. Accuracy of Economic Impact Multipliers: An appraisal for foresters. Journal of Forestry, 87(8):27-32.

i. *This paper evaluates several common impact projection methods applied to forestry decision situations. Accuracy of projection methods is addressed by comparing national forest harvest employment impact through economic base, input-output, and a "no change" (national forest harvest has no effect on employment) analysis for various time frames and geographical regions. Methodological procedures were not detailed (for example, adjustments to IMPLAN models were not described). Results indicate that methods generated substantial, widespread projection error.*

137. Seppala, R., C. Row, and A. Morgan (eds.). 1983. Forest Sector Models. Proceedings of the First North American Conference, International Institute for Applied Systems Analysis, Williamsburg Virginia, Dec. 1 - 3, 1981. Published by A.B. Academic Publishers, Berkhamsted, Herts, United Kingdom. 354 pages.

b. *This text describes the Forest Sector Project of IIASA. The Program is an attempt to cooperatively develop models of forest sectors that can be linked together to form an international model useful for projecting the development of resources, the progress of industry, and the flows of trade worldwide. Excellent discussion of forest economics forefront (early 1980's).*

138. Siegel, P.B. and T.G. Johnson. 1991. Using IMPLAN for a Break-Even Approach to Input-Output Analysis: An Example Using the Conservation Reserve Program. In: Proceedings: IMPLAN, May 20-22, 1991; Western Rural Development Center, Oregon State University, Corvallis, OR; pp. 117-131.

i. *This paper presents a break-even approach to quantify the level of beneficial activity needed to exactly offset the reductions in economic activity due to the Conservation Reserve Program. The activity analyzed are increases in recreational land usage. The authors use IMPLAN to generate input-output models for Virginia.*

139. Siverts, E. 1983. Uses of Input-Output Analysis in Forest Planning, A paper presented at the Midwest Forest Economist Conference, University of Wisconsin, Madison, August 29-31, 1983.

7. *This paper discusses the IMPLAN input-output system and it's uses in response to two aspects of National Forest Management Act (NFMA) regulations. The aspects discussed include (1) the problem solving nature of NFMA that requires plans be prepared which address various issues, concerns and opportunities, and (2) the requirements to determine the environmental, social and economic effects of each alternative. Good IMPLAN history.*

140. Siverts, E., C. Palmer, K. Walters, and G. Alward. 1983. IMPLAN User's Guide, United States Department of Agriculture, Forest Service, Systems Application Unit, Land Management Planning, Fort Collins, Colorado.

h. *Initial user's guide for operation of IMPLAN. Details operation of software system and interactive capabilities circa 1983.*

141. Siverts, E. 1985 Analytical Opportunities Using IMPLAN, a paper presented at the Midwest Forest Economist Conference, Iowa State University, Ames, Iowa, May 30-31, 1985.

h. *Techniques of using the IMPLAN system which minimize several of the limitations of I/O analysis are described. These techniques permit users to achieve a fuller utilization of the various aspects of I/O models. Estimation of regional accounts and the use of models in a final demand analysis are detailed.*

142. Siverts, E. 1987. Economic Impact Assessment, A paper presented at the U.S. Forest Service's Social Science Workshop, Arlington, VA, April 14-16, 1987.

h. *Contrasts a rather simplified perspective of economic equity with economic efficiency. Discusses IMPLAN in a framework within which questions of "equity" can be evaluated.*

143. Siverts, L.E., G. Alward, J. Wagner, and K. Walters. 1987. Interim IMPLAN Version 2.0 User's Guide. USDA Forest Service, Systems Applications Unit, Land Management Planning, Fort Collins, CO.

h. *This user's guide contains the necessary syntax statements for using IMPLAN version 2.0 programs.*

144. Siverts, L.E. 1988. Modeling Regional economic change at the county level: An IMPLAN application. Unpublished Ph.D. dissertation, Michigan State University, East Lansing, Michigan.

h. *This dissertation outlines and implements a validation study of IMPLAN. Tests were made of the holistic accuracy of the model in estimating actual economic changes that occurred in two rural western U.S. counties as compared with measured data for employment, wage income, and population. Three different models that depict variations in household consumption and income were evaluated.*

145. Siverts, L.E., and D.E. Chappelle. 1989. A Comparison of Actual Changes in Employment and Income With Predictions Using IMPLAN Models for Two Rural Western Counties. Paper prepared for Western Regional Science Association, February 19-22, 1989, San Diego, CA. 28 pages.

h. *This paper describes tests made of the IMPLAN model's holistic accuracy in estimating actual economic changes that occurred in two rural western U.S. counties as compared with measured data for employment, wage income, and population. Three different models that depict variations in household consumption and income were evaluated.*

146. Siverts, L.E. and W. Maki. 1990. Information Partnerships through IMPLAN. A paper presented at the National Governors' Association Meeting, Anchorage, AK; May, 1990.

e. *This paper provides discussion of extending IMPLAN to various state and local organizations. It describes the IMPLAN system components, IMPLAN's contribution to information partnerships and user groups' contributions. Results of information partnerships are also discussed.*

147. Siverts, L.E. 1990. Ecological and Economic Accounting Systems. A paper presented at the Ecological Economics Workshop, St. Paul, Minnesota, April, 1990.

h. *Three separate strategies are outlined for future incorporation of ecological accounting using an I/O modelling system such as IMPLAN. These include (1) continuing with current models which keep macro-economic accounting models separate from individual modelling systems for micro-economics, hydrology, and wildlife, (2) incorporating environmental I/O (as discussed in Miller and Blair, 1985), and the preferred (3) improving economic accounts, implementing environmental accounts and incorporating societal values.*

148. Skountzos, T. 1988. Social Accounting Matrix Multipliers in a Developing Economy: the Case of Greece. Economics of Planning, 22(1-2):57-71.

g. *This paper establishes quantitative relationships between production activities, factor incomes and household incomes in Greece and decomposes these relationships into separate effects. A 3 sector-set SAM is used.*

149. Smith, S.M. and D.L. Barkley. 1990. Local Input Linkages of Rural High Technology Manufacturers. Unpublished review paper. 23 pages.

c. *This paper identifies the determinants of the level of local backward linkages (input purchases) for high and low technology manufacturers located in nonmetropolitan counties in the western U.S. A set of establishment and county characteristics is examined with two-limit tobit regression analysis.*

150. Sohn, I. 1986. Readings in Input-Output Analysis: Theory and Applications. Oxford University Press, New York, NY. 452 pages

d. *This text presents a compilation of writings by various authors regarding the current (1986) forefront of input/output analysis. Of interest to this study are papers by Walter Fisher on aggregation criteria for I/O analyses, Per Sevaldson on input-output coefficient stability, and Anne Carter on energy, environment and economic growth.*

151. Stevens, B.H., G.I Treyz, and D.J. Ehrlich, and Bower, J.R. 1980. A New Technique for the Construction of Non-Survey Regional Input-Output Models. International Regional Science Review, 8(1980):189-212.

d. *This paper develops and tests a technique for creating regional I/O models based on national I/O technological coefficients. The regional purchase coefficient (RPC) is based on substitution between extra- and intra-regional sources in response to relative delivered costs. Components of model output are compared to survey-based models resulting in the conclusion that RPC techniques can provide low-cost models which are acceptably accurate for use in regional impact analysis.*

152. Sullivan, J. and J.K. Gilless. 1989. Cumulative Employment Effects on Northern California's Wood Products Industries from National Forest Timber Harvests. Forest Science 35(3):856-862.

c. *Econometric models of labor demand are used to examine the relationship between timber harvest levels and employment in the logging and sawmill industries of northern California. Results suggest that this relationship is not linear implying that timber harvests have cumulative effects across national forests.*

153. Sullivan, J. and J.K. Gilless. 1990. Hybrid Econometric/Input-output Modeling of the Cumulative Economic Impacts of National Forest Harvest Levels. Forest Science, 36(1990):863-877.

d. *Econometric and I/O methods are combined to assess the multiforest personal income impacts of timber harvesting activities on regional economies in Northern California. Results indicate that depending upon the timber harvest levels of other national forests in the area, projected changes in personal income resulting from a change in harvest-level on one of two forest studied varied by as much as 27 percent.*

154. Sutomo, S. 1989. Income, Food Consumption and Estimation of Energy and Protein Intake of Households: A Study Based on the 1975 and 1980 Indonesian Social Accounting Matrices. Bulletin of Indonesian Economic Studies, 25(3):57-72.

g. *This paper uses the 1975 and 1980 SAMs prepared by the Indonesian government to examine the links between household income and food consumption. Results showed that there existed some household groups which consumed less, including households which were above the assumed per capita disposable income poverty line.*

155. Taylor, D.T., C. Phillips and C. Young. 1991. The Regional Economic Impact of Great Basin National Park: An Application of IMPLAN. In: Proceedings: IMPLAN, May 20-22, 1991; Western Rural Development Center, Oregon State University, Corvallis, OR; pp. 131-144.

i. *This paper focuses on the economic impact of Great Basin National Park. It provides a recreation application which extends IMPLAN capabilities.*

156. Teeter, L., G.S. Alward and W.A. Flick. 1989. Interregional Impacts of Forest-Based Economic Analysis. Forest Science, 35(1989):515-531.

i. *Forest based economic activity is presented which highlights the interdependence among industries in separate producing regions. Interindustry transactions for the U.S. and four subregions were developed using IMPLAN and combined with inter-region product trade flow estimates from a gravity model resulting in an interregional I/O model emphasizing forest-based industries.*

157. Thomas, M.G. 1989. Regional Strategies for Rural Economic Development Through the Forest Resource. Unpublished report of the Midwest Research Institute, Kansas City, KS. 11 pages

c. *This paper presents a perspective on natural resources as a key focus for rural economic development strategies. Discussion includes reasons why rural areas have had difficulty capturing natural resource potentials.*

158. Tinbergen, J. 1985. Production, Income and Welfare: The Search for an Optimal Social Order. University of Nebraska Press, Lincoln, NB. 210 pages.

b. *This work describes, in an analytical fashion, the relationships between production factors (land, labor, capital), income formation, welfare functions, and a view of optimization with regard to social welfare.*

159. Todaro, M.P. 1985. Economic Development in the Third World, Third Edition. Longman Inc., White Plains, NY. 648 pages.

b. *This economic development textbook was developed for courses in the same focusing on economic problems associated with third world countries. A contemporary perspective is provided which integrates aggregate economic growth with issues dealing with poverty, inequality and unemployment. Many notable sections are contained within; particularly good discussion is included for topics dealing with alternative development theory (chapter 3), development planning (chapter 15) and monetary and fiscal policy (chapter 16).*

160. Treyz, G.I. and B.H. Stevens. 1985. The TFS Regional Modeling Methodology. Regional Studies, 19(1985):547-562.

d. *This paper presents the Treyz, Friedlaender, Stevens (TFS) regional modelling approach. This approach represents an alternative to constructing regional models using traditional econometric procedures by structuring a model based on economic theory which is successively calibrated using information from many sources and estimating parameters along the way from studies encompassing all regions.*

161. USDA, Forest Service. 1982. An Analysis of the Timber Situation in the United States 1952 - 2030. USDA Forest Service Forest Resource Report No. 23, Washington, DC.

a. *This manual presents a comprehensive database regarding the past, current (1982) and future timber situation using historical data, current inventory and projections. A current revision is available (citation 164) updated to 1989.*

162. USDA, Forest Service. 1984. IMPLAN Briefing Document, Systems Application Unit. Land Management Planning, Fort Collins, Colorado.

h. *This paper provides a quick summary of IMPLAN analytical capabilities, applications, access information, user support and future development circa 1984.*

163. USDA, Forest Service. 1988. The South's Fourth Forest: Opportunities to Increase the Resource Wealth of the South. USDA Forest Service Misc. Publication No. 1461, Washington, DC. 512 pages.

a. *This extensive data set includes projections which focus attention on the South's current timber situation and its ability to perform in the future from supply and demand perspective for the next 40 years.*

164. USDA, Forest Service. 1990. An Analysis of the Timber Situation in the United States: 1989-2040. USDA Forest Service General Technical Report RM-199, Washington, DC. 268 pages.

a. *This manual presents a comprehensive database regarding the current (1989) and future timber situation in the U.S. using inventory data and projections.*

165. USDA, Forest Service. 1990. A Strategic Plan for the 90's: Working Together for Rural America. June, 1990 Report, Washington, DC. 22 pages.

c. *This plan documents the USDA Forest Service's revised policy on rural development. The Plan includes six opportunities for change, which are presented as goals. Each goal is discussed in an issue statement. Methods to achieve goals are also discussed.*

166. Uwakonye, M.N., D.F. Schreiner, D.D. Badger, and M.D. Woods. 1992. Estimating the Impact of a Large Water-based Natural Resource Project on the Local Economy by Means of a SAM. Oklahoma Agricultural Experiment Station, Research Report P-926, Oklahoma State University, Stillwater, OK. 27 pages.

g. *This research report develops and implements a SAM for estimating the impacts and benefits from the Broken Bow Reservoir in Southeastern Oklahoma on the local economy. Impacts were measured in terms of economic sector output, regional value added, regional household income, factor payments, commodity supplies, and regional exports. Imputed factor payments for the reservoir as well as nonmarket commodities supplied from the reservoir are developed and discussed.*

167. Varian, H.R. 1984. Microeconomic Analysis, Second Edition. W.W. Norton and Company, Inc., New York, NY. 348 pages.

j. *Advanced textbook on microeconomic theory. Excellent mathematical discussion of general equilibrium theory and welfare economics.*

168. Virginia Cooperative Extension Service. 1985. Forest Resources in Regional Economic Development. Proceedings of the Fifteenth Forestry Forum, April 11-12, 1985. 109 pages.

b. *This compilation of papers discusses the current status of policy and industrial perspective of forest resources in regional economic development. Focus is on Virginia but could be more broadly construed for other Eastern and Southern states.*

169. Wagner, J. and L.E. Siverts. 1989. Micro IMPLAN System using 1977 data: Release V2-77. A final report of work conducted in cooperation with Western Rural Development Center, Corvallis, OR and University of Idaho, Moscow, ID.

h. *This report discusses the steps used in adapting the 1977 data to construct a new release of the software, referred to as IMPLAN v2-77.*

170. Westoby, J. 1987. The Purpose of Forests. Basil Blackwell, Inc., New York, NY. 343 pages

b. *This compilation of writings by Westoby over the course of 30 years spans an important time period for world forestry. Discussion includes population pressures, socioeconomic needs and forest resource constraints as they impact supply and demand of global timber resources. The point is made that global forest resources are not so much about trees as people.*

171. White, W.A., K.M. Duke and K. Fong. 1989. The Influence of Forest Sector Dependence on the Socioeconomic Characteristics of Rural British Columbia. Information Report BC-X-314, Forestry Canada, Pacific and Yukon Region, Pacific Forestry Centre, Victoria, BC. 26 pages.

b. *Data from the 1981 and 1986 Canadian censuses are analyzed to determine the influence of forest sector dependence on various socioeconomic characteristics in rural British Columbia's incorporated communities and territorial subdivisions.*

172. Williamson, J.G. 1974. Late Nineteenth-Century American Development: A General Equilibrium History. Cambridge University Press, New York, NY. 350 pages.

b. *This economic history text provides a general equilibrium analysis for problems and phenomena during the time period of the U.S. civil war and World War II. Interesting analysis of agriculture during the period (chapters 7 and 8).*

173. Williamson, J.G. and P.H. Lindert. 1980. American Inequality: A Macroeconomic History. Academic Press, New York, NY. 362 pages.

b. *This economic history text focuses on income distribution and attempts to explain why certain time periods in American history were marked by greater income inequalities.*

174. YoungDay, D.J. and R.D. Fight. 1979. Natural Resource Policy: The Distributional Impact on Consumers of Changing Output Prices. Land Economics, 55(1):11-27.

b. *This paper develops a methodology for examining the impact on consumer purchasing power of changes in output prices stemming from a wide range of natural resource policies.*

175. Young-Kon, Koh. 1990. Modeling Commodity and Factor Market Interaction Using a Regional SAM Based CGE Framework. Unpublished review paper. 51 pages.

j. *This paper presents a computable general equilibrium (CGE) model for the state of Oklahoma to analyze the impact of commodity markets on factor returns.*

176. Young-Kon, Koh. 1991. Analysis of Oklahoma's Boom and Bust Economy. Unpublished Ph.D. thesis, Department of Agricultural Economics, Oklahoma State University, Stillwater, OK. 163 pages plus appendices.

j. *This study constructs a social accounting matrix and develops a computable general equilibrium model for the state of Oklahoma that facilitates analysis of economic impacts of commodity market disturbances on factor markets. The model emphasizes multi-dimensional income distribution including functional, geographic, and size distributions.*

Index of Authors:

(Appendix C)

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APPENDIX D

DATABASES AND SEARCH PROCEDURES USED IN IDENTIFYING LITERATURE

Database	Keywords Used
Agricola (1984-1/1991)	compensating variation consumer surplus and (forest or natural resource) forest and economic and impact and analysis implan input-output and forestry regional and economic and development and forest social and accounting and (matrix or matrices) welfare and economics and (forest or natural resource)
Economic Literature Index	social()account? and matr? (forest? or timber? or wood) and (economic()impact or national()accounts or income()distribution enterpri?()budget? (production or management or enterprise()system) and (timber? or wood or forest?) (agricult? or forest? or timber? or wood) and ((multi(w)year or multi()year or multi-year or multi()product or multi-product) and production)
Sociological Abstracts	social()account? and matr? (forest? or timber? or wood) and (economic()impact or national()accounts or income()distribution enterpri?()budget? (production or management or enterprise()system) and (timber? or wood or forest?) (agricult? or forest? or timber? or wood) and ((multi(w)year or multi()year or multi-year or multi()product or multi-product) and production)
Dissertation Abstracts (1990)	social accounting socioeconomic and development and forestry

Legend:

()	indicates adjacency between statements
(w)	indicates that statement prior is found in same sentence as statement following
?	truncation symbol indicates that statement can have any ending

General use of parentheses indicates order of execution with statements within parentheses executed prior to those statements outside of parentheses.

APPENDIX E

ACRONYMS

To assist the reader, the following is a listing of acronyms found throughout the dissertation.

BEA	Bureau of Economic Analysis
BLM	Bureau of Land Management
CGE	computable general equilibrium
ERP	Effective Rate of Protection
FIPS	Federal Information Processing System
FPGE	Farm Policy in General Equilibrium
FTE	full time equivalent
GAMS	General Algebraic Modeling System
I/O	input-output
IIASA	International Institute for Applied Systems Analysis
IMPLAN	IMpact analysis for PLANning
IMS	Interindustry Modeling System
IPASS	Interactive Policy Analysis Simulation System
IUFRO	International Union of Forest Research Organizations
LDC	less developed country
MGA	Modeling to Generate Alternatives
NFMA	National Forest Management Act
NIPA	National Income and Product Accounts
OSHA	Occupational Safety and Health Administration
PAM	policy analysis matrix
PARD	Policy Analysis for Rural Development
PARVS	Public Area Recreation Visitors Study
RAS	R matrix, A matrix, S matrix (a balancing method)
REMI	Regional Economic Models, Inc.
RPC	regional purchase coefficient
SAM	social accounting matrix
SIC	Standard Industrial Classification
SIMLAB	Minnesota Regional Development Simulation Laboratory
SOFIA	Southern Forest Inventory and Analysis
STEB	Stevens, Treyz, Ehrlich, and Bower
TFS	Treyz, Friedlaender, Stevens
USDA	United States Department of Agriculture
USFS	United States Forest Service (USDA)

APPENDIX F

INVERTED MATRICES

	Production Sectors						Factor Income							Institutions						Households		
Prod. Sectors	1.123167	0.14539	0.007693	0.259715	0.014061	0.006176	0.005847	0.005656	0.005239	0.00697	0.006583	0.005821	0.006815	0.007858	0.002649	0.010985	0.008332	0.009868	0.006451	0.027055	0.011257	0.007536
	0.002434	1.031259	0.001137	0.001055	0.060059	0.000256	0.000284	0.000276	0.000254	0.000314	0.000326	0.000283	0.000302	0.000349	0.000118	0.000488	0.000426	0.000429	0.000313	0.001773	0.000548	0.000245
	0.005736	0.043371	1.008003	0.005216	0.013754	0.024681	0.004006	0.003878	0.003584	0.004636	0.004546	0.003965	0.004506	0.0052	0.001753	0.007269	0.005832	0.006396	0.004411	0.021196	0.007772	0.004368
	0.003277	0.006923	0.005073	1.024139	0.005594	0.007691	0.009519	0.009205	0.008534	0.011528	0.010673	0.009481	0.011303	0.013032	0.004394	0.018218	0.013413	0.016036	0.010513	0.040702	0.018293	0.013204
	0.000473	0.001179	0.02054	0.001711	1.24559	0.001088	0.00036	0.000348	0.000322	0.000418	0.000409	0.000358	0.000406	0.000469	0.000158	0.000655	0.000525	0.000576	0.000396	0.001905	0.000706	0.000381
	0.13424	0.16476	0.182569	0.095701	0.208819	1.212851	0.175339	0.169752	0.15688	0.202736	0.198957	0.174426	0.197118	0.227358	0.076653	0.317824	0.255238	0.279653	0.193079	0.929058	0.339442	0.191979
Factor Income	0.034851	0.059588	0.082475	0.041177	0.08244	0.175197	1.025628	0.024811	0.022931	0.029647	0.029077	0.025495	0.028828	0.033251	0.01121	0.046481	0.037294	0.040899	0.028222	0.135523	0.049611	0.028136
	0.023703	0.036413	0.061554	0.03527	0.06986	0.157472	0.022993	1.02226	0.020573	0.026597	0.026087	0.022873	0.025862	0.02983	0.010057	0.041699	0.03346	0.036691	0.02532	0.121609	0.04451	0.025237
	0.007415	0.01062	0.010429	0.007478	0.013507	0.053543	0.007773	0.007526	1.006955	0.00899	0.00882	0.007733	0.008741	0.010082	0.003399	0.014093	0.011314	0.012401	0.00856	0.041156	0.015048	0.00852
	0.05125	0.112357	0.000742	0.012009	0.011802	0.001211	0.000426	0.000412	0.000382	1.000501	0.000482	0.000424	0.000488	0.000563	0.00019	0.000787	0.000613	0.000693	0.00047	0.002107	0.000822	0.000511
	0.016708	0.032655	0.154708	0.098684	0.217337	0.081477	0.012645	0.012241	0.011315	0.014669	1.014337	0.01258	0.014271	0.016459	0.005549	0.023009	0.018367	0.020246	0.013927	0.066121	0.024471	0.014091
	0.104211	0.183508	0.25793	0.086106	0.197609	0.365287	0.053565	0.051858	0.047927	0.061967	0.060773	1.053287	0.060256	0.0695	0.023432	0.097154	0.077947	0.085486	0.058987	0.28323	0.103693	0.058813
	0.10734	0.219518	0.000959	0.024919	0.013316	0.000639	0.000613	0.000593	0.000549	0.000726	0.000691	0.00061	1.000709	0.000817	0.000276	0.001142	0.000678	0.001005	0.000676	0.002927	0.00118	0.000766
Institutions	0.00203	0.00419	0.000367	0.000575	0.000588	0.000535	0.000527	0.00029	0.000251	0.010366	0.000269	0.001134	0.01287	1.000114	3.85E-05	0.00016	0.000127	0.00014	9.66E-05	0.000458	0.00017	9.8E-05
	0.037512	0.077659	0.004324	0.010024	0.009058	0.006396	0.009021	0.004762	0.004108	0.188046	0.004317	0.011055	0.248789	0.001452	1.00049	0.00203	0.001615	0.001786	0.001227	0.005781	0.002153	0.001254
	0.000624	0.001372	7.52E-05	0.000188	0.000241	0.000141	0.000609	0.000296	0.000252	0.013713	0.000253	-0.00012	-0.00086	3.08E-05	1.04E-05	1.000043	3.43E-05	3.79E-05	2.6E-05	0.000123	4.57E-05	2.65E-05
	0.027127	0.049638	0.097376	0.052671	0.114142	0.104386	0.117937	0.114584	0.047933	0.087696	0.365151	0.126486	0.017506	0.020191	0.006807	0.028226	1.022613	0.024836	0.017122	0.081849	0.030095	0.017144
	0.102561	0.212286	0.016558	0.028674	0.02872	0.024393	0.028512	0.015317	0.013247	0.576259	0.01404	0.047647	0.632215	0.005272	0.001778	0.00737	0.005878	1.006485	0.004459	0.021119	0.007831	0.004529
	0.130553	0.225158	0.376696	0.17588	0.378547	0.580209	0.818013	0.811527	0.828107	0.120778	0.652349	0.773362	0.095973	0.110695	0.03732	0.154741	0.124108	0.136157	1.093931	0.450675	0.165116	0.093751
Households	0.008281	0.014065	0.029525	0.014174	0.031034	0.041204	0.055412	0.054924	0.049593	0.006903	0.069797	0.053538	-0.00177	-0.00168	-0.00057	-0.00236	0.102843	-0.00256	0.061349	1.032057	0.01175	0.006676
	0.128613	0.250374	0.162013	0.094725	0.178594	0.231035	0.310528	0.297031	0.274479	0.518495	0.346037	0.313938	0.524292	0.604019	0.20365	0.844369	0.43809	0.743919	0.334513	0.181476	1.066589	0.037895
	0.067701	0.129163	0.105381	0.057598	0.113058	0.15337	0.209058	0.202579	0.192919	0.236584	0.214862	0.206755	0.235439	0.271071	0.091394	0.378936	0.221515	0.334092	0.241756	0.120021	0.044018	1.025031

Figure 16. *(I - A)* $^{-1}$ Calculated From Endogenized Portion of McCurtain County Social Accounting Matrix Using Quattro Pro, Version 3.00.

	Production Sectors						Factor Income							Institutions						Households		
Prod. Sectors	1.122821	0	0.00744	0.259559	0	0.006135	0.005806	0.005616	0.005201	0.006924	0.006535	0.00578	0.00677	0.007807	0.002632	0.010914	0.008269	0.009605	0.006405	0.026797	0.011177	0.007499
	-0.00234	-1	-0.00014	-0.00094	0	-0.0002	-0.00026	-0.00025	-0.00023	-0.00028	-0.0003	-0.00026	-0.00027	-0.00032	-0.00011	-0.00044	-0.00039	-0.00039	-0.00028	-0.00163	-0.0005	-0.00022
	0.005629	0	1.00777	0.005156	0	0.02466	0.003991	0.003864	0.003571	0.004619	0.004528	0.00397	0.004492	0.005181	0.001747	0.007243	0.005809	0.006373	0.004394	0.021106	0.007743	0.004354
	0.003258	0	0.00498	1.024125	0	0.007685	0.009516	0.009201	0.008531	0.011524	0.010669	0.009478	0.011299	0.013028	0.004392	0.018212	0.013408	0.016031	0.010509	0.040682	0.018286	0.013201
	-0.00038	0	-0.01649	-0.00137	-1	-0.00067	-0.00029	-0.00028	-0.00026	-0.00034	-0.00033	-0.00029	-0.00033	-0.00038	-0.00013	-0.00053	-0.00042	-0.00046	-0.00032	-0.00153	-0.00057	-0.00031
	0.133776	0	0.179102	0.095259	0	1.212637	0.175236	0.169653	0.156788	0.202619	0.198839	0.174324	0.197005	0.227227	0.076609	0.317642	0.255066	0.279492	0.192966	0.92847	0.339242	0.191879
Factor Income	0.034681	0	0.081107	0.041008	0	0.175114	1.025589	0.024773	0.022885	0.029603	0.029032	0.025456	0.028785	0.033201	0.011194	0.046412	0.037236	0.040838	0.028179	0.1353	0.049535	0.028096
	0.023591	0	0.060397	0.03514	0	0.157404	0.022963	1.022231	0.020546	0.026564	0.026053	0.022844	0.02583	0.029792	0.010044	0.041646	0.033416	0.036645	0.025287	0.121443	0.044452	0.025207
	0.007385	0	0.010204	0.00745	0	0.05353	0.007767	0.007519	1.006949	0.008982	0.008812	0.007726	0.008734	0.010073	0.003396	0.014081	0.011304	0.01239	0.008553	0.041118	0.015035	0.008514
	0.050983	0	0.000531	0.011887	0	0.001179	0.000394	0.000381	0.000353	1.000465	0.000444	0.000392	0.000454	0.000523	0.000176	0.000731	0.000565	0.000644	0.000434	0.001906	0.000759	0.000483
	0.01655	0	0.15112	0.098355	0	0.081281	0.012574	0.012172	0.011252	0.014586	1.014256	0.012509	0.014191	0.016367	0.005518	0.02288	0.018263	0.020133	0.013849	0.065736	0.024332	0.014017
	0.103707	0	0.254646	0.085661	0	0.365078	0.053461	0.051757	0.047834	0.061849	0.060653	1.053183	0.060141	0.089367	0.023387	0.096969	0.077793	0.085323	0.058872	0.282629	0.10349	0.058713
	0.106821	0	0.000708	0.024694	0	0.000584	0.000552	0.000534	0.000495	0.000659	0.000622	0.00055	1.000644	0.000743	0.00025	0.001038	0.000787	0.000914	0.000609	0.002549	0.001063	0.000713
Institutions	0.00202	0	0.000356	0.00057	0	0.000534	0.000526	0.000288	0.00025	0.010364	0.000268	0.001133	0.012869	1.000113	3.8E-05	0.000157	0.000126	0.000139	9.52E-05	0.000451	0.000167	9.69E-05
	0.037327	0	0.004164	0.009938	0	0.006373	0.008999	0.00474	0.004067	0.186021	0.004291	0.011032	0.248765	0.001424	1.00048	0.001991	0.001581	0.001752	0.001202	0.005641	0.002109	0.001234
	0.000621	0	7.1E-05	0.000186	0	0.00014	0.000609	0.000295	0.000251	0.013712	0.000253	-0.00012	-0.00086	3.03E-05	1.02E-05	1.000042	3.37E-05	3.72E-05	2.56E-05	0.00012	4.49E-05	2.61E-05
	0.026968	0	0.095487	0.052468	0	0.104277	0.117892	0.11454	0.047892	0.087644	0.365098	0.126441	0.017455	0.020133	0.006788	0.028144	1.022546	0.024764	0.017072	0.081694	0.030006	0.017099
	0.102054	0	0.016054	0.028434	0	0.024326	0.028449	0.015256	0.013191	0.576169	0.013967	0.047585	0.632147	0.005194	0.001751	0.007261	0.005783	1.006389	0.004389	0.020729	0.007709	0.004474
	0.129684	0	0.370422	0.175148	0	0.579834	0.817846	0.811365	0.827957	0.120587	0.652158	0.773195	0.095788	0.110481	0.037246	0.154442	0.123861	0.135894	1.093747	0.449729	0.16479	0.093585
Households	0.008237	0	0.029011	0.014119	0	0.041174	0.055399	0.054912	0.049582	0.006889	0.069783	0.053525	-0.00178	-0.0017	-0.00058	-0.00238	0.102825	-0.00258	0.061335	1.031986	0.011726	0.006683
	0.12796	0	0.159033	0.094243	0	0.23083	0.310412	0.296918	0.274375	0.518364	0.345904	0.313823	0.524165	0.603873	0.2036	0.844164	0.437918	0.743739	0.334385	0.180795	1.066363	0.037785
	0.067357	0	0.103498	0.057321	0	0.153246	0.20899	0.202515	0.19286	0.23851	0.214787	0.206689	0.235367	0.270966	0.091366	0.37882	0.221417	0.333969	0.241683	0.119638	0.043889	1.024968

Figure 17. *(I - A supply determined) -1* Calculated From Endogenized Portion of McCurtain County Social Accounting Matrix Using Quattro Pro, Version 3.00.

VITA

David William Marcouiller

Candidate for the Degree of

Doctor of Philosophy

Thesis: DEVELOPMENT AND USE OF A SUPPLY-DETERMINED SOCIAL ACCOUNTING MATRIX TO EVALUATE ECONOMIC IMPACTS OF FOREST PRODUCTIVITY ON DISTRIBUTION OF REGIONAL FACTOR INCOME

Major Field: Agricultural Economics

Biographical:

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Education: Graduated from Thomas Alvin Edison High School, Minneapolis, Minnesota, in June, 1978; received Bachelor of Science Degree in Forest Management with emphasis in Ecosystems and Silviculture from the University of Minnesota at St. Paul in May, 1983; received Master of Science Degree in Forest Economics and Policy from the University of Minnesota at St. Paul in February, 1988; completed requirements for the Doctor of Philosophy Degree from Oklahoma State University at Stillwater in December, 1992.

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