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AN EMPIRICAL STUDY OF THE EFFECTS OF TAXATION ON INVESTMENT EXPENDITURES BY SELECTED FIRMS IN THE FOREST PRODUCTS INDUSTRY

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAII IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN ECONOMICS

DECEMBER 1983

By
William Ronnie Singleton

Dissertation Committee:
Richard Pollock, Chairman
Moheb A. Ghali
Howard D. Lowe
James E.T. Moncur
Jack P. Suyderhoud
Lyndon L. Wester
ACKNOWLEDGEMENTS

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The author also expresses his gratitude to his parents for their continuous encouragement during his scholastic studies. Finally, the author extends his warmest appreciation and sincerest thanks to his wife, Janet, for her encouragement and invaluable assistance throughout this project.
The purpose of this research is to conduct an empirical investigation of the effects of corporate income taxation on investment expenditures and tax parity at the industry level. The forest products industry is selected for two primary reasons. First, the composition of the firms’ capital stock of both depreciating and appreciating assets presents an interesting study in investment demand theory. Second, the industry is subject to special tax provisions that make it of interest for a study in taxation theory, as well as tax design and evaluation.

The approach taken is to first review the theoretical constructs of the investment process in depreciating assets within the context of the neoclassical theory of investment demand, and to extend the theory to the appreciating asset case. Theoretically consistent models are derived for three asset categories: equipment (short-lived, deprecia-
ting), structures (long-lived, depreciating) and timber (long-lived, appreciating).

The methodology used is that of comparative statics. Previously derived models are adjusted for taxation variables, and to incorporate the more recent work on the effects of the inflation-taxation interaction. The models are then applied to a data base constructed for the period 1967-1981, and consisting of a panel of firms selected from the industry. Hypotheses of the determinants of the model are tested, and the evidence evaluated concerning the effect of selected tax variables that enter the model in a theoretical predetermined manner. The coefficients of the models can be used to estimate the magnitude of any tax induced investment attributable to selected tax variables. The coefficients can also be used in alternative tests that will allow inferences to be made concerning the impact of the tax provisions on either the magnitude or composition of investment expenditures.

The results provide empirical evidence relevant to the investment demand literature suggesting that certain tax instruments affect the amount and composition of investment expenditures. Results, however, appear sensitive to elasticity assumptions embodied in the model's structure. The investment tax credit appears to stimulate investment
expenditures, and creates a bias to short-lived assets. Capital gains tax provisions applicable to the industry also stimulate investment expenditures, although to a lesser degree than the investment credit, and tend to favor the appreciating asset case. The 1979 corporate tax rate decrease seems to have had little measurable effect in stimulating investment. Calculations of effective tax rates for each asset category tend to confirm the composition bias resulting from the selected tax provisions.

Empirical evidence is also provided for certain timber taxation issues. After adjustment for measuring unrealized timber income, model results indicate that capital gains provisions stimulate timber investment, and reduce the effective tax rate of timber income. Effective tax rates on timber income indicate that timber is not currently taxed at excessive rates relative to other assets, nor would it be in the absence of the preferential capital gains provisions. In addition, the results denote that taxing accrued timber income would not result in industry rates exceeding statutorily prescribed levels.

The results provide information for evaluating broader tax policy issues. Comparisons of tax expenditures for preferences, and the resulting induced investment, raise
questions as to the effectiveness of using indirect instruments, such as taxation, to achieve investment incentive policy goals. Comparing the effective tax rates in a tax environment of no investment credit, no capital gains tax, and taxing accrued timber income suggests a relatively equal tax burden among categories of assets.
# TABLE OF CONTENTS

## ACKNOWLEDGEMENTS

## ABSTRACT

## LIST OF TABLES

## LIST OF GRAPHS AND DIAGRAMS

## CHAPTER ONE. INTRODUCTION

Nature of the Research Problem ...................................................... 1
Discussion of Primary Substantive Issues ........................................... 4
Research Approach and Methodology ................................................. 11
Theory and Analytical Framework for Evaluating Issues ....................... 21
Organization of Study ..................................................................... 29

## CHAPTER TWO. REVIEW OF RELATED LITERATURE

Investment Demand Issue .................................................................. 33
Neutrality Issue - The Composition Effect .......................................... 42
Interindustry Tax Parity .................................................................... 47
Impact of Alternative Taxation Instruments ......................................... 51
Tax Incentive Policy Effectiveness ...................................................... 57
Conclusions ..................................................................................... 58

## CHAPTER THREE. MODEL DEVELOPMENT

Standard Neoclassical Investment Model .............................................. 61
Criticisms of SNIM .......................................................................... 67
Justification for the Use of SNIM ......................................................... 75
Modifications of the Basic SNIM ........................................................ 79
Summary - The Modified GSNIM ......................................................... 85
<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1</td>
<td>Composition of Investment Expenditures</td>
<td>7</td>
</tr>
<tr>
<td>4-1</td>
<td>Firm Ownership of Timber Acreage</td>
<td>96</td>
</tr>
<tr>
<td>5-1</td>
<td>Summary Statistics for Alternative Lag Specifications of Investment Expenditures</td>
<td>136</td>
</tr>
<tr>
<td>5-2</td>
<td>Summary Statistics for Alternative Lag Specifications of Price and Output Variables</td>
<td>138</td>
</tr>
<tr>
<td>5-3</td>
<td>Summary Statistics for Alternative Measures of Rate of Return</td>
<td>141</td>
</tr>
<tr>
<td>5-4</td>
<td>Summary Statistics for Alternative Specification of Modified GSNIM Model</td>
<td>143</td>
</tr>
<tr>
<td>5-5</td>
<td>Summary Statistics of Alternative Estimates of Inflation</td>
<td>146</td>
</tr>
<tr>
<td>5-6</td>
<td>Summary Statistics of Alternative Price Elasticity Estimates</td>
<td>148</td>
</tr>
<tr>
<td>5-7</td>
<td>Model Results - Unitary Elasticity Assumption</td>
<td>152</td>
</tr>
<tr>
<td>5-8</td>
<td>Model Results - Relaxing Unitary Price Elasticity Assumption</td>
<td>154</td>
</tr>
<tr>
<td>5-9</td>
<td>Estimates of Effective Tax Rates by Asset Category</td>
<td>163</td>
</tr>
<tr>
<td>5-10</td>
<td>Effective Tax Rate of the Industry</td>
<td>166</td>
</tr>
<tr>
<td>6-1</td>
<td>Estimates of Direct Effects of Alternative Tax Instruments on Investment Expenditures</td>
<td>172</td>
</tr>
<tr>
<td>6-2</td>
<td>Estimates of Alternative Tax Policies on Effective Tax Rates</td>
<td>181</td>
</tr>
<tr>
<td>6-3</td>
<td>Comparison of Tax Cost and Tax Induced Investment Expenditures</td>
<td>190</td>
</tr>
</tbody>
</table>
# LIST OF GRAPHS AND DIAGRAMS

<table>
<thead>
<tr>
<th>Graph</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1</td>
<td>% of Investment By Asset Category</td>
<td>8</td>
</tr>
<tr>
<td>5-1</td>
<td>Comparison of Observed and Predicted Values</td>
<td>155</td>
</tr>
<tr>
<td></td>
<td>of $I_e$</td>
<td></td>
</tr>
<tr>
<td>5-2</td>
<td>Comparison of Observed and Predicted Values</td>
<td>158</td>
</tr>
<tr>
<td></td>
<td>of $I_s$</td>
<td></td>
</tr>
<tr>
<td>5-3</td>
<td>Comparison of Observed and Predicted Values</td>
<td>160</td>
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<td></td>
<td>of $I_f$</td>
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<table>
<thead>
<tr>
<th>Diagram</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Application of I.R.C. Sections 631 and 1231</td>
<td>213</td>
</tr>
<tr>
<td>2</td>
<td>Application of I.R.C. Section 631</td>
<td>214</td>
</tr>
</tbody>
</table>
CHAPTER ONE
INTRODUCTION

I. Nature of the Research Problem
   A. Characteristics of the Industry

       1. Industry distinctions

       Two important characteristics distinguish firms in the forest products industry from other firms and make them of special interest. The first characteristic is the unusual composition of their capital stock. Forest products companies, like most firms, employ land, buildings and equipment; however, they also make major investments in timber. Timber is a unique asset in that it is long-lived and appreciates in value over time. A relatively long gestation period is required before the firm realizes any cash income from its timber investment.

       The second distinguishing characteristic is the tax provisions that apply to firms in the industry. The regular corporate tax provisions, such as available tax depreciation or the investment tax credit are applicable. Forest products firms are able through special tax provisions, however, to convert a substantial portion of their income from ordinary income subject to the regular corpor-
ate tax rates to capital gain income which is generally taxed at a lower rate.

2. Tax design and evaluation controversies related to the forest products industry

The distinguishing tax provisions and composition of capital stock of firms in the industry have led to significant theoretical and policy controversies. These controversies basically concentrate on the broader economic issue of how taxes affect investment expenditures, as well as related questions about equity or tax parity. One question would be whether the unique investment characteristics of the industry require special or preferential tax provisions to accomplish predetermined policy objectives for the industry beyond tax parity; e.g., reforestation. Alternatively, the issue would be whether the regular tax regime applying to all industries creates a disincentive for this industry, thus indicating a need for special tax preferences or relief. If a bias could be proven to exist, additional questions must be addressed:

1) Does restructuring or reducing taxes for the industry for equity reasons significantly change behavior? For example, would taxes affect the level (magnitude) or composition of investment expenditures, either fortuitously or by intent?
2) Would the tax cost of the subsidy be worth the benefits obtained?

B. Problem Statement

The literature reflects conflicting analytical views as to whether the current tax regime creates a pro timber bias or excessively taxes timber income. Even if an unequivocal case could be made for preferential treatment of timber income to achieve tax parity, the issue of whether features of the tax structure do modify investment behavior remains unsettled. Empirical results in the investment demand studies conflict, and few empirical studies with timber as the dependent variable have been conducted.

Thus, the present literature does not provide conclusive a priori or empirical evidence to resolve neither the general or industry specific conflicts. This problem is exemplified by Sunley's (1972) statement: "... too little is known about the impact of the timber tax subsidy" (p. 329). It would appear beneficial if additional empirical evidence and analyses were provided that would be useful in resolving the controversies. The focus of this dissertation effort is to provide empirical evidence that addresses the controversial issues relevant to taxation of the forest products industry, as well as provide a case study of the
more general issues involving the effects of tax provisions on investment behavior.

II. Discussion of Primary Substantive Issues

Conducting an empirical study of the effects, or providing answers for the general question of how the corporate income tax provisions affect the industry, requires that the substantive issues be more explicitly specified.

A. The Investment Demand Issue

The investment demand issue is concerned with whether tax variables of any kind stimulate the absolute amount or magnitude of investment expenditures in capital goods. If such an effect is present, the issue also encompasses determining the methods or channels through which such effects occur. The issue of any tax induced magnitude effects is important for any industry, including forest products, in addressing whether taxes can be used to affect investment decisions.

B. Neutrality Issue - Composition Effects

Tax neutrality refers to the minimization of distortion in resource allocation after the imposition of a tax relative to pretax market conditions. This efficiency goal would be achieved if a tax alters before-tax rates of return proportionately across all assets and/or industries. Implicit in a study of tax neutrality is determining if the
tax has induced a change in behavior by economic agents, such as altered investment behavior relative to a pre-tax world. Such tax induced changes could be a desired change in conformity with predetermined policy objectives, or an undesirable change. With the exception of the tax incentive policy effectiveness question, an evaluation of the normative issue of the desirability of the tax induced change is beyond the scope of this study. Accordingly, the issue will be limited to a positive study of the neutrality of a given tax in a given industry. Within this context, emphasis will be placed on determining whether tax variables have influenced either the level or composition of investment expenditures.

Investment in the forest products industry is composed of the following major categories of assets:

a) equipment - assets with a relatively short economic life, that depreciate in response to use over time;

b) structures - assets with a relatively long economic life that depreciate in response to use over time;

and

c) timber - assets with a relatively long economic life that appreciate in value over time.

A neutral tax or tax regime would be one which did not bias corporate investment toward assets with either differ-
ent lives (equipment versus structures and timber) or appreciation characteristics (appreciating versus depreciating). Reference to Table 1-1 and Graph 1-1 indicates that the composition of investment expenditures has changed in the 1967-1981 period. Although the percentage of annual investment in structures relative to total investment has remained relatively constant, the proportion for equipment has increased, and for timber has decreased. The emphasis of the composition effect, then, is whether taxes have affected investment in one category relative to another during the sample period. This issue is particularly important for the forest products industry which makes substantial investments in different asset categories.

C. Interindustry Tax Parity - Relative Taxation of the Industry

The issue of interindustry tax parity is concerned with determining how equitably the representative firms in the forest products industry are taxed relative to firms in other industries. One measure of an equitable tax would be one which would result in the effective tax rate being the same across industries; i.e., would alter the before-tax rate of return, and the resulting effective tax rates, proportionately across industries. This issue is particularly important for evaluating the arguments
### TABLE 1-1
Composition of Investment Expenditures by Sample Firms (millions of 1967 dollars)

<table>
<thead>
<tr>
<th>Year</th>
<th>Equipment $</th>
<th>%</th>
<th>Structures $</th>
<th>%</th>
<th>Timber $</th>
<th>%</th>
<th>Total $</th>
</tr>
</thead>
<tbody>
<tr>
<td>1967</td>
<td>397.0</td>
<td>67</td>
<td>57.0</td>
<td>10</td>
<td>135.0</td>
<td>23</td>
<td>589.0</td>
</tr>
<tr>
<td>1968</td>
<td>332.2</td>
<td>64</td>
<td>65.8</td>
<td>12</td>
<td>123.7</td>
<td>24</td>
<td>521.7</td>
</tr>
<tr>
<td>1969</td>
<td>484.3</td>
<td>60</td>
<td>72.6</td>
<td>9</td>
<td>251.4</td>
<td>31</td>
<td>808.3</td>
</tr>
<tr>
<td>1970</td>
<td>550.6</td>
<td>73</td>
<td>93.8</td>
<td>12</td>
<td>115.9</td>
<td>15</td>
<td>760.3</td>
</tr>
<tr>
<td>1971</td>
<td>494.9</td>
<td>73</td>
<td>91.3</td>
<td>13</td>
<td>92.1</td>
<td>14</td>
<td>678.3</td>
</tr>
<tr>
<td>1972</td>
<td>565.7</td>
<td>76</td>
<td>68.2</td>
<td>9</td>
<td>109.1</td>
<td>15</td>
<td>743.0</td>
</tr>
<tr>
<td>1973</td>
<td>474.5</td>
<td>78</td>
<td>56.7</td>
<td>10</td>
<td>74.2</td>
<td>12</td>
<td>605.4</td>
</tr>
<tr>
<td>1974</td>
<td>714.2</td>
<td>78</td>
<td>84.0</td>
<td>9</td>
<td>115.6</td>
<td>13</td>
<td>913.8</td>
</tr>
<tr>
<td>1975</td>
<td>750.1</td>
<td>84</td>
<td>94.7</td>
<td>11</td>
<td>43.4</td>
<td>5</td>
<td>888.2</td>
</tr>
<tr>
<td>1976</td>
<td>813.4</td>
<td>87</td>
<td>61.7</td>
<td>7</td>
<td>60.6</td>
<td>6</td>
<td>935.7</td>
</tr>
<tr>
<td>1977</td>
<td>757.4</td>
<td>85</td>
<td>59.0</td>
<td>7</td>
<td>75.7</td>
<td>8</td>
<td>892.1</td>
</tr>
<tr>
<td>1978</td>
<td>725.6</td>
<td>84</td>
<td>77.7</td>
<td>9</td>
<td>64.3</td>
<td>7</td>
<td>867.6</td>
</tr>
<tr>
<td>1979</td>
<td>1040.4</td>
<td>85</td>
<td>89.3</td>
<td>7</td>
<td>97.0</td>
<td>8</td>
<td>1226.7</td>
</tr>
<tr>
<td>1980</td>
<td>1014.0</td>
<td>86</td>
<td>102.6</td>
<td>9</td>
<td>57.6</td>
<td>5</td>
<td>1174.2</td>
</tr>
<tr>
<td>1981</td>
<td>738.8</td>
<td>83</td>
<td>82.3</td>
<td>9</td>
<td>70.2</td>
<td>8</td>
<td>891.3</td>
</tr>
<tr>
<td>Total</td>
<td>9853.1</td>
<td>1156.7</td>
<td>1485.8</td>
<td>8</td>
<td>12495.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Annual reports and other financial information supplied by sample firms. See Chapter Four for method of compilation.
GRAPH 1-1
% OF INVESTMENT BY ASSET CATEGORY

% 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0

\[
\begin{align*}
I_e &= \text{equipment investment} \\
I_s &= \text{structures investment} \\
I_t &= \text{timber investment}
\end{align*}
\]

YEARS 19-81

- 8 -
pertaining to excessive taxation of an industry under the current tax system.

D. Impact of Alternative Taxation Methods

An additional issue of interest indicated in the literature is the impact of alternative taxation systems on investment expenditures and on effective tax rates. The more controversial tax instruments applicable to the industry are:

a) the capital gains provision; and

b) taxing accrued (as opposed to realized) income from holding timber.

To address the tax policy/design issue of alternative taxation methods or systems, three basic models or regimes pertaining to the timber industry have to be distinguished. The first can be loosely referenced as the "normal" or baseline system. This is the more general approach that characterizes corporate income taxation; i.e., taxation of realized income at ordinary rates. However, since this basic system was thought to be unfair when applied to the timber producing industry, Congress modified the basic approach by permitting capital gains treatment for timber income; i.e., realized income was taxed at capital gains tax rates. This will be referenced simply as the "capital gains" approach. Over time there has been a growing criticism or opposition
to this approach from analysts. Some have advocated a third model or regime involving the taxation of accrued income in contrast to realized income. This regime can be further distinguished between the tax rates applied to the accrued income; i.e., ordinary tax rates or capital gains tax rates. This proposed regime will be referenced as the accruals-ordinary rates and the accruals-capital gains rates, respectively. The "capital gains" regime or approach is the one presently used.

The present corporate tax system also involves the use of various ad hoc incentives. These have been superimposed on the basic or normal system as it applies to most firms or industries. However, in the case of the forest products industry they have been superimposed on the capital gains regime. Appendix A presents a review of the detailed tax provisions applicable to the industry.

Addressing the issue of alternative taxation environments would be helpful for assessing the possible role of different tax instruments in improving the efficiency and equity of the present tax regime. Such insight would be useful in determining the most appropriate methods for taxing the industry.
E. Tax Incentive Policy Effectiveness

The tax policy effectiveness issue addresses the costs of, and benefits derived from, the use of indirect tax policies to accomplish prescribed objectives of a tax incentive nature. This issue is often referred to as the "bang-for-buck" issue in the literature and represents one measure of the effectiveness of a given policy. The tax incentives of particular interest are:

a) the investment tax credit; and

b) the capital gains tax provisions available to the industry.

This information should prove useful for decision makers in assessing the issue of whether the benefits derived from the use of tax policy to encourage investment are worth the lost tax revenue (cost), or whether more direct policies, such as reforestation grants, might be more effective.

III. Research Approach and Methodology

A. Approach

It is necessary to first establish a theoretical framework to organize the diverse analytical and empirical aspects of this study. This study is conducted within the context of the neoclassical theory of investment demand which will be reviewed in a subsequent section of this
chapter. Theoretically consistent models will then be derived which can be used to test hypotheses constructed for the various substantive issues. The fitted equations can also be used for simulation purposes. The results of the model application are then discussed in the context of the initial research issues and general questions of how taxes affect investment expenditures in the forest products industry.

B. Model Development and Application

The model that will be used in this study will be an extension of the standard neoclassical investment demand model. The model, and a review of its numerous criticisms, will be presented in a subsequent chapter. In view of these criticisms, a justification for its use in this study will be presented. The chapter will then incorporate various modifications and develop a model that reflects both the criticisms and the unique characteristics of investment by firms in the timber industry. A separate estimating model will be developed for each investment category: equipment, structures and timber.

The estimating equations will then be applied to a data base of sample firms representative of the industry. Initially, an exploration of the parameter space will be conducted to estimate structural characteristics of the
model, such as the form of the lag distribution. Then, an evaluation of the sensitivity of the model to certain assumptions will be made. After the final form of the model is determined, it can then be employed in evaluating the specific research issues.

C. Specific Methodology for Research Issues

The specific methodology employed will vary depending upon the issue. In each case, a review of the related literature will be made. To properly address the primary issues, hypotheses will be constructed and tested using the previously developed model. In addition, simulations and estimates of effects will also be made. The secondary issues do not involve hypothesis testing, but instead are addressed in the context of evaluating statistical information resulting from estimation of the model. This section will present the general area of related literature, hypotheses, and implications of each test for each research issue.

1. Investment demand issue

a) Relevant literature

The investment demand strand of literature covers both the theory of investment demand and the issue of the effects of taxation on investment demand. The numerous theoretical and empirical studies conducted in this area
reflect significant controversies on the role of taxation as a determinant of investment demand. Some analysts (e.g., Jorgenson) argue that investment is very responsive to tax variables; however, others, like Eisner, argue that tax policy per se has little impact. Other authors (e.g., Coen) may recognize the impact of taxes, but attribute major importance to other variables such as supply of internal funds.

b) Hypothesis specification

The specific null hypothesis that would address the question of any tax-induced magnitude effects on the level of investment expenditures would be as follows:

\[ H_0: \] Current federal income tax provisions have no effect on the amount of investment expenditures by selected firms in the forest products industry.

The neoclassical model does not permit a direct test of the significance of the tax variable. The impact of taxation on investment is tested indirectly when the relative price and output terms are tested. Thus, an initial test will be conducted for the null hypothesis on the significance of the determinants of investment demand as prescribed by the neoclassical theory as follows:

- 14 -
$H_G$: Relative price and output variables do not have a significant, positive effect on investment expenditures.

The hypothesis will be tested by applying the model to the sample data and estimating the coefficients of the relative price and output variables for each separate category of investment. The dependent variable will be either equipment, structures or timber expenditures, and the determinants are the price and output variables. If the null hypothesis that the coefficients equal zero can be rejected, then the significance of the relative price/output variables will be implied, permitting rejection of the $H_G$ null hypothesis.

Rejection of the $H_G$ null hypothesis also implies that the determinants of investment demand are consistent with the neoclassical formulation. This initial step of establishing the significance of the relative price and output variables is crucial, for it is through the relative price term that tax variables affect investment expenditures.

The role of taxation is derived theoretically from neoclassical capital theory, and enters as a determinant in the relative price term through the cost of capital. The null hypothesis of no tax induced magnitude effects, $H_M$,
will be rejected if the indirect test of the price/output coefficients associated with the tax parameters yield significant coefficients. This test of $H_M$ will establish whether the tax variables affect the amount of a firm's investment expenditures.

Although an indirect test may not provide a method for statistically evaluating the tax variable independently from other effects that might enter into the cost of capital, the formulation does provide a theoretical means of inferring the significance of the tax variable, and a convenient method for estimating the magnitude of tax induced effects.

c) Estimation of the magnitude effect

Testing the null hypothesis $H_M$ will determine if a magnitude effect may be present. If the tax variables are considered significant, then the fitted equation obtained from estimating the model can be applied by a simulation technique and an estimate of the magnitude of the effect of the tax variable on the dependent variable obtained. An estimate of the magnitude of the tax effect will be made for each of the tax variables of issue; namely, the investment tax credit, the 1979 reduction in corporate tax rates and the capital gains provisions.
2. Composition effect or intra-industry tax neutrality
   
a) Relevant literature

The composition effect issue is addressed in both the investment demand literature, tax neutrality studies and the timber taxation literature. The issue is particularly important as a timber tax issue, and the literature indicates a controversy as to whether the more general corporate taxation system (the baseline system) creates a permanent, long-run bias against timber investment relative to investment in other assets.

b) Hypothesis specification

The neutrality of a given tax on the composition of investment will be assessed by two methods. First, by using the previously developed estimates of the magnitude of the effects of different tax variables, a simple comparison of the absolute amount of investment in different asset groups can be made. This comparison would provide evidence for evaluating how a given tax variable will affect the amount of investment in one category of assets relative to others. The second method will involve hypothesis testing of the neutrality of a given tax for different categories of assets in terms of comparative rates of return.

The specific definition for evaluating the neutrality of a given tax has been a controversial subject.\(^2\) For
purposes of this study, a neutral tax is one which alters rates of return across capital or fixed assets proportionally. The extent to which the pre-tax rates change as a result of a given tax reflects the effective tax rate. Thus, a neutral tax environment would be defined as one in which effective tax rates were equated across different categories of capital assets.

Given this definition, the specific null hypothesis that would address the issue of the neutrality of a given tax on the composition of investment would be:

\[ H_c: \text{Current federal tax provisions affect the before tax rate of return for different classes of assets proportionally.} \]

The hypothesis will be tested by estimating the effective tax rates for each investment category under alternative taxation methods. The effect of the tax changes on the before-tax rate of return reflected in the effective tax rates will then be compared. If the tax change does not reduce the pre-tax rates of the different asset classes proportionally, the hypothesis of no tax effect will be rejected. Rejection of the null hypothesis implies that selected tax variables have an effect, at least temporarily, on the composition of investment expenditures by sample firms in the industry. It assumes that there are no offset-
ting diffusion or capitalization effects; e.g., if the price of assets and/or price of output varies as a result of tax induced changes in the composition of investment.

3. **Interindustry tax parity**

This issue is discussed in the timber taxation literature in the context of whether the industry is preferentially taxed because of the existing capital gains provisions or is excessively taxed because one of its substantial investments (timber) is still excessively taxed, in spite of special preferences. Using proportional effects on before-tax rates of return as criteria for tax neutrality, an industry average of the effective tax rate can be calculated. Consistent with other studies in the literature, the rate will be calculated as a weighted average of the effective tax rates of the different classes of capital stock the sample firms own. This estimate could then be compared with the effective rates for other industries. Thus, empirical evidence would be available for assessing the argument of whether the industry is excessively or preferentially taxed relative to other industries.

4. **Impact of alternative taxation instruments**

The empirical evidence provided for this issue is primarily for use in evaluating the arguments of the relative taxation of either specific assets, or additional
evidence for evaluating the taxation of the industry. Using the results obtained from the simulation of the magnitude effect of alternative tax policies on investment expenditures, estimates of effective tax rates can also be made for timber and for the industry. Specifically, effective tax rates and estimates of magnitude effects would be calculated for timber and the industry under the following simulated tax scenarios:

a) no capital gains provisions; or
b) taxing timber income using an accrued income tax concept (as opposed to a realized income concept)

The simulated changes in investment expenditures and resulting tax rates for each alternative would be meaningful evidence for evaluating the effects of alternative tax policies.

5. **Tax incentive policy effectiveness**

Authors in both the timber tax literature and the investment demand literature have raised the issue of whether the costs (foregone tax revenues) of tax incentives are worth the benefits (increased investment) obtained. Information can be provided for this issue by estimating the tax savings generated by the sample firms from utilizing selected tax variables. These amounts would represent the cost to the Treasury of the use of the tax provision.
The benefits would be represented by the additional investment generated as reflected in the simulations conducted with the investment demand issue. An immediate argument could be raised that other benefits, in addition to increased investment, result from certain tax provisions. The purpose of this research, however, is to only provide the specific empirical evidence as one factor in the complex normative issue of assessing whether the benefits of a policy are worth its costs.

IV. Theory and Analytical Framework for Evaluating Issues

This section will first present the theoretical background for selected analytical issues or paradigms. This is done so that the empirical work and resulting interpretations have a unifying framework. Also, it will permit an evaluation to be made in later chapters of the consistency of the empirical results with what would be predicted by theory. The section will then provide a description of the tax variables of interest for this study.

A. Neoclassical Theory of Investment Demand

The theoretical framework for this study is the neoclassical theory of investment demand which is attributable, to a large extent, to the various contributions of Jorgenson. The initial point in developing the theory is Fisher's "Separation Theorem"(3). This theorem allows,
under conditions of perfect competition, production decisions to be made independently of consumption decisions. The firm will then choose inputs for use in production which will maximize the wealth or net present value of the firm. This gives the objective function of the firm at time \( t \) as:

\[
W = \int_0^T e^{-rt}(pQ - wL - qI) \, dt
\]

where

- \( W \) = wealth of the firm
- \( r \) = after-tax real financing cost
- \( p \) = price of output
- \( Q \) = output
- \( w \) = price of labor input
- \( L \) = labor input
- \( q \) = price of a unit of capital goods
- \( I \) = investment in capital goods

where all variables are at \( t \) point in time.

Maximization of the firm's wealth, assuming an homogeneous output and two variable inputs, is subject to a production constraint and a constraint based on the relationship of investment \( (I) \) and capital stock \( (K) \). The production constraint is given as:

\[
Q = f(L_t, K_t)
\]
The investment-capital stock constraint, assuming the services of the capital good expire or require replacement at a constant rate \(d\), is given as:

\[ I_t = \dot{K} + dK_{t-1} \quad (1.3) \]

where

\( \dot{K} \) = net changes in capital stock

The maximization of (1.1) subject to (1.2) and (1.3) in the static theory of the firm yields the following marginal productivity conditions:

\[ \frac{\partial Q_t}{\partial L_t} = \frac{w}{p} \quad (1.4) \]
\[ \frac{\partial Q_t}{\partial K_t} = \frac{c}{p} \quad (1.5) \]

where

\( c = q(d+r-(\dot{q}/q)) \) or the implicit user cost of capital (derived from the relationship that the price of new capital goods, \(q\), must equal the present value of future rentals).

Once these fundamental relationships are established, an investment equation can be derived. Assuming a Cobb-Douglas production function, capital's share is represented as:

\[ Q_t = f(K_t, L_t) = K_t^{\alpha}L_t^{1-\alpha} \]
\[ \frac{\partial f}{\partial K_t} = \alpha Q_t/K_t \quad (1.6) \]
Combining (1.6) with the marginal productivity conditions for capital in (1.5) yields the optimal level of capital stock \( K' \) as:

\[
K'_t = \frac{ap_tQ_t}{c_t} \tag{1.7}
\]

Given \( K' \) and rewriting the investment-capital stock relationship in (1.3) as:

\[
K'_t - K_{t-1} = I_t - dK_{t-1} \tag{1.31}
\]

Substituting (1.7) into (1.31) and rearranging yields the following investment equation:

\[
I_t = u_i \left( \frac{ap_tQ_t}{c_t} \right) + dK_{t-1} \tag{1.8}
\]

where \( u_i \) is a lag operator defining the proportion of the difference in \( K' \) and \( K_{t-1} \) that will be completed each period.\(^{(5)}\)

Gross investment represents the firm's attempt to close any gap between its actual level of \( K \) and its desired level \( (K') \) while providing for replacement investment \( (dK_{t-1}) \). The desired capital stock depends on the value of the output, the implicit user cost of the capital input, and the elasticity of output with respect to capital input. As noted by Hall and Jorgenson (1971), the adjustment to the desired level of capital stock will not be attained instantaneously because of the time lapse between initiation and completion of a project. Thus, a proportion of investment projects will be completed each year, and the
investment process will be represented as a distributed lag function.

B. Application of the Neoclassical Theory to the Appreciating Asset Case

The depreciating asset case is usually the focus of neoclassical investment demand studies, thus the literature is not well developed in the area of appreciating assets(6). The appreciating asset case, however, can be analyzed in the context of the neoclassical formulation after an appropriate adjustment in the user cost of capital (c) to reflect the physical characteristics of timber.

The user cost of capital for depreciating assets in a nontax environment was previously given as:

\[ c = q \left( r + d - \frac{\dot{q}}{q} \right) \]  \hspace{1cm} (1.91)

As noted by King (1974), (c) reflects a financial cost (r), a physical cost (d) due to deterioration of the capital stock, and an element to reflect changes in nominal prices (\(\dot{q}/q\)). The price changes can be a result of either changes in the acquisition price of the asset, or to changes in net revenues. The increase in asset acquisition prices is referred to in the literature as "capital gains" (for example, see Jorgenson and Stephenson, 1967, or Fralick, 1981). Hendershott and Hu (1980) expanded the term (\(\dot{q}/q\)) to include changes in net revenues.
The adjustment to (c) required for the appreciating asset case can be viewed in either of two ways with invariant results. First, if one accepts the Hendershott and Hu (1980) interpretation of \((\dot{q}/q)\) as an increase in net revenues, increases in the value of timber over time would accordingly be reflected in the price term. Since the asset does not physically deteriorate(7), the physical cost term (d) would be zero. Thus, the user cost (c) at (1.91) is reduced by the annual appreciation via the price term \((\dot{q}/q)\).

Alternatively, the appreciation rate could be treated symmetrically with the physical cost term (d). Since timber physically appreciates over time, as opposed to depreciates, the cost term would simply be of reverse sign or \((-d')\). Treating appreciation as negative depreciation is consistent with Samuelson's (1964) study of tax neutrality and economic depreciation. A similar approach was also recommended by Tideman (1975) in his analysis of measuring the user cost of capital (c). Again, the user cost (c) at (1.91) is reduced by the appreciation rate, however, it is via the negative term \((d)\)\(^8\).

Although the same effect of appreciation reducing the user cost of capital (c) occurs with either approach, this study will distinguish between appreciation that results
from price changes \(\frac{\dot{q}}{q}\) and that resulting from physical growth \(-d'\). This distinction seems, a priori, to be theoretically preferable, and after adjustments that will be discussed in subsequent chapters, allows the model to deal with the effects of inflation. The user cost of capital in the appreciating asset case, then may be written as:

\[
c = q ( r - d' - \frac{\dot{q}}{q} )
\]

(1.92)

The neoclassical theory provides the theoretical basis for developing models and testing hypotheses as to whether observed investment behavior agrees with the theoretical formulation. If the neoclassical model does explain investment behavior then hypotheses can be tested concerning any tax effects on the amount of investment (magnitude effect).

C. Theoretically Predicted Results

The neoclassical theory of investment demand stresses the role of output and relative prices for determining investment demand. Tax variables enter the investment equation indirectly through the user cost of capital term \(c\), which then influences the level of desired capital stock. The specific manner in which these variables alter \(c\) will be discussed more completely in Chapter 3 - Model Development. The important relationship to stress at this point is that with the neoclassical formulation, variables which reduce \(c\) should, cet. par., increase \(I\), and vice
versa. Since taxes, in addition to other variables, affect (c), theory would predict a tax-induced response in investment expenditures.

D. Description of Tax Parameters

The various types of federal taxes assessed on firms in the forest products industry and different concepts of taxable income are discussed in detail in Appendix A. This study will be restricted to analyzing the effects of the federal corporate income tax provisions based upon a realized income concept. This restriction does not imply that studies of other timber taxes at the subnational level, such as the property tax, are not important. Rather it is argued that the federal corporate income tax is more appropriate for the issues being addressed in this study because:

- a) it is significant in amount (the current nominal rates are 46% of corporate taxable income in excess of $100,000);
- b) it is relevant to the type of management choices being addressed (certain taxes apply only to certain types of investment); and
- c) it is relatively tractable compared to subnational taxes.
The federal corporate income tax is composed of numerous specific provisions and has changed numerous times. The provisions and changes of particular interest for this study are:

a) the investment tax credit;
b) the 1979 reduction in corporate tax rates;
c) the capital gains provisions for timber.

V. Organization of Study

This chapter has presented the purpose of the study, the specific issues that will be addressed, and the general methodology that will be employed. The remainder of this study will be devoted to conducting the research. The dissertation will be organized by chapters. Chapter 2 will provide a review of the studies in the literature which relate to the substantive issues. The literature and models relating to methodology and basic analytics are reviewed in Chapter 3, and the model application is discussed in Chapter 4. The results of the study will be presented in Chapter 5, with a discussion of the implications for the substantive research issues in Chapter 6. Concluding remarks and indications for the direction of future research will also be presented in Chapter 6. In addition, various Appendices are included that provide additional information on specific topics or issues.
FOOTNOTES

1. Since the composition of assets varies across industries, this issue unavoidable overlaps at least part of the more classic neutrality issue. However, there is enough difference in substance, method and analysis to treat it as a separate issue.

2. The purpose of this study is not to evaluate the controversy surrounding the definition of a neutral tax. Instead, the purpose at this point is to compare the effects of tax variables on different types of assets. A useful approach for discussing relative taxation is within the theoretical framework of tax neutrality. Thus, tax effects can be compared using a given definition of a neutral tax. Accordingly, for purposes of this paper, a definition is selected that is accepted by a consensus of the studies in the literature and that seems least subject to theoretical criticisms. Such a definition is that summarized by Gravelle (1981) and others (for example, Gaffney, 1967; Tideman, 1975; Sunley, 1976(b); Auerbach and Jorgenson, 1980):

   A neutral tax is one which alters before-tax rates of return proportionately.

3. For a discussion and exposition of the Separation Theorem, see Hirshleifer (1970).

4. See Henderson and Quandt (1980) for a concise derivation of the marginal productivity conditions, particularly for the definition of (c).

5. See Hall and Jorgenson (1971) for the specific derivation of the lagged investment demand function within the neoclassical framework.

6. The literature on investment demand for the appreciating asset case varies in terminology and analytics. Some studies of residential housing are referred to as studies of appreciating assets, however, these are actually cases of physically depreciating assets with expectations of price appreciation. This study distinguishes between appreciation due to physical characteristics as opposed to appreciation in nominal prices.

   Most of the studies of physically appreciating assets, such as timber, are concerned with the optimal rotation issue, and hold the initial plantation decision constant.
This paper, instead, will hold the time variable constant, and allow initial investment expenditures in timber to vary. As discussed by Hirshleifer (1970), investment in initial plantation costs and the time variable in the optimal rotation issue are substitutes.

A final comment concerns the analytics employed in studying tax effects and appreciating assets. Most studies (for example, Gaffney, 1967, Thompson and Goldstein, 1971, Chisholm, 1975, and Bentick, 1980) stress maximization of profits at the firm level, but use unconstrained optimization techniques. Thus, taxes enter the equations directly and are analyzed as to their effect on marginal solutions. In an alternative approach, however, the objective function of profit maximization can be subjected to constraints, such as production, financing and others. Profit maximization subject to constraints is the approach used in this research, since it is more appropriate for an empirical study of the positive issues raised in this chapter.

7. Although timber generally appreciates due to physical growth over time, some deterioration could be said to occur as a result of insects, fire, storm or biological occurrences. It is assumed that losses due to these causes are reflected in the net revenue term \((q/q)\).

8. The consistency of the treatment of the appreciation rate as negative depreciation with the neoclassical theory can be illustrated algebraically in a manner similar to Hendershott and Hu's (1980, pp. 322-323) depreciating asset case, but with slight changes in notation. At the margin, a firm's investment decision in a depreciating asset can be written as:

\[
q = \lim_{t \to \infty} \frac{pQ}{(1+r)^t} \frac{(1+(\dot{q}/q)-d)^{t-1}}{\sum_{t=1}^{\infty} (1+(\dot{q}/q)-d)^{t-1}} \frac{pQ}{(1+r)^t}
\]

where the variables are as previously defined. Since

\[
\lim_{t \to \infty} \frac{(1+(\dot{q}/q)-d)^{t-1}}{(1+r)^t} = \frac{1}{(r+d-(\dot{q}/q))},
\]

\[
pQ/q = r+d-(\dot{q}/q)
\]

for marginal investments, which, after rearranging, corresponds to (1.91).

The appreciating asset case would be as follows:

\[
q = \lim_{t \to \infty} \frac{pQ}{(1+r)^t} \frac{(1+(\dot{q}/q)+d')^{t-1}}{\sum_{t=1}^{\infty} (1+(\dot{q}/q)+d')^{t-1}} \frac{pQ}{(1+r)^t}
\]

where

\[
\lim_{t \to \infty} \frac{(1+(\dot{q}/q)+d')^{t-1}}{(1+r)^t} = \frac{1}{(r-d'-(\dot{q}/q))},
\]
\[ \frac{pQ}{q} = r - d' - \left( \frac{q}{q} \right) \]
for marginal investments, which, after rearranging, corresponds with (1.92).

9. The effect of the property tax on various decisions of timberowners has been the topic of numerous articles. For examples, see Gaffney (1979); Pasour & Holly (1976), Klemp-erer (1974), Fairchild (1935), Manning & Thompson (1969) and others. Subnational taxes would perhaps play a more critical role on specific investment alternatives, such as locational choices of whether to make a timber investment in the Northwestern vs. Southeastern U.S.
CHAPTER TWO

REVIEW OF RELATED STUDIES

The purpose of this chapter is to review studies relevant to the substantive research issues raised in Chapter One. Most of the research comes from the broad areas of investment demand, tax neutrality and timber taxation. The literature in each of these areas is extensive. Instead of presenting an exhaustive survey of such a large body of writing, this chapter will present major studies representative of the differing positions for each issue. The literature relevant to methodology, model development and econometric technique will be provided in subsequent chapters.

I. The Investment Demand Issue

The effect of taxation on investment demand has been a controversial issue in both the theoretical and policy literature. Within the neoclassical theory literature, the issue is usually concerned with determining the existence of any stimulative effects of various tax provisions. The results of empirical studies of tax induced investment have ranged on a continuum from a strong stimulative effect to a minimal, if any, effect.
A. Studies Indicating Highly Stimulative Tax Effects

Studies associated with Jorgenson (such as Hall and Jorgenson, 1967 and 1971; Gordon and Jorgenson, 1976) generally indicated substantial effects on investment expenditures due to certain tax variables. The studies employed the standard neoclassical investment model (see Chapter Three for a discussion of the model and its assumptions), and made estimates of the direct effect of tax induced changes. The tax variables affected investment by increasing the desired level of capital stock \( (K') \) through the user cost of capital \( (c) \). Tax variables reducing \( (c) \) resulted in an increase in \( (K') \), and investment would occur as firms moved from current \( (K) \) to desired \( (K') \). The results varied slightly, but overall indicated a relatively strong stimulative response of investment expenditures in manufacturing equipment to the investment tax credit, a strong response of all investment to accelerated depreciation, and only a slight response to the corporate tax rate.

One study (Hall and Jorgenson, 1971) estimated that the investment tax credit resulted in a 22 percent increase in manufacturing equipment investment expenditures for the 1962-1970 time period. A more recent study (Gordon and Jorgenson, 1976) estimated that the investment tax credit provisions during 1962-1972 caused the level of capital
stock to increase 5.5 percent. The influence of the credit was often dramatic, as inferred in Hall and Jorgenson (1967) in which it accounted for 40.9 percent of net investment in manufacturing equipment in 1963.

The impact of more liberal depreciation policies was also very definite in the Jorgenson-type studies. The stimulative effects of accelerated depreciation methods ranged from 16.9 percent of net investment in manufacturing equipment (20.8 percent for manufacturing structures) for 1954-1963 to 17.5 percent (15.0 percent for manufacturing structures) for 1954-1970. The effects of allowing the use of shorter useful lives for depreciation purposes was less dramatic, but still important (estimated to have increased equipment investment 7 percent over the 1962-1970 period). Similar stimulative effects were evident in Bischoff's (1971a) comparative study, which estimated the effect (using a Jorgenson-type formulation) of shorter useful lives, to be over $7 billion for 1971-1973 only.

Investment responses to changes in corporate tax rates have not been as pronounced as they were to investment credit and depreciation liberalization rules. In fact, the econometric results of Hall and Jorgenson (1971) indicated that the effect of the 1964 reduction in corporate tax rates was not only small, but even negative. A priori, one
would expect that a reduction in tax rates would reduce the cost of capital, cet. par., increasing investment expenditures. Nickell (1978, p. 200) attributed this conflicting result to tax depreciation being greater than economic depreciation, thus mitigating most tax rate effects. Jorgenson (1971) accounted for the results as due to the partial equilibrium approach, noting that when secondary effects were considered, total investment increased as a result of the 1964 rate reductions. The results could also be explained by reference to the counteracting effects a tax rate decrease would have on (c), as will be subsequently discussed in Chapter Three.

Similar results were obtained by Green (1980) in a comparative study of four major macroeconomic models. The models were derived from the neoclassical theory of investment demand and applied using simulation techniques for increases in the investment tax credit, reduction in tax lives for depreciation purposes and a reduction in the corporate tax rate. All models showed increases in investment and output, but a relatively long response time for the simulated changes in tax policy. Investment tax credits and tax life reductions were effective policy tools for stimulating investment. In addition, unlike the Jorgenson studies, a reduction in corporate tax rates was found
to be highly stimulative. This result, however, is not inconsistent with Jorgenson's, since his studies specifically failed to incorporate feedback effects that would occur in a more general macroeconomic model.

Hendershott and Hu (1980 and 1981) also found tax policy an effective avenue for increasing investment. In their (1980) study, they analyzed the effect of tax variables on a neoclassically determined cost of capital. They found that allowing replacement cost depreciation, extending the investment credit to structures and reducing corporate tax rates all reduced the user cost of capital. The largest reduction was attributable to depreciation changes and the least to rate reductions. As previously noted, a lower user cost of capital will, cet. par., increase investment.

Their (1981) study attempted to extend the neoclassical formulation to include firm market values ("q" theory) and capacity utilization as determinants, and to refine the data base by controlling for the effects of expenditures on pollution control equipment. A tax policy simulation indicated that if lives for depreciation purposes were reduced, the ending balance of the nation's capital stock in 1978 would have increased from $800 billion to $910
billion. Thus, both studies indicate relatively strong responses of investment behavior to changes in tax policy.

The research presented in this section relied upon some variation of the neoclassical theory of investment demand for structuring the role of tax variables. The results indicated that even with varying analytics, data bases and estimating techniques, investment is highly responsive to certain tax instruments.

B. Results Indicating Less Responsive Tax Induced Investment

Not all studies concur that investment expenditures are highly responsive to tax variables. Some studies attribute the significant tax induced investment response findings to certain questionable characteristics of the model used for estimation. Chapter Three will address various model criticisms of the standard neoclassical investment model (SNIM), however, it will be useful at this point to review the results when variations of the SNIM are made. Three general types of variations appear frequently in the literature: structural variations, variations of the model's determinants and varying the restrictions imposed by certain assumptions of the model.

Bischoff (1971b) contended that the structures of the relative price and output variables of the Jorgenson formu-
lation accounted for a portion of the tax induced investment response. When Bischoff allowed a separate lag structure for the price and output variables, the resulting tax effects on manufacturing equipment were not as large as those found in Jorgenson's various studies. The investment tax credit was significant using Bischoff's structural change, however, it was estimated to increase investment expenditures by only .6 percent in 1963 as opposed to Hall and Jorgenson's (1967) 40.9 percent. The largest effect found by Bischoff was just under 9 percent in 1966.

Similar findings of less tax induced investment were reported by Bischoff (1971b) for the depreciation provisions. He noted that the accelerated depreciation methods and more liberal depreciation lives combined only increased investment expenditures by less than 3 percent in 1966. In a comparative forecasting simulation study, Bischoff (1971a) found that the variation of a separate lag for relative prices and output reduced predicted additional investment expenditures resulting from changes in depreciation policies from the Jorgenson model estimate of $7 billion to $4.1 billion (1971-1973). Thus, the separate lag structures indicate that a portion of the reported increased investment in many studies was attributable more to previous increases in output than to tax variables alone.
Structural characteristics were also the objects of criticism by Eisner (1969). Eisner's findings were similar to Bischoff's on the issue of misspecification arising from separate lag structures for the price and output variables. In addition, Eisner argued that Hall and Jorgenson's (1967) indirect test of the influence of tax variables were not conclusive. He attempted a direct test of tax variables by allowing them to enter as separate determinants in the equations. Using the case of accelerated depreciation, Eisner found the separately specified tax variable to be negative in sign and not significant as determinants of investment. Accordingly, he attributed very little influence to tax policies as stimulants for investment. (4)

Similar findings of a lesser investment response to tax variables were reported by Coen (1971), when the Jorgenson-type models were varied by including cash flow variables as determinants of the speed in which gaps between actual and desired levels of capital stock were filled. Using the variable speed adjustment model, Coen estimated that tax variables generated only $2 billion of additional investment for the period 1954 to mid-1962, and $2.8 billion for mid-1962 to 1966. Alternatively, if the emphasis was on the level of capital stock, Coen argued that tax variables over the 1954-1966 period increased the
net capital stock by only $4.0 billion. Thus, Coen and others argued that a portion of investment attributed to tax variables was actually a measure of the influence of a firm's liquidity.

Many studies (Coen, 1969; Chirinko and Eisner, 1981; and others) also argued that the reported effectiveness of tax variables depended heavily upon the neoclassical model's assumptions of the responsiveness of desired capital to output and price variables. When the models were modified to relax certain assumptions, most notably the assumption of unitary price and output elasticities, the results indicated only moderate tax effects. Eisner and Nadiri (1968), Coen (1969) and others repeatedly argued that price elasticities were substantially less than unity as assumed by Jorgenson. Eisner's (1969) analysis indicated that after relaxing the unitary elasticity assumption, the role of relative prices was only 1/6 of that reported by Jorgenson.

Although it is often difficult to compare many studies because of differing data sets, analytics or style, the investment demand literature nonetheless reflects a controversy that is not yet settled on the effects of tax variables on investment demand. The results of different studies vary, although most studies indicate some tax
effect. Accordingly, it would appear that this study could provide additional empirical evidence for evaluating arguments on the effectiveness of tax policy in stimulating investment expenditures, using the timber industry as the focus for an in-depth inquiry.

II. Neutrality Issue - The Composition Effect

A Federal Reserve (1981) study of capital formation concluded that the existing capital stock of the U.S. is seriously misallocated, particularly toward less durable assets (assets with shorter useful lives). The study, along with others to be reviewed, attributed a major part of the distortions to tax laws. This section will present a representative sample of these studies from the different areas of the literature.

A. Investment Demand Studies

Investment demand studies that distinguished investment by asset type generally focused on two major groups: equipment and structures. Studies such as Coen (1969) or Hall and Jorgenson (1971), when estimating investment expenditures attributable to tax incentives with the neoclassical model, generally concluded that the relative magnitude of tax induced investment favored equipment versus structures. This bias was primarily due to the investment tax credit provisions emphasizing equipment investment.
Similar conclusions were reached by Corcoran (1981) and Mauskopf and Conrad (1981). Corcoran analyzed the effects of taxes on the composition of business investment in terms of their effect on rates of return. Then an estimate of changes in alternative capital shares based upon changes in rates of return was made. Corcoran concluded that the investment credit alone created an estimated 2 percentage points shift in the percentage composition of business investment from structures to equipment. Mauskopf and Conrad also noted a bias to equipment, but suggested it decreased rapidly as inflation increased.

B. Studies in Tax Neutrality

Numerous studies of tax neutrality also indicate that current tax laws create a bias to shorter lived assets (such as equipment) instead of assets with a longer life (such as non-residential structures). The studies reviewed in this section evaluate the neutrality of a tax variable as reflected in a measure of effective tax rates (ETR). (5)

Jorgenson and Sullivan (1981) and Auerbach and Jorgenson (1980) conducted time series studies of effective tax rates by major asset category (equipment and structures) and by subcategories. Their results indicated that until
1962, measures of (ETR) were either approximately equal or higher for equipment. After 1962 (the year the investment credit rules were applied), the bias, reflected in a relatively lower (ETR), definitely shifted to equipment.

Similar conclusions were reached by Hall (1981) and Gravelle (1982). Hall estimated the (ETR) separately for equipment and plant under various scenarios of inflation, depreciation, financing and sectors (taxed and untaxed). The results consistently indicated that the prevailing tax laws favored equipment investment. Gravelle's study was concerned with measuring the social costs of sectoral capital misallocation. In the process of this measurement, (ETR's) were calculated which yielded similar findings: a bias to shorter lived assets.

The studies in the tax neutrality literature varied in assumptions, particularly concerning inflation rates and discount rates. However, the results consistently indicated a bias toward short lived assets. The long lived asset case, however, used structures as the example, and did not address timber as a specific asset category. The issue of neutral taxation of timber, though, has received extensive attention in the timber taxation literature.
C. Timber Taxation Analyses

Gaffney (1967), in a theoretical study, used a rate of return criterion to analyze the effect of various tax structures on the rate of capital turnover. His analysis focused on any tax induced bias among asset classes (depreciating, appreciating, constant value and land) and within an asset class (such as a bias in the timber rotation period). In reference to the composition effect, he concluded that a tax structure employing a realized income concept created a bias in the composition of investment expenditures toward appreciating assets such as timber, regardless of the tax rates applied at the time of realization.

The appreciating asset bias, according to Gaffney, was due to the ability of the owner to defer payment of income taxes until the timber is harvested and sold. This effect was cumulative in nature, representing not only the deferral in the current year, but also the amounts accrued in all prior years. The cumulative effect represented the deferral not only of the tax, but also the indefinite deferral of imputed interest on the taxes, which implicitly compounds over time. Thus the firm, in effect, received an interest-free loan from the government which is not paid until the timber is cut. This deferral attribute, he
concluded, is inherent in a tax structure based upon a realized, as opposed to an accrual, method of taxing income.

Gaffney's conclusions were also supported by a theoretical study by Chisholm (1975). For firms that are maximizing the present value of a future income stream and are equating after-tax rates of return across maturities of investments, Chisholm concluded that the realized income tax induced a bias to long lived investments. The bias was also due to the ability to defer payment of taxes until income is realized.

Although the results of Chisholm's and Gaffney's studies are similar, important differences exist. The former incorporates additional assumptions about the elasticity of supply of forest land when comparing the effects of various tax structures. Chisholm's study also noted the importance of clearly defining the initial tax environment and the tax structures being compared when analyzing the subsequent effects of a tax. His study used an accrued income tax situation as a benchmark for a neutral tax when concluding that a realized income tax induces a longevity bias, which in Chisholm's opinion, leads to a lower tax burden (ETR) for long lived assets like timber.
Jackson (1975), however, reached opposing conclusions. In a theoretical analysis of timber which addressed the investment and cutting decisions simultaneously, he concluded that imposition of an income tax would create a bias against timber investment. It is, however, important to note the different analytics employed. Not only was the analysis conducted by solving for both the plantation and rotation solution simultaneously, the initial reference point for imposing the tax differed. Jackson's benchmark for comparing the results after imposition of an income tax was an initial zero tax environment. This differed from Chisholm's benchmark of an accrued income tax.

The varying areas of literature indicate a consensus that tax induced distortions have affected the composition of investment expenditures. The bias is generally to equipment, with conflicting analyses concerning the effects on timber. Research in this area can provide additional insight into the relative tax effects on the different types of investment assets in the industry.

III. Interindustry Tax Parity

Controversy exists in the literature on whether the forest products industry is taxed excessively when compared with other industries. The arguments are basically from two sources. In the timber tax literature, the arguments
are usually of a more descriptive or ad hoc nature. In the tax neutrality literature, emphasis is on comparative industry effective tax rates; i.e., (ETR's).

A. Arguments in the Timber Tax Literature

Sunley (1972 and 1976a) and Condrell (1978 and 1981) are representative of the opposing views of whether the forest industry is excessively taxed. Condrell contended that the industry was at a disadvantage when compared with other industries. Abstracting from any general equilibrium adjustments that might occur, he concluded this disadvantage was due to a firm's timber holdings being such high risk, long-term investments with relatively unregulated factor and product markets. For examples he cited cases of other industries that are dependent upon long-term investment bases, such as utilities or railroads, as being either regulated, subsidized or guaranteed rates of return. For firms with shorter term investment projects, such as most agricultural crops, the relative risks of ownership were less since the crops were rotated annually. These firms were also often subsidized or operated in protected markets.

Sunley characterized this argument as "the most favored taxpayer theory of tax revision". Since one group of taxpayers had a special tax benefit, equity required
that the benefit be extended to others. His solution was to deny any special tax benefits to all taxpayers. His argument implicitly assumed that interindustry parity was achieved if all taxpayers were subject to the same tax structure.

B. Studies in Tax Neutrality

The approach for assessing interindustry tax parity in the tax neutrality literature is usually within a comparative (ETR) framework instead of the more descriptive or normative arguments advanced by industry proponents. The (ETR's) are sometimes calculated by differing methods, and the industry classification may differ, however, limited inferences can still be made.

For example, Rosenberg (1969) and a study by the Office of Tax Analysis (OTA) (1978) calculated (ETR's) based upon the ratio of taxes paid by industry group to the income of that particular group. The studies were for different sample periods (1953-1959 for Rosenberg and 1972 for OTA) and both made various refinements to the data bases in an effort to improve measurements. Neither study used an industry classification comparable with the forest products industry used in this study; however, both used two groups that comprise a major portion of the industry: the lumber and wood products group and the paper and allied...
products group. In the OTA industry ranking by (ETR), the paper group ranked second highest (ETR = .384) and the lumber group ranked seventh (ETR = .346) of nineteen industry groups. The Rosenberg study ranked the lumber group much lower (ETR = .287), although the paper group (ETR = .486) was close to the total manufacturing average (ETR) of .474. (It appeared that Rosenberg's analysis did not include the preferentially taxed capital gain component for the paper group that was properly reflected for the lumber group).

Using similar industry classifications, but with the definition of (ETR) employed in this study, Jorgenson and Sullivan (1981) also estimated industry (ETR's). The industry (ETR's) represented a weighted average of the (ETR) for each category of assets (except timber). For the year selected by the authors, 1973, the (ETR's) for the paper group and lumber group were .22 and .23, respectively. For 1979, the (ETR's) were .16 and .18, respectively. These rates placed the two groups in the lowest quartile of (ETR) for 44 industries compared.

Gravelle used a similar measure of (ETR), but did not report the sub-industries separately because there was little variation with the overall rate for total manufacturing. The (ETR) for total manufacturing ranged from .368 to
.409 depending upon the estimate of inflation used. The inference that the (ETR) of the lumber or paper sub-industries would be this high is surprising in view of other studies in the literature.

Neither the timber tax or neutrality literature provide strong evidence of the industry being excessively taxed. Instead, the opposite inference might be made based upon measures of comparative industry (ETR's).

IV. Impact of Alternative Taxation Instruments

Altering the current tax regime is a major issue in the timber tax literature. The alternatives most often discussed are elimination of the capital gains provision (cg) of IRC Section 631; i.e., a return to the pre-1943 treatment involving taxation of realized income at ordinary rates, and the use of an accrued, instead of realized, income concept.

A. Capital Gains Available Under IRC Section 631

Mead (1959) and Condrell (1978 and 1981) are representative of the proponents of the present capital gain treatment for timber cutting. Mead discussed the important role of (cg) in accomplishing Congressional objectives, such as those indicated in Senate Report No. 627 (1943). These objectives were to increase timber investment by improving the rate of return, to correct perceived inequities of
taxing income at ordinary rates that required many years to be realized, and to achieve horizontal equity in the industry\(^6\). He provided numerical examples of how (cg) reduced the before-tax cost of growing timber (thus, improving the rate of return), thereby providing the financial incentive to invest in timber.

Condrell agreed with Mead, arguing that (cg) had been successful in eliminating inequitable treatment of timber owners and in encouraging timber investment. Without the tax provisions, he contended, many investors would not invest in timber due to its high risk, the long time period before receiving a return and the illiquidity during this period. In his (1978) study, he presented statistical evidence indicating the positive effect of capital gains in timber investment. He noted that since the inception of the (cg) laws in 1944, reforestation had increased over nine times the pre-law level. Also, since 1944, annual timber growth exceeded timber cutting by over three billion cubic feet, whereas prior to 1944, cutting exceeded growth by over seven billion cubic feet per year.

Sunley (1972 and 1976a) disagreed with the inference of (cg) increasing timber investment. Instead, he attributed the major changes in timber investment to other variables, such as different pre- and post-1944 economic
environments, a surge in the demand for wood products (particularly in response to the post-1944 increase in demand for residential housing), and the disappearance of "virgin" or old-growth forests. He also noted the lack of any empirical evidence on the issue of whether (cg) increased timber investment.

Sunley contended that (cg) led to quantity and price distortions in various markets, a bias in timber ownership structures, and a prolonging of the timber rotation period. He concluded (1972) that the indirect subsidy of the timber industry via tax provisions should be reduced or eliminated. If an industry subsidy was desired, it should be direct and targeted toward desired activities such as reforestation and more efficient management practices; i.e., use of reforestation grants.

Fralick (1981), in an analysis of how various tax policies affect the demand for real capital, also questioned whether the use of capital gains tax rates increased investment demand. He did not speculate on how (cg) were affecting the economy, but noted the uncertainty of the sensitivity of investment spending to capital gains taxes.

Numerous other authors argued for the elimination of (cg) for timber income. Bentick (1980), in a comparative analysis of land use by forestry and annual crops, conclu-
ded that (cg) was "... too blunt a tool..." for achieving tax parity and recommended that it be abolished, implying a return to the pre-1943 tax system. The case for (cg) overcoming any perceived inequities was also questioned by Gaffney (1967) and Samuelson (1976). They contended that timber income was already receiving a comparative benefit of tax deferral until timber income is realized, and that to then tax the income at capital gain rates, which are lower than ordinary rates, was unnecessary or an added benefit.

B. Taxation of Accrued Income

The ability of owners to defer taxes on timber income until realized (when the timber is cut) was deemed to be inefficient or inequitable by numerous authors. Trestrail (1961) characterized the annual increase in value of standing timber as income in the current period that should be currently subject to tax. Gaffney (1967) argued that the failure to tax this unrealized income (accrued income) created a presumably inefficient bias to appreciating assets such as timber. This result occurred even if the income was taxed at ordinary rates. Samuelson (1976a) concurred and indicated that the tax deferral characteristic created a "tax loophole" for owners. Sunley (1972) argued that failure to tax accrued income created a "mismatching" of income and expense under the current tax
Tideman (1975), in an analysis clarifying the correct measure of the cost of capital, reached similar conclusions; i.e., that the annual increment in value of appreciating assets should be taxed as income in the year of increase, not deferred until realization.

Not all authors agreed with proponents of an accrued income tax regime. Thomson and Goldstein's (1971) theoretical analysis stressed that many of the analyses, particularly Gaffney's, made faulty assumptions concerning the incidence of a tax and the role of land supply and rents. Thomson and Goldstein's study arrived at opposite conclusions concerning any bias in a realized income tax. They find that for the special case of a single cycle (one rotation period), a realized income tax is non-neutral with respect to rotation periods. In the more appropriate infinite cycle case, however, they found the realized income tax to be neutral.

Similar conclusions were reached in Bentick's (1980) theoretical analysis, however, he found that the non-neutral aspects were due to different reasons. Bentick, when comparing the taxation of forestry with the taxation of annual crops, concluded that disallowing the immediate deductibility of establishment costs created the bias in rotation periods and diverted capital to other uses. His
recommendation was a realized income tax with immediate
deductibility of establishment costs.

Bentick specifically took exception with Trestrail and
Samuelson's conclusions that taxation of forests provided a
"tax loophole" due to the owner's ability to defer payment of taxes. Instead, he concluded that paying taxes annually on accrued income represented paying taxes in advance of the receipts on which the tax is based. This, he conclud­
ed, would divert resources out of forestry. Bentick assumed that such a tax is fully capitalized in land values and that shorter rotation periods will result. He made his comparison of the accrued tax with an initial zero tax situation as a benchmark.

Chisholm (1975) attempted to resolve the controversy, particularly between the positions taken by Gaffney and Thomson and Goldstein. He analyzed the opposing arguments, after making adjustments so that the studies were based upon common assumptions concerning tax incidence, market constraints and initial tax environments in which a tax is imposed. His conclusions favored the Gaffney position, and contended that an accrued income tax would be more effi-
cient.
The controversy continues as to how timber income should be taxed, and the role of alternative tax regimes in achieving tax parity and market efficiency.

V. Tax Incentive Policy Effectiveness

In addition to estimating the magnitude of any additional investment attributed to tax incentives, some studies in the investment demand literature estimated the resulting tax expenditures and compared the estimates as an indication of the effectiveness of the tax provisions. Green's (1980) tax policy simulation predicted that either increases in investment tax credit rates, reductions in corporate tax rates, or reduction in tax lives for depreciation would yield increased investment expenditures averaging twice the revenue loss to the Treasury. These results were present in the various macroeconomic models compared by Green.

Other studies do not indicate such a strong tax expenditure/investment relationship. Coen (1968 and 1971) modified elasticity assumptions in the neoclassical model and added a liquidity variable as a determinant. Simulation results indicated that tax policies had saved firms $5.1 billion (a tax loss for the Treasury) for 1954 to mid-1962, yet tax-induced investment was only $2.0 billion. From mid-1962 through third quarter 1966, tax savings gener-
ated $8.6 billion, yet tax-induced expenditures increased only $2.8 billion.

Similar studies have been applied to the capital gain provisions. Sunley (1976a) presented Treasury Department statistics that the capital gain subsidy produced an estimated $215 million in lost revenue in 1976 and attributed approximately 40% of the amount to the five largest corporations in the industry. Subsequent Treasury Department testimony discussed by Condrell (1981) indicated that the revenue loss had increased to $350 million in 1978 (due to the increase in stumpage prices). As previously noted by Sunley, estimates of increased investment attributable to the (cg) provisions were not available to make a complete tax expenditures/increased investment comparison.

VI. Conclusions

This chapter has presented a review of studies related to the substantive issues that will be addressed by this dissertation. The purpose was to indicate the controversy that exists in the literature on most of the issues, and to suggest that the results of this research effort can provide additional empirical evidence for evaluating the various arguments.
FOOTNOTES

1. Jorgenson (1979) and Nickell (1978) provide extensive surveys of the literature on the analytical and econometric studies of investment demand.

2. The four macroeconomic models were those of the Bureau of Economic Analysis of the Department of Commerce (BEA), Chase Econometric Associates (Chase), Data Resources, Inc. (DRI) and the Wharton Econometric Forecasting Association, Inc. (Wharton).

3. Sunley's comments on the Hendershott and Hu (1981) study indicated disappointing results for the use of "q" theory as a determinant. The role of capacity utilization is reflected in a more generalized version of the standard neoclassical investment demand model and is incorporated in the model developed in Chapter Three. Exclusions of pollution control expenditures as non-productive investment appears unwarranted. It could be argued that legislation requiring investment expenditures for pollution control equipment represents internalization of a social cost that is firm specific, hence a part of the long-run cost of production for the firm.

4. Hall and Jorgenson (1969) rebutted many of Eisner's comments, noting in particular the specification error created in Eisner's work.

5. As previously noted in Chapter One, controversy exists concerning the appropriate measure of neutrality. It was concluded that, based upon a consensus of the literature and theoretical reasons, a neutral tax would be one which reduced before-tax rates of return proportionately across asset categories. The relative change in before- and after-tax rates of return represents a measure of effective tax rates. As noted by Fiekowsky (1977), caution must be exercised in interpreting effective tax rates, noting that the resulting rates are not indicative of shareholder wealth. The measures are useful for making comparisons of relative tax shares and this is their intended use for this study.

6. Horizontal equity refers to a principle of taxation that taxpayers in equal income positions should be treated equally for tax purposes. Prior to 1944, and the passage of what is now IRC Section 631, the only way a timberowner could receive capital gain treatment was to sell the timber outright for a lump sum. If the timber was cut by the owner.
and used as a raw material in his/her business (such as for lumber production), the income from such activities was treated as ordinary income. If the owner sold the timber under a cutting contract, the payments received were treated as royalties and taxed as ordinary income. This disparity in the tax treatment of timberowners was viewed by many as horizontally inequitable.

7. According to proponents of timber taxation reform, a mismatching of income and expense occurs because timberowners can deduct certain timber expenses, such as interest, property taxes and maintenance expenses, in the period in which they are incurred. The expenses reduce other forms of ordinary business income. Tax recognition of income with which these expenses are associated, however, is deferred until a later period when the timber is cut. Thus, the time periods in which deductions are allowed and when income is recognized are not matched. Also, the income that will be recognized in later periods when the timber is cut will be larger due to the previous deduction of expenses, but subject to capital gains tax rates. Hence, in addition to a mismatching of income and expense, income has also been shifted from ordinary to capital gain status.
The underlying model used for this study is a variation of the neoclassical investment model. This chapter will discuss the basic neoclassical investment model and the channels through which taxes affect investment behavior. The various criticisms of the model will then be analyzed and its use, in view of these criticisms, justified. To overcome some of the criticisms, adjustments will be made and the modified model to be used in this study will be presented.

I. Standard Neoclassical Investment Model

A. Basic Formulation of Estimating Equation

The Jorgenson (1963) formulation of the neoclassical theory of investment demand was presented in Chapter 1. The model derived from this theory is referred to as the standard neoclassical investment model (SNIM) and was given at (1.8). After restatement of the lag operator and with inclusion of an error term, the resulting estimating equation is written as:

\[ I_t = I_n + I_r = a \sum_{i=1}^{N} b_i (p_{t-i} Q_{t-i} / c_{t-i}) + dK_{t-1} + e_t \]  

where

\[ N \]

- 61 -
and remaining variables are as previously defined. In most studies, \( (d) \) is usually an assumed constant value. In the SNIM, \( (a) \) is assumed to be unitarily elastic. \( (Q) \) is generally represented by aggregate measures of output, such as Business Gross Product or Gross National Product. The distributed lag function reflected in \( (\sum b_i) \) is typically specified as an Almon polynomial lag of various orders and lag periods. The \( (p) \) and \( (c) \) variables are often combined for analytical purposes to represent a relative output/input price term \( (p/c) \), and denoted as \( (V) \). \( (V) \) is proportional to the equilibrium capital stock/output ratio for given output prices \( (p) \) and user costs \( (c) \) at time \( (t) \). Since relative prices occupy such a critical role in the neoclassical theory, the \( (V) \) notation will be used in this study also. Expected output prices \( (p) \) are usually represented by output price indices, but the user cost of capital is generally more complex in computation.

B. **User Cost of Capital—Depreciating Asset Case**

The user cost of capital will differ between depreciating and appreciating assets in the specification of depreciation \( (d) \) and in the tax variables. The user cost of depre-
ciating assets will also differ between equipment and structures due to alternative taxation provisions.

1. Equipment

The user cost of equipment as previously expressed at (1.91) is affected by numerous tax variables, most notably the investment credit and various depreciation methods. After restatement for the tax factors, the user cost of capital for equipment becomes:

\[ c_{et} = \frac{q_t(r_t+d_t-(\dot{q}/q)_t)(1-k_t-u_tz_t)/(1-u_t)}{(1-u_t)} \]  

where

- \( q_t = \) price of a capital input
- \( r_t = \) real after tax cost of financing
- \( d_t = \) depreciation or replacement rate
- \( \dot{q}/q = \) rate of change in input prices
- \( k_t = \) rate of investment tax credit (2)
- \( z_t = \) present value of the depreciation deduction
- \( u_t = \) statutory tax rate

and other variables are as previously defined.

The price of a capital input \( q_t \) is usually reflected by various producer price indices. The cost of financing \( r_t \) is usually assumed to be exogenously determined and based upon financial factors such as bond yields, dividend rates, the ratio of per share earnings to market prices, or some previously determined constant. (3) The depreciation
rate \( (d) \) is typically an assumed constant. The tax rates \( (u_t) \) and \( (k_t) \) are those statutory rates per the Internal Revenue Code.

The present value of the depreciation deduction \( (z_t) \) for tax purposes is more complex in its calculation. After the initial investment, the deduction saves tax dollars without requiring cash expenditures. The time period for discounting the future deductions is based upon the useful lives for tax purposes, not the economic useful life as reflected in the replacement rate \( (d_t) \). \( (z_t) \) is also influenced by the depreciation method used for tax purposes (see Appendix A for a discussion of the alternative methods available). An example of the formulation for \( (z_t) \) using the sum-of-the-years-digits depreciation method is (4):

\[
z_{SYD} = \frac{2}{(rT)}[1 - (1-e^{-rT})/(rT)]
\]

where

\( T = \) useful life of the asset for tax purposes
and other variables are as previously defined.

Most studies assume that firms are using the optimal method that yields the highest \( (z_t) \), or assume a weighted average of methods based upon Treasury Department statistics.
2. Structures

The user cost of capital for structures is essentially the same as that for equipment, except for the tax variables \((k)\) and \((z)\). Most structures do not qualify for the investment tax credit \((k)\), and additional limits are placed on the depreciation methods that can be used. Useful lives for tax purposes are also usually appreciably longer for structures than for equipment. If a more restrictive depreciation method is used, such as the 150 percent declining balance method, the calculation of \((z_t)\) becomes\(^{(4)}\):

\[
Z_{db} = \left(\frac{\Theta}{T}\right) \frac{(1-e^{-[r+(\Theta/T)]T'})}{(r+(\Theta/T)) + [e^{-(\Theta/T)}T'(T-T')]}[e^{-rT'} - e^{-rT}] 
\]

where

\(\Theta\) = a fixed proportion of the straight-line rate
\(T'\) = the number of years to the "switch-over" point from declining balance to straight-line methods that will optimize \((z)\) and other variables are as previously defined.

The user cost of capital for structures, restated for tax provisions becomes:

\[
C_{st} = q_{t}(r_{t} + d_{t} - (q/q)_{t})(1-u_{t} z_{t})/(1-u_{t}) \quad (3.22)
\]

C. User Cost of Capital—Appreciating Asset Case

The cost of capital for the appreciating asset case will require an alternative specification of both \((d)\) and
the tax provisions. As noted in Chapter 1, the appreciation rate \( d' \) will replace \( d \). The tax provisions reflect the absence of \( k \) and \( z \) for the timber case, and the statutory tax rate on timber income is reduced by the capital gain benefits realized by the firm. (See Appendix A for a discussion of the tax treatment of timber)\(^{(5)}\).

Thus, the user cost of capital for timber becomes:

\[
c_{ft} = q_t(r_t - d'_t - \frac{q_t}{q}(1 - u'_t)). \tag{3.23}
\]

where

\( d'_t \) = the appreciation rate of timber
\( u'_t \) = the statutory tax rate reduced by the capital gain benefit

and other variables are as previously defined.

The price of capital \( q_t \) will be reflected by stumpage price indices, which represent the price at which timber can be purchased. The appreciation rate \( d' \) will be determined by reference to U.S. Forest Service timber growth data. The tax rates \( u'_t \) are those provided by the Internal Revenue Code, except that the capital gain reduction will reflect the aggregate use of the tax benefit by the sample firms.

The previous discussion of the basic formulation of the SNIM was not intended as a literature review\(^{(6)}\) or an exhaustive analysis. Rather, the purpose was to provide a
basic framework of the model, its underlying assumptions, and the approaches used in its application. This framework will prove useful in the subsequent sections when reviewing the various criticisms of the SNIM and when modifications are made in developing the final model to be employed in this study.

II. Criticisms of SNIM

Although the SNIM, or some variation of it, has been used extensively in empirical research, the model is not free of criticisms. Many of the early objections have either been incorporated into more recent versions of SNIM, or have been sufficiently rebutted. This section will review those criticisms that still remain controversial or that might be of importance in this research. The review will divide the criticisms of the SNIM into the following categories for expositional convenience:

- determinants of investment demand;
- specification of the model;
- assumptions employed by the model.

A. Determinants of Investment Demand

When discussing the issue of the propriety of the determinants of investment demand specified in the SNIM, one must distinguish between differing determinants that are due to alternative theories as opposed to those that
accept the theory supporting the SNIM, but question the determinants employed within that theoretical framework. An example of differing determinants due to alternative theories would be the role of the market value of the firm. Summers (1981), using Tobin's "q" theory (7), emphasized the importance of the market value of the firm's stock as a determinant of real investment demand. The neoclassical theory of investment demand, however, does not employ market value of shares as a determinant. Alternative theories are not employed in this study, thus the issue of importance will be those criticisms of the determinants employed within the neoclassical theoretical framework. Accepting the theory supporting the SNIM, two of the major criticisms of the determinants of the model are the alleged improper treatment of inflation, and the role of expectations.

1. Inflationary effects on determinants

Tideman (1975), in an analytical study, criticized the derivation of the user cost of capital term (c) in the SNIM. The criticisms were primarily directed at the omission of inflation adjustments for the financing cost term (r), and the failure to recognize the inflation-taxation interaction, particularly on the present value of the depreciation deduction (z). Tideman developed an alternative specification of (c) that included inflationary effects.
A formulation of (c) similar to Tideman's was employed by Feldstein (1980) in an empirical study of inflationary effects on the determinants of investment demand. Like Tideman, Feldstein contended that inflation affects the cost of funds (r) and the present value of the depreciation deduction (z) in the cost of capital (c), and that the omission of inflationary effects will bias the result. Feldstein adjusted (r) to reflect the real net cost of the use of debt, and defined (r) to be a weighted average of debt and equity. Moreover, his formulation recognized that during a period of inflation, fixed debt will be paid in future depreciated dollars, thus the real cost will be less than the nominal cost.

Using similar reasoning, the present value of the depreciation deduction (z) is fixed and declines when the rate of inflation rises. To compensate for this effect, Feldstein discounted the future depreciation deductions using the nominal cost of funds. The nominal cost of funds used as the discount rate was the real cost of funds, (r), plus the inflation rate. Using an inflation adjusted (z) and (r), Feldstein argued that the model's explanatory power (as measured by $R^2$) was increased, and that the investment cycles were more accurately predicted.
2. Role of expectations

Another criticism of the SNIM is of its omission of the importance of uncertainty and expectations. The need for integrating expectations and uncertainty was acknowledged by Jorgenson (1979), a major proponent of the SNIM. Eisner (1979), a consistent critic of the SNIM, stressed the importance of expectations in the investment decision making process, particularly with respect to expected output (Q). This criticism was enhanced by Birch and Siebert (1976). Their empirical investigation supported Eisner's contention that expected variables, in addition to current and lagged variables, are significant in explaining investment expenditures. Ando, et al (1974) also stressed the importance of expectation formations, particularly with respect to price changes in the post-1964 time period.

B. Model Specification

1. Restrictions of a partial equilibrium model

The criticisms of the specification of the model can be classified into two main types. The first is of a general nature. It questions the propriety of the use of SNIM in evaluating the effects of taxes on investment because it represents a partial equilibrium model as opposed to a general equilibrium model. Break (1974) stressed the deficiencies of the SNIM because it omitted important
general equilibrium effects, such as the indirect output effect on prices that will presumably result from more investment; the tax effect on the savings function of the economy; and the tax effect on \( r \). The SNIM holds output effects and the before-tax \( r \) constant, thus restricting the economic environment to a partial analysis. Accordingly, with these restrictions, the tax induced interactive effects of investment and the supply of funds from savers and the shifting of taxes (and changing before-tax \( r \)) to a nontaxed sector (noncorporate) are not analyzed as they would be in a complete model.

2. Structural specification

The other type of specification criticism deals with the econometric specification of the model. Numerous issues have been raised concerning the lag pattern of the determinants of investment behavior. The arguments have focused on two main issues, the "putty-clay" hypothesis and the effect of liquidity on the speed of adjustment.

a) Liquidity effects

The liquidity effect on the speed of adjustment was stressed by Coen (1971). He developed a variable speed adjustment model in which the cash resources of the firm entered as a variable. The availability of funds variable primarily influenced the reaction time to changes in the
determinants of investment demand. He found the variable speed model superior in goodness of fit to the SNIM.

b) "putty-clay" hypothesis

The issue of the "putty-clay" hypothesis, as noted by Break (1974), becomes important because, in addition to output (Q), relative factor prices (V) are determinants in the SNIM. Since the tax variables are contained in (V), its specification is critical. The SNIM employs a "putty-putty" hypothesis in which investment responds with equal speed to both changes in output and to changes in relative prices via an appropriately determined distributed lag. Thus, capital is highly malleable and can be changed at any time in response to changes in relative prices. The "putty-clay" hypothesis, however, recognizes that flexibility in choice of capital and productive processes exists before purchasing assets, but once purchased, the assets and techniques become more like clay (ex-ante vs. ex-post substitution). Thus, because of the rigidity of capital stock already in place, new investment will not respond as quickly to changes in relative prices as the SNIM might suggest. Accordingly, one would expect a different reaction time to the determinant (Q) as opposed to (V). This hypothesis was supported in Bischoff's (1971b) study in which he allowed the (V) variable to lag differently...
than the (Q) variable. He found the "putty-clay" approach to be more general and provided more explanatory power than the SNIM.

C. Assumptions of the SNIM

The SNIM makes certain assumptions concerning the behavior of the firm and the economic environment in which it operates. Several of the more fundamental assumptions of the model have been questioned, most notably the constant replacement rate (d) and Cobb-Douglas production function assumptions.

1. Cobb-Douglas production function

The properties of a Cobb-Douglas (CD) production function, and the role of technology it implies, make it mathematically convenient for empirical studies. Numerous critics, however, seriously question the appropriateness of such an assumption. Fisher (1971) notes the strong restrictions imposed on the way the cost of capital can enter the investment function with such a production form, and that results of the SNIM may depend heavily on this assumption. The specificity of the results on the (CD) form has also been empirically supported by the findings of Eisner and Nadiri (1968). Eisner (1979) also questions the theoretical assumption implied by (CD) of a unitary elasticity of substitution. He cites numerous empirical studies that
yield elasticities significantly less than one. Lucas' (1969) cross-sectional studies found elasticities close to unity. However, when using time-series data, which SNIM employs, he concluded that the elasticities were less than one.

2. Constant replacement rate

The assumption of replacement investment \( (I_R) \) being a fixed, proportional rate \( (d) \) of capital stock has also been a controversial issue. Several critics have argued that \( (I_R) \) is not such a passive variable, but that it too responds to economic variables. This sensitivity was evidenced by Feldstein and Rothschild (1972) in which \( (I_R) \) was found to be influenced by changes in interest rates and by tax variables. Eisner (1972) concluded that liquidity and capacity utilization also influence \( (I_R) \). Even in the SNIM results (such as Gordon and Jorgenson, 1976), the coefficients associated with the capital stock \( (K) \) variable in the estimating equation have consistently and significantly differed from the assumed \( (d) \) values employed in determining \( (c) \). The mere existence of a positive coefficient for \( (K) \) does not conclusively support an assumption of a constant proportional replacement rate. The implication of these arguments is that a portion of the tax induced net investment is attributable to the effect of
taxes on \( I_r \). Thus, by assuming a constant \( d \), the tax induced effects on \( I_n \) are possibly overstated.

III. Justification for the Use of SNIM

After a section citing the major criticisms of the SNIM, it would seem appropriate to question why the SNIM, or any variation of it, is still used so extensively in the literature or why a variation of it will be used in this study. The principal reasons that will be advanced in this section to justify its use are its stronger theoretical support than competing models, and its superior predictive and explanatory power when compared with other models. It is also more easily modified to compensate for the previous criticisms.

A. Comparative Theoretical Support

The SNIM is based upon a theory of investment behavior that appears to be deeply established in microeconomic theory. The assumptions employed in SNIM of profit maximizing firms, output subject to a production function, marginal efficiency conditions and the importance of relative prices have been used extensively in microeconomic analysis. Green (1980) felt that the neoclassical investment theory represented "... the most ambitious attempt to date to develop a dynamic theory of investment behavior based upon rigorous microeconomic principles" (p. 339). The bene-
fit of a strong theoretical framework supporting the SNIM is not present in many of the competing investment models.

The comparatively stronger theoretical formulation of the SNIM is evident in comments by Green (1980) and Fisher (1971). Green, in a comparative study of major macroeconomic models (general equilibrium or complete systems of models), noted that financial variables in investment models were often introduced in an arbitrary manner. This criticism appeared directed at those who questioned the omission by the SNIM of cash-flow variables. The comparative theoretical weakness of the cash-flow or liquidity models in relation to the SNIM was also emphasized by Fisher. In his comparison of the SNIM (and a generalized version of it), Coen's cash-flow model, and a general equilibrium model, he noted that "...the forms of their (the liquidity and general equilibrium models) investment functions are derived from considerations theoretically less rigorous and possibly less satisfactory than those that underlie the functions used by Bischoff (the generalized SNIM) and Jorgenson (the SNIM)" (p.247).

Arguing the comparative strengths of theoretical models on a priori grounds is difficult at best. The case has been made, however, that the theoretical formulation from which the SNIM is derived is at least a relatively
rigorous one relying on analytically strong economic principles. Additional information useful for comparing models and justifying the use of SNIM or a variation of it, can be obtained by evaluating how well different models explain observed investment behavior.

B. Comparative Predictive and Explanatory Power

Numerous comparative studies of investment behavior have been conducted. Jorgenson (1979), in an exhaustive review of the investment demand literature, compared the SNIM with the classic accelerator model and various liquidity models. For studies of both individual firms and industry groups, based upon the number of significant coefficients and the correctness of their predicted sign, Jorgenson ranked the SNIM first, then the accelerator model and finally the liquidity model. A similar comparative study of models explaining investment expenditures in equipment and in construction was conducted by Bischoff (1971a). Based upon "goodness of fit" of the equation ($R^2$) and minimizing the standard error of the estimate (SEE), the generalized version of the SNIM performed best. This type of comparative analysis was a frequent dissertation topic. Examples would be Morgan (1969) and Bosworth (1969). In each case, the SNIM was considered the better predictive
and explanatory model, with the generalized version of the SNIM performing better than the standard version(8).

Given the strong theoretical foundation and explanatory power of the SNIM, a justifiable case can be made for its use. The explicit criticisms of the previous section, however, must still be addressed before the model, or some variation of it, can be used. Therein lies the final justification for the use of the SNIM: its flexibility in accommodating modifications to overcome various criticisms.

C. Flexibility of Model

A key advantage of the SNIM is its flexibility in incorporating variations, and accommodating relaxed assumptions. This is due to the fundamental theoretical premises employed by the model. The criticisms of the determinants of SNIM, such as omission of inflationary effects, can easily be incorporated. In the case of inflation, adjustment is made to the (r) variable which is used in determining the cost of capital (c). The assumption of a Cobb-Douglas production function can be replaced with a Constant-Elasticity of Substitution (CES) function, and adjustments affecting the distribution of the lag parameters can be incorporated. The criticisms of the basic model then should not be viewed as sufficient to warrant rejection. Instead, because of its strong theoretical framework, excel-
lent explanatory power and flexibility, the criticisms should be viewed as issues requiring modification to the basic SNIM.

IV. Modifications of the Basic SNIM

A. Analytical Framework

The criticisms of the SNIM indicate that some modifications to the basic model presented in the initial section of this chapter may be warranted. The first criticism that will be addressed will not be a modification, but will instead establish the analytical approach, or "view-of-the-world", that will be employed. The choice must be made as to the use of a partial equilibrium (and the assumptions that it implies), as opposed to a general equilibrium analysis. The choice of approach, one could argue, depends upon the information one wishes to derive from the study. The arguments that a partial equilibrium model fail to consider "feedback" or indirect effects are not without warrant. However, a partial equilibrium approach will yield important information on the direct effects of the variables in question. The purpose of this study is to view the direct effects of taxation on a limited sector of the economy. Accordingly, one could argue that while the partial model may miss a portion of the entire macroeconomic picture, it would seem reasonable, a priori, to expect
it to capture important relationships of a more direct nature (10). Accepting the partial equilibrium approach as a given, the next step is to generalize the basic SNIM in an effort to mitigate some of the issues previously raised.

B. The Generalized SNIM

The generalized version of the SNIM (GSNIM) is primarily attributed to the work of Bischoff (1971b). Use of the GSNIM is advantageous in overcoming some of the criticisms of the SNIM, and it is generally rated more favorably than the basic SNIM in comparative studies.

1. Comparative studies-GSNIM and SNIM

The comparative studies of the GSNIM and the basic SNIM generally support the GSNIM as being the "better" model. The criteria have been both in terms of the relative explanatory power of the model, and in terms of qualitative characteristics. The superior explanatory power of the GSNIM, as measured by "goodness-of-fit" ($R^2$), minimization of the standard error of the estimate and predictive accuracy, was found by Bischoff (1971a, 1971b), Morgan (1969) and others. The superiority of the model in terms of qualitative characteristics could be best characterized by Fisher (1971) in which he compared models based upon their vulnerability to criticism. He preferred
the GSNIM of Bischoff to Hall and Jorgenson's SNIM. In the comparison, he stated "...From the point of view of the pure theory of the determinants of the desired capital stock by the firm, I find his (Bischoff's) analysis superior to the others" (pp. 248-249).

2. Advantages of GSNIM

The GSNIM also has an advantage over the SNIM in that it overcomes two important criticisms of the SNIM. First, the GSNIM relaxes the assumption of a Cobb-Douglas production function and assumes a more flexible constant elasticity of substitution (CES) formulation. The (CES) function does not impose the restriction of unitary elasticity of substitution between capital and labor imposed by the Cobb-Douglas function.

Second, the GSNIM separates the effects of changes in output and changes in relative prices. This is done by permitting the lag pattern of investment due to changes in relative prices to differ from the lag pattern due to changes in output. The SNIM uses the same lag pattern for both prices and output combined. This formulation allows Bischoff to test and accept the hypothesis of ex-ante substitution of capital, but a fixed ex-post capital/output ratio (the putty-clay hypothesis)[11]. As noted by Harberger (1971), this is a very important difference. The
lag pattern with this formulation is a rapid initial investment response to a change in output (Q), but a slower response to a change in relative prices (V), (which contains the tax variable). The SNIM shows a rapid, rising initial response which tapers after some point (often referred to as the "inverted J"). Thus, the effects of the tax variable, or other policy tool, contained in (V) may be biased toward overestimating the tax effect.

Finally, the GSNIM has other properties that may prove advantageous. Unlike early variations of SNIM, GSNIM does not use lagged dependent variables as regressors. This reduces the degree of autocorrelation in the estimation process. Second, the GSNIM attempts to incorporate the effects of technological change in the (CES) production function and thus into the relative price term, (V). These factors, in addition to the structural improvements and more favorable explanatory power, indicate that the GSNIM is preferable to the SNIM. Accordingly, after additional modification, it will be the model employed in the remainder of this study.

C. Incorporation of Inflation into the GSNIM

The inflation adjustment advocated by Feldstein (1980) (see discussion in Criticisms section) is easily incorporated into the GSNIM. Like the SNIM, both (r) and (z), the
variables affected by the inflation adjustment, enter into the determination of the cost of capital \((c)\). Although the measurement of \((r)\) differs between the Feldstein and the Bischoff formulation\(^{12}\), the inflation adjustment is invariant. Since inflation was so pronounced during a portion of the sample time period (over 11% per year as measured by changes in the Consumer Price Index in 1974 and again in 1979), the inflation adjustment seems appropriate for this study.

D. Analysis of Unincorporated Criticisms

The previously cited issues that were not incorporated into the modified version of the model are:

- the liquidity effects on the specification of the lag distribution;
- the role of expectations as determinants in the model; and
- the assumption of a constant replacement rate.

1. Liquidity effects

The issue of the liquidity effects was discussed in a previous section when comparing theoretical formulations of alternative models. As Green (1980) noted, neoclassical investment theory is not well developed in the case of less than perfectly competitive financial markets, where, a priori, liquidity variables would become important.
Although it might be argued that these variables are important, rather than arbitrarily introducing them without theoretical support, the model will omit their use (13).

2. The role of expectations formation

The role of expectations and decision-making under conditions of risk is also in a developmental stage theoretically. Few would argue with Eisner's repeated contentions on the importance of expectations. Yet modeling the effect of expectations in an environment of risk is far from being well developed. Numerous studies (14) have been conducted attempting to capture the expectations formulations. Most models, however, only state that some specification of expectations of selected variables can be important, but that further work in the field is necessary. In many cases the expectations developed rely, to a large degree, on past values of the variable in question. Accordingly, the use of lagged values of recent periods (which would have a relatively heavy weight in measures of future expectations based on past values) as a proxy for expected values seems to be justified in terms of estimating or modeling efficiency. This approach is consistent with numerous related studies, such as Bischoff (1971b), Ando, et al (1974) and Hendershott and Hu (1980).
3. The constant replacement rate

The replacement rate for determining \( (I_r) \) does not occupy the critical role in the GSNIM as it does in SNIM, nor does it in this study. In the GSNIM, the coefficient associated with replacement is subsumed in the estimated coefficients of \((Q)\) and \((V)\) (see Bischoff, 1971b, p. 75). This reflects Bischoff's definition of \((I_t)\) providing additions to capacity, both for expansion and replacement (Bischoff, 1971b, p. 73). In effect, \((I_r)\) will be allowed to respond to \((V)\) and \((Q)\) in the same manner as \((I_n)\). In this study, since the policy issue of importance in the relative short run is gross investment \((I_t)\), the distinction between tax effects on \((I_n)\) versus \((I_R)\) becomes less important. Accordingly, an assumption of a constant \((d)\) does not seem inappropriate.

When considering the justification of certain features of the GSNIM, the modifications previously incorporated, and the comments of distinguished economists, the revised model seems to be a theoretically preferable partial equilibrium model.

V. Summary—The Modified GSNIM

The modifications resulting from criticisms of the SNIM have resulted in a variation that will henceforth be referred to as the modified GSNIM. The current model will
employ a (CES) production function with m factors, which
when normalized could be written as:

\[
Q = \left( \sum_{i=1}^{N} \alpha_i \right) \left( \alpha - 1 \right) / \sigma, \sigma / \sigma - 1 \\
\]

where

\[
Q = \text{output in physical units} \\
X_i = \text{input of the ith factor} \\
\sigma = \text{the elasticity of substitution, assumed constant over time} \\
\alpha_i = \text{the distribution parameter for the ith factor, assumed constant over time}
\]

Maximizing profit subject to the production constraint, and adjusting actual capacity to the desired capacity results in the following general equation:

\[
t = \sum_{i,j=1}^{N} b_{ij} V_{t-1} Q_{t-1}^j + e_t
\]

(3.5)

where the different summation signs refer to the separate lags of the relative price term (V) and the output term (Q), and (\( \sum_{i,j=1}^{N} \)) refers to an estimate of (a), the elasticity term.

The variable (K), unlike the SNIM specification, is not included in the equation. Bischoff, in his analysis of how additions to capacity are made, shows that the variable is redundant and adds nothing to the explanatory power of the model. As before, (V) is a relative price term of output price (p) and the cost of capital (c). The cost of capital is still as given at (3.21) (3.22) and (3.23) for
equipment, structures and timber respectively, except for $(r)$ and $(q/q)$. $(r)$ is now defined as an inflation adjusted real after tax rate of return similar to the Feldstein or Tideman formulation:

$$r = (DE(1-u)i+\hat{p})+(1-DE)e$$

(3.6)

where

- $i$ = a long-term bond interest rate;
- $\hat{p}$ = expected rate of inflation, based upon ARIMA estimates of past inflation; and
- $e$ = equity cost, defined as the ratio of market value per share price to an adjusted earnings per share.

$DE = $ the debt/equity ratio of the firm (or an average of firms in an industry)

The rate of change in factor prices $(q/q)$ will be omitted from the specification of $(c)$. This is consistent with most studies of investment behavior. As noted by Fralick (1981), the exact linkage between the capital gain term $(\hat{q}/q)$ and investment behavior is not fully developed. As will be seen in the subsequent chapter, price changes are subsumed in the calculation of $(r)$, specifically in deriving the cost of equity funds $(e)$.

By imposing a restriction of a given number of periods on the lag distribution, and employing a lag technique
developed by Almon (1965) to specify the weights of the lag (see subsequent chapter for specification of the length and order of the lag distribution), the following estimating equation is derived (referred to by Bischoff (1971b) as the expenditures equation; see p. 88–89 for a detailed description):

\[ I_t = \sum_{i=1}^{N} b_{i,t-i} V_{t-i} - Q_{t+i+1} + \sum_{i=1}^{N} b_{i,t-i} V_{t-i} Q_{t-i} + e_t \]  

where

\( N \) = the number of lag periods

Bischoff (1971b) applied the expenditure equation to quarterly data, thus the lagged price and output variables bear a close proximity in time to the investment decision. In this study annual data are used, thus the differential lag times of \((V)\) and \((Q)\) are all within one observation (1 year). Accordingly, Bischoff's expenditure equation is condensed to the following:

\[ I_t = \sum_{i=1}^{N} b_{i,t-i} V_{t-i} Q_{t-i} + e_t \]  

This formulation will be referred to as the "modified GSNIM" (15). The effect of condensing the expenditure equation is that the fixed price, variable output specification (the "putty-clay" hypothesis) is constrained to some degree. This constraint seems less objectionable than inferring a relatively fixed, long lag for the \((V)\) and \((Q)\) variables. In addition, this specification retains the
other advantages of the GSNIM. It also allows an alternative for testing the "putty-clay" hypothesis by allowing the lags for (V) and (Q) to vary.

The exact specification of the "modified GSNIM" may vary depending on the type of investment. This would be consistent with previous studies which allow some flexibility in the estimating equation. For example, the SNIM at (3.1) and the GSNIM at (3.7) have also been estimated using the following equations:

\[
I_{et} = b_0 + b_1 (\Delta pt_{t}/ct) + ab_2 (\Delta pt_{t-1}/ct_{t-1}) - b_3 I_{t-1}
\]

(Hall and Jorgenson, 1967)

\[
I_t = b_0 + b_1 K_{t-1} + \sum_{i=1}^{N} b_i (pt_{t-2}/ct_{t-2})
\]

(Gordon and Jorgenson, 1976)

\[
I_{et} = b_0 + \sum_{i=1}^{N} b_i (pQ/c)_{t-i} + b_{n+1} K_{t-1}
\]

(Bischoff, 1971a)

\[
I_{et} = b_0 + \sum_{i=1}^{N} b_{1,i} (p/c)_{t-i-1} Q_{t-i} + \sum_{i=1}^{N} b_{2,i} (p/c)_{t-i-1} Q_{t-i-1} + b_{n+1} K_{t-1}
\]

(Bischoff, 1971a)

\[
I_{st} = b_0 + \sum_{i=1}^{N} b_i [(p/c)_{t-i} Q_{t-i} + b_{n+1} K_{t-1}]
\]

(Bischoff, 1971a)

where

\[
I_{et} = \text{investment in equipment}
\]

\[
I_{st} = \text{investment in structures}
\]
Accordingly, some variation in the exact specification of (3.8) due to asset type variations would be expected. For example, the number of lag periods, $i$, would be expected to vary among different assets. As indicated in comparing (3.94) and (3.95), some difference in the manner in which the price and output terms interact would also be expected. The appropriate specification for each asset type of the "modified GSNIM" will be determined in subsequent chapters. This study will apply the model not only to equipment and structures, but also to timber or the appreciating asset case. The resulting models for each asset category will then be used for testing hypotheses of the impact of taxation on investment expenditures. Since any impact may be small, the model will also estimate the magnitude of any apparent stimulative effects.
1. Jorgenson has made extensive contributions to the investment demand literature, most notable Jorgenson (1963), Hall and Jorgenson (1967, 1971) and Gordon and Jorgenson (1976).

2. During the period 1962-1964, the Long Amendment required that the base for calculating depreciation be reduced by any investment tax credit \((k)\) claimed. This adjustment appears in the numerator of the cost of capital as follows:

\[
C_t = q_t (r_t + d_t) \left(1 - k_t - u_t z_t + u_t z_t k_t\right) / \left(1 - u_t\right)
\]

This adjustment is not reflected in this study since it is not in the sample period.

3. Assuming a constant before tax rate of return implicitly assumes that the tax burden is not shifted, but is borne by the firm.

4. For the derivation of the depreciation formulae, see Hall and Jorgenson (1971), pp. 19-20.

5. It is necessary to reduce the regular corporate tax rate \((u)\) by the capital gain benefit to properly reflect the taxation of income that accrues to timber. Unlike equipment, a major portion of income assignable to timber is due to appreciation and growth. This portion is taxed at capital gains rates. The remaining timber output, like equipment, is taxed at ordinary rates. Thus, \((u')\) in effect represents a weighted average of the tax assessed on the different types of timber income.

6. For a comprehensive review of various applications of SNIM, see Jorgenson (1979).

7. "q" theory attributes a strong role to market valuations in the objective function being maximized by the firm. For a discussion of this theory in the context of an empirical study of the corporate income tax, see Summers (1981) or Hendershott and Hu (1981).

8. Morgan, however, did find that the internal funds or liquidity model performed better for the unincorporated service industry composed generally of smaller businesses. Since this group is not in the sample of this study, this
contradictory evidence does not defeat the use of a variation of the SNIM.

9. A particularly important general equilibrium issue to consider when determining the analytical framework is the assumption of constant output effects, or no feedback from the investment-output decisions. This would seem especially important for the forest products industry where timber output (harvesting) and investment (plantation) are so closely related. As noted in the discussion of the appreciating asset case in Chapter One, the issue of when to harvest is held constant. As noted in the narrative, assuming output effects are constant does not imply their lack of importance, but only that the emphasis of this study is on direct effects of tax variables.

10. A possible argument against the use of a partial equilibrium model would be that general equilibrium effects might invalidate the results of a partial analysis. Since variations of the SNIM have been employed successfully in many complete model systems (for examples, see Green, 1980), it would appear that the basic relationships of the model have general validity.

11. The analytics employed and examples of the "b" matrix of an ex-post fixed proportions as opposed to ex-post freely variable proportions is presented in pages 71-80, Bischoff (1971b).

12. Bischoff (1971b) uses a weighted average of long-term bond interest rates and the dividend/price ratio as a cost of funds. Feldstein uses a weighted average of the long-term bond interest rates and the earnings/price ratio. The large firms employed in this study have relatively low debt/equity ratios, indicating a high degree of financing with internal funds. Accordingly, the earnings/price ratio used by Feldstein would be more indicative of the capital cost involved in using equity.

13. Use of financial variables would seem, a priori, to require a complete model where they would probably enter the financing function. Nickell (1978) provides an excellent discussion and review of the analytics of the financing decisions of firms.

15. The modified GSNIM formulation may bear a resemblance to the SNIM. Bischoff (1971a), in a comparative study of investment models, referred to a similar equation as the SNIM. However, reference to the Hall and Jorgenson formulation (1971, p.26) and Bischoff (1971b, p.92), indicates that the modified GSNIM is not the same as the original SNIM. Even Bischoff (1971a) uses a similar equation (but with a nonlinear price variable) for estimating investment in long-lived depreciable assets. Thus, the equation used in this study is intended to incorporate the improvements of the GSNIM, yet adopt it for annual data.
CHAPTER FOUR
ESTIMATION OF MODEL VARIABLES

This chapter is concerned with the methodology and measurement techniques employed in establishing the data base and determining the variables used in the model's estimating equations. The initial section will specify the firms and time periods selected for the sample. The remainder of the chapter will discuss the sources of the data, and any transformations necessary to arrive at the final values used.

I. Sample Selection

The time period selected for the study was 1967-1981, with annual observations being used. Due to the specification of a distributed lag for investment expenditures, it was necessary to include observations for 1962-1966 for selected variables. Data were generally not available in sufficient detail prior to 1967 to enable extension of the sample period and still have necessary lag periods for the first year of the estimation. The use of annual, as opposed to quarterly, observations seemed to be an acceptable approach based upon a review of the investment demand literature(1). The use of annual observations was preferable due to the limited amount of sufficiently detailed
quarterly information. The literature also suggests that the lag time for investment is in excess of one year, thus the use of annual data will not artificially extend the investment cycle significantly\(^{(2)}\).

Most data sources at the industry level classify firms by the type of output as opposed to ownership of assets\(^{(3)}\). Thus, major timberowners are classified in numerous industry categories, most notably the lumber and wood products category, and paper, pulp and allied products category. Since an important issue in this study is the taxation of timber owners, a sample group based upon timber ownership instead of output seemed most appropriate. A classification by timber ownership and value of timber holdings was prepared by Galluccio (1980). His ranking of the fourteen largest timber firms is presented in Table 4-1.

The firms used for this study were selected from this ranking. The selection criteria were that:

a) data must exist in sufficient detail for the sample period;

b) the firms must be U.S. based firms; and

c) the firms must be classified according to the Standard and Poors Industrial Classification in either class #2400 (lumber and wood products) or #2600 (paper, pulp and allied products).
**TABLE 4-1**

FIRM OWNERSHIP OF TIMBER ACREAGE (as of 1979)

<table>
<thead>
<tr>
<th><strong>RANK</strong></th>
<th><strong>COMPANY</strong></th>
<th><strong>ACRES OWNED (000)</strong></th>
<th><strong>EST. TIMBER VALUE ($MILLION)</strong></th>
<th><strong>BOOK VAL./SH. AS TIMBER STATED</strong></th>
<th><strong>ADJUST</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>WEYERHAUSER</em></td>
<td>5923</td>
<td>9534</td>
<td>21.05</td>
<td>89.77</td>
</tr>
<tr>
<td>2</td>
<td>INTERNAT’L PAPER</td>
<td>8410</td>
<td>3857</td>
<td>53.76</td>
<td>117.17</td>
</tr>
<tr>
<td>3</td>
<td>*GEORGIA-PACIFIC</td>
<td>4500</td>
<td>3404</td>
<td>17.99</td>
<td>42.98</td>
</tr>
<tr>
<td>4</td>
<td>*CROWN ZELLERBACH</td>
<td>2053</td>
<td>2910</td>
<td>40.59</td>
<td>147.99</td>
</tr>
<tr>
<td>5</td>
<td>*CHAMPION INTERNAT’L</td>
<td>3066</td>
<td>2120</td>
<td>27.46</td>
<td>58.83</td>
</tr>
<tr>
<td>6</td>
<td><em>BOISE CASCADE</em></td>
<td>2664</td>
<td>1703</td>
<td>42.28</td>
<td>100.41</td>
</tr>
<tr>
<td>7</td>
<td>ITT (RAYONIER)</td>
<td>1274</td>
<td>1575</td>
<td>39.14</td>
<td>48.91</td>
</tr>
<tr>
<td>8</td>
<td>*ST. REGIS PAPER</td>
<td>3179</td>
<td>1571</td>
<td>37.44</td>
<td>79.58</td>
</tr>
<tr>
<td>9</td>
<td>LOUISIANA-PACIFIC</td>
<td>880</td>
<td>1319</td>
<td>21.53</td>
<td>59.10</td>
</tr>
<tr>
<td>10</td>
<td>BURLINGTON NORTHERN</td>
<td>1492</td>
<td>1294</td>
<td>65.19</td>
<td>105.88</td>
</tr>
<tr>
<td>11</td>
<td>PACIFIC LUMBER</td>
<td>165</td>
<td>1268</td>
<td>14.33</td>
<td>119.50</td>
</tr>
<tr>
<td>12</td>
<td><em>SCOTT PAPER</em></td>
<td>2914</td>
<td>1222</td>
<td>26.20</td>
<td>55.37</td>
</tr>
<tr>
<td>13</td>
<td>POTLATCH</td>
<td>1311</td>
<td>1210</td>
<td>31.84</td>
<td>107.43</td>
</tr>
<tr>
<td>14</td>
<td>MACMILLAN BLOEDEL</td>
<td>1305</td>
<td>1091</td>
<td>33.52</td>
<td>88.59</td>
</tr>
</tbody>
</table>

Source: Galluccio (1980), p.62
* = selected for sample
** = ranked by timber value
The selection criteria in b) and c) were imposed in an attempt to develop a more homogeneous group, thus minimizing any extraneous influences when measuring tax effects.

Using the selection criteria, the firms indicated by (*) were selected for the sample. MacMillan Bloedel was excluded because it is a Canadian based firm. ITT (Rayonier) was excluded because it is a wholly-owned subsidiary of International Telephone and Telegraph, thus data would not permit calculations of the cost of capital variable (c) in the model. Louisiana-Pacific spun-off from Georgia-Pacific in 1972 and thus was not in existence for the entire sample period. Burlington Northern, a conglomerate primarily operating in the railroad industry, was not classified in the #2400 or #2600 industry categories. International Paper, Pacific Lumber and Potlatch were excluded because the data did not provide sufficient detail of the composition of capital stock.

Data for the remaining firms were combined to represent a sample of the forest products industry. The combined timber acreage owned by the seven sample companies was approximately one-third of the total acreage of all firms in the forest products industry(4). The sample seemed to be representative of the industry, particularly
of those firms that would benefit the most from the industry specific tax provisions.

II. The Data Base

A data base was developed that contained the information necessary for estimating the parameters of the modified GSNIM. The model of investment expenditures in each of the (jth) asset categories of equipment, structures and timber was previously given at (3.8) as:

\[ I_{j,t} = \sum_{i=1}^{N} b_{i,j} V_{j,t} + q_{t-i} + e_{t} \quad (5) \]

The data for the study were obtained from a variety of sources. Individual firm information was primarily obtained from annual reports and reports filed with the Securities and Exchange Commission (often summarized by Moody's Industrial Manual, a financial information service). Price information was generally provided by various issues of Survey of Current Business. Additional data were derived from predetermined equations as required by the model.

A. Investment Equation - Equipment

1. The dependent variable - Investment (I)

\( I_{e,t} \) represents investment expenditures, in constant dollars, per year in machinery and equipment. The base year for normalizing nominal dollars was 1967. The nominal dollar data for \( I_{e,t} \) were obtained primarily from company
annual reports for each firm and the \( (k) \) companies were combined to obtain industry totals. Thus:

\[
I_e = \frac{\sum_{k=1}^{N} I_{ke}}{N} \quad \text{(in nominal dollars)} \quad (4.2)
\]

where

\( N \) = the seven companies selected for the sample

Nominal dollars are then deflated by the input price deflator \( (q_e) \).

The appropriate measure of \( (q_e) \) has been the subject of some discussion in the literature. Since no distinction by types of equipment was made in this study, the resulting aggregate would seem best represented by an aggregated price deflator. The GNP Implicit Price Deflator for producers durable equipment is such a measure, and accordingly, was used for \( (q_e) \). Data were obtained from various issues of *The Survey of Current Business*. The original price data, which used a base period of 1972, were rebased to a 1967 base year.

2. The output variable \( (Q) \)

The output variable, \( (Q_t) \), represents sales per period stated in 1967 base year dollars. The values for \( (Q_t) \) represent the sum of the sample firms' sales in nominal dollars, deflated by a weighted average producer price index, or:

\[
Q = \left( \frac{\sum_{k=1}^{N} Q_k}{P} \right) \\
\]

\( (4.3) \)
where

\( Q_k \) = the (k) firm's sales for the period
\( p \) = output price index for the period

\((Q_k)\) in nominal dollars were obtained from firm annual reports. A distinction exists between output (subject to a greater degree of intrafirm control) in neoclassical theory and sales (influenced more by actions external to the firm). Due to the relatively short lead time necessary for orders to result in sales in the industry, and assuming optimal inventory controls, the distinction would not be expected to significantly affect the results of this study. This assumption (sales as a proxy for output) is also reflected in numerous studies of investment demand at the firm and industry level\(^{7}\). \((Q)\) is common for the investment equations in all asset categories.

The output price index \((p)\) used to deflate sales represented a weighted average of output prices for the lumber and wood products category \((p_L)\) and the paper, pulp and allied products category \((p_p)\). The weights were based upon an average of each sample firm's sales in each category, or:

\[
p = \left[ \left( \sum_{k=1}^{N} w_k/N \right) p_L \right] + \left[ \left( \sum_{k=1}^{N} 1-w_k/N \right) p_p \right]
\]  \hspace{1cm} (4.4)

where
\[ w_k = \% \text{ of the (kth) firm's sales represented by} \]
\[ \text{l-}w_k = \% \text{ of the (kth) firm's sales represented by} \]
\[ N = \text{number of sample firms} \]
\[ P_l = \text{producer price index for lumber and wood products} \]
\[ P_p = \text{producer price index for paper, pulp and allied products} \]

The average weights \( (w_k) \) and \( (l-w_k) \) for each firm were obtained from firms' annual reports. For years in which detail of the composition of sales was not available, a weighted average based upon the years in which sufficient detail existed was used. The price indexes \( (P_l) \) and \( (P_p) \) were obtained from the U.S. Bureau of Labor Statistics, Producer Price Indexes, By Commodity (and its predecessor, Wholesale Prices and Price Indexes).

3. The relative price term \( (V) \)

The relative price term \( (V) \) represents a ratio of output prices \( (p) \) to the user cost of capital \( (c_e) \), and is given as:

\[ V_e = p^a c_e^{-a} \quad (4.5) \]

where

\[ a = \text{the price elasticity of demand for the factor} \]
\[ p = \text{the implicit price deflator for output as calculated at (4.4)} \]

\[ c_e = \text{the user cost per unit of equipment}^{(8)} \]

The price elasticity of demand (\( \alpha \)) was assumed to be equal to unity. Although this assumption is often criticized, sufficient support exists to warrant its continued use in this study\(^{(9)}\). Estimates employing price elasticities other than unity were made and the results are presented in the following chapter for both the unitary elasticity and other-than unitary elasticity assumptions. The calculation of the user cost of capital is not an assumed value, and requires more discussion.

\( \text{a) Derivation of the user cost of capital (c) } \)

The user cost of capital, as developed at (3.22) to incorporate tax variables, is restated as:

\[ c_e = q_e (r + d_e) (1 - k - u z_e) / (1 - u) \]  

\( (4.6) \)

where

\[ q_e = \text{implicit price deflator for equipment input} \]

\[ r = \text{the after-tax finance cost or rate of return} \]

\[ d_e = \text{depreciation rate for equipment} \]

\[ k = \text{effective rate of investment tax credit} \]

\[ z_e = \text{present value of depreciation deduction for equipment} \]

\[ u = \text{statutory tax rate} \]
The user cost of capital \( (c_e) \) represents an annual average of the sample firms and serves as an estimate for the industry's \( (c) \). Accordingly, for variables that required calculation based upon industry specific information, data for the sample firms were obtained, then averaged for use in calculating \( (c_e) \). Other variables, such as \( (q_e), (d), (k) \) and \( (u) \), were based upon alternative sources of information.

b) User cost of capital-the \( (q) \) variable

The implicit price of capital input in the case of equipment, \( (q_e) \), is represented by the GNP Implicit Price Deflator for producers durable equipment (1967 base year). Consistent with numerous investment demand studies, \( (q_e) \) was used to both deflate \( (I_e) \) and to calculate the user cost of capital \( (c_e) \). In \( (c_e) \), \( (q_e) \) served as a measure of the relative current price of the input factor (normalizing to $1). Accordingly, the change in the price of the factor also seemed to be an appropriate scale for deflating investment expenditures \( (I_e) \) to constant dollars.

c) User cost of capital-the tax variables \( (k \) and \( (u) \)

The statutory tax rate \( (u) \) is given by the Internal Revenue Code (IRC) and varied from 48% to 46% for the sample period. As explained in Appendix A, the corporate
income tax is not constant for all income levels, however all firms in the sample had income levels that subjected marginal income to the highest corporate rate. Accordingly, the highest rate for any year served as an approximation of the marginal tax rate for use in evaluating marginal investment decisions.

The IRC also specifies the investment tax credit rates (see Appendix A for a discussion of the credit). This credit is available for equipment, but the rates vary depending upon the tax life of the asset. Due to this variability, effective rates, instead of the highest statutory rates, were used. Effective rates were estimated from financial statement information or from other studies(10) and ranged from 0% (during the suspension period) to 9%.

d) User cost of capital—the depreciation rate \( (d_e) \)

The depreciation rate \( (d_e) \) used in estimating equations has varied extensively in investment demand studies. Bischoff (1971b) used an assumed rate of .16, and noted that the results did not seem to be sensitive to absolute values of \( (d_e) \) over a range of .10 to .20. Consistent with the Bischoff study, the model did not seem sensitive to alternative estimates over a similar range. The rate for equipment used for this study, .1225, is based upon the Hulten and Wykoff (1981) estimates of economic depreciation.
rates for various asset categories. The rate was assumed constant over the sample period.

e) User cost of capital—the cost of finance \((r)\)

The variable \((r)\) is used in various contexts and with varying definitions. Generally, it represents the rate of return that can be earned on marginal investments, thus it also represents the opportunity costs of funds. Viewing \((r)\) as the opportunity rate of return, a profit maximizing firm would use this rate as a measure of the cost of financing alternative investment projects and as the rate for discounting future cash flows. Thus, the terms financing cost, discount rate or rate of return are often used synonymously to define \((r)\).

Economic theory suggests that, in equilibrium, after-tax rates of return \((r)\), adjusted for risk and earnings expectations, will be equated across assets by the market. As noted by Nickell (1978), however, estimates of \((r)\) have varied extensively among investment demand studies. The differences in choice of \((r)\) do not imply studies of disequilibrium conditions. Rather, the differences reflect alternative theories of corporate finance, and varying methods of measurement.

Alternative theories of the financing decisions of firms will result in different measures of \((r)\). If one
adopts the Miller-Modigliani (1966) approach, \( (r) \) would be defined as a weighted average of the costs of external finance (debt) and internal finance (equity). This approach is employed in numerous studies, such as Feldstein (1980), Bischoff (1971b), Jorgenson and Stephenson (1967), and Green (1980) (in the DRI model, 1980). Other studies, such as Gordon and Jorgenson (1976), Coen (1971), Eisner and Nadiri (1968), assume that \( (r) \) is best represented by the cost of external finance only.

Additional differences will also result depending on the assumptions of how \( (r) \) is measured. Although an equilibrium \( (r) \) may exist, observing the appropriate rate may not be possible due to measurement difficulties. Thus, as noted by Bischoff (1971b), estimates are made of the unobservable true rate \( (r) \). Bischoff's (1971b) study of investment in producers' durable equipment approximated \( (r) \) as a weighted average of Moody's Composite Industrial bond yield and Moody's industrial dividend-price ratio. Eisner and Nadiri (1968), in a study of total investment in U.S. manufacturing used the Government's long-term bond interest rate. Green's (1980) analysis of the BEA and Chase models of aggregate nonresidential investment used Moody's domestic corporate bond rate and AA utility bond rates respectively. Jorgenson and Siebert (1968), in a study of
individual firm's gross investment, relied on firm specific financial statement information of income and asset values. In a study of investment by OBE-SEC classified industries, Jorgenson and Stephenson (1967) employed the ratio of total adjusted corporate profits for each industry to the market value of the firms in each industry as an estimate of \( r \). Still other studies have simply assumed a constant value of before-tax \( r \). Thus, there exists a plethora of methods for estimating the parameter \( r \).

Due to the controversy surrounding the discount rate (the solution of which is beyond the scope of this study), and the lack of strong a priori reasons for selecting a particular method or concept of measurement, this study will employ alternative estimates of \( r \). The calculations of \( r \) will be made both with and without the internal finance variable, and will rely on market determined interest rates as estimates of the external finance variable. This approach to dealing with the controversy surrounding \( r \) has been used by other authors, such as Hendershott and Hu (1981).

Since industry specific values of the cost of internal and external finance for the timber industry are not available, a series will be developed to estimate these costs. The series will represent an average of the costs of the
sample firms in the industry. The approach of estimating industry values based upon averages of the composite firms seems theoretically preferable, since the resulting estimates will more closely reflect the risk profile and earnings expectations for the industry than more highly aggregated measures. This approach is similar to industry studies such as those by Jorgenson and Stephenson (1967), and underlies the methods used by the various investment services for estimating industry variables.

The resulting estimate of \( r \) will incorporate the effects of inflation in a manner consistent with Ando, et al (1974), Tideman (1975) and Feldstein (1980). Thus, using the Feldstein approach of the discount rate being a weighted average of the cost of external finance and internal finance for the relevant aggregate (in this case, the sample firms of the industry), \( r \) is written as:

\[
r = [DE(1-u)i-p]+(1-DE)e
\]

(4.7)

where

\( DE = \) average debt/equity ratio of the sample firms
\( i = \) interest rate on borrowed funds
\( p = \) expected rate of inflation
\( u = \) tax rate, as previously defined
\( e = \) equity cost, as calculated at (4.9)
The alternative specification of \( r \) being represented by the cost of external finance only, but including the Feldstein inflation adjustment, would be:

\[
\begin{align*}
    r_e &= (1-u)i-p \\
    \text{(4.8)}
\end{align*}
\]

i) External financing cost

\( (DE) \) is calculated each time period (year) based upon financial information provided by annual reports of Moody's Industrial Manual. Debt equals the sum of current liabilities, long-term debt and deferred income taxes. Equity equals the sum of preferred stock, common stock, additional paid-in capital (or other similar description) and retained earnings. The \( (DE) \) ratio is then multiplied by the real after-tax interest cost and represents the cost of the external finance portion of \( r \).

The real after-tax interest cost is the nominal interest cost \( (i) \) reduced by the tax rate and inflation rate. The marginal interest cost \( (i) \) is the opportunity cost of new bond issues facing each firm. The Moody's bond rating of each company provided a risk profile. The average annual yield based upon that rating was deemed to be the opportunity or marginal interest cost if a firm desired to issue new bonds. If no rating was available, Moody's Composite Average of Yields on Corporate Bonds was used. The interest rates were then averaged for the firms in the
sample. The final adjustment, \( \hat{p} \), was calculated as a ten year moving average (static expectations) of the change in the annual Consumer Price Index-Urban as provided by the Survey of Current Business.

ii) Internal financing cost

Consistent with the Feldstein formulation, equity cost \( e \) is the ratio of nominal earnings per share (EPS) to stock prices per share (STKP). (EPS) data for each firm was available from Value Line Investor's Service and firm (STKP) data from Daily Stock Price Record\(^{11}\). The nominal (EPS) value however, is based upon an accounting convention of historical cost\(^{12}\). This concept does not directly consider the effects of inflation and may use inventory methods that do not reflect current costs in measuring income. Any adjustment for artificial inventory profits did not seem warranted in this study. A survey of recent annual reports indicated that most of the inventory was valued under a LIFO convention which will match costs that approximate current costs against income. An approximation of the effect of non-LIFO valued inventory on average industry values of \( e \) indicated a minimal impact.

The omitted effects of inflation on conventional (EPS) was of a sufficient magnitude to warrant adjustment. The measurement of income based upon historical cost concepts
during an inflationary period will not reflect economic income for the period. The major adjustments required were to incorporate purchasing power gains or losses from holding net monetary liabilities or assets and to adjust depreciation (depletion) to reflect current cost\(^{(13)}\). Thus, (e) could be written as:

\[
e = \frac{(\text{EPS}_H + \text{PGLS} - \text{DEPADJ})}{\text{STKP}}
\]

(4.9)

where

\[
\text{EPS}_H = \text{EPS, historical cost-average for industry, or } \frac{\sum_{k=1}^{N} \text{EPS}_H}{N}
\]

\[
\text{STKP} = \text{average stock price per share, or } \frac{\sum_{k=1}^{N} \text{STKP}_k}{N}
\]

\[
\text{PGLS} = \text{purchasing power gain or loss adjustment-per share, averaged for industry}
\]

\[
\text{DEPADJ} = \text{depreciation adjustment-per share, averaged for industry}
\]

The calculation of purchasing power gain or loss (PGL) was in accordance with the algorithm recommended in Financial Accounting Standards Board Statement No. 33 (FASB #33). The data necessary for the calculation was obtained from company annual reports and Moody's Industrial Manual.

The depreciation and depletion amounts in the conventional (EPS) are based on historical costs. Sufficient detail to restate depreciation and depletion in current
costs was not available for the entire sample period. An approximation of the current cost of the decline in value was made by restating depreciation expense as .1225 times the historical cost amount. The factor .1225 was obtained from a study of economic depreciation rates by Hulten and Wykoff (1981) and represents the rate of decline in value of an asset. Thus, the resulting depreciation expense is still based upon historical cost, however, the use of the economic depreciation rate at least provides a reasonable estimate of current cost depreciation. The depletion amount, which represents the cost of timber harvested, is adjusted for changes in the price level of timber, thus approximating the current cost of the timber. The difference between the adjusted depreciation and depletion amounts, and those indicated in company annual reports, was combined with the purchasing power gains and losses. These amounts were then scaled to a per share basis and represent the inflation adjustment of conventional (EPS). The resulting equity cost of (4.9) represents the cost of internal finance (e) used at (4.7).

f) User cost of capital-the (z) variable

The present value of future depreciation deductions (z) for calculating taxable income would be represented in general form as:
\[ z = \int_0^T e^{-rs} D(s) \, ds \]

where

\( r = \) the discount rate, previously defined

\( D(s) = \) depreciation deduction for asset at age \( s \)

\( T = \) the lifetime of the asset for tax purposes

The deduction, \( D(s) \), is based upon the original cost of the asset and depends upon the depreciation method selected (see Appendix A for a discussion of depreciation methods). A survey of the financial statements of the sample firms indicated that all firms used some type of accelerated depreciation method for tax purposes. The sum-of-the-years digits (SYD) method and declining balance (DB) method are the most frequently used accelerated methods. The present values of the two methods are approximately equal for equipment over the relevant range of \( (T) \) and \( (r) \) used in this study. This finding is consistent with Bischoff (1971b). Accordingly, this study will assume the use of the SYD method (14). As developed at (3.31), the present value of the SYD deduction is:

\[ z_{\text{SYD}} = \frac{2}{(rT)} \left[ 1 - \frac{(1-e^{-rT})}{(rT)} \right] \]  

\[(4.10)\]

where

\( T = \) the useful life for tax purposes

and other variables are as previously defined.
The tax lives, T, represent an approximation of the Asset Depreciation Range (ADR) lives initiated in 1969, and prescribed by U.S. Treasury Department Regulations. The ADR groups for which the approximation is made are the lumber and wood products group and the paper and allied products group. The ADR tax lives range from 5 to 15.5 years depending upon the type of equipment. Accordingly, a mid-point of 10 years was selected for this study and assumed constant for the sample period. The resulting (z) was calculated using alternative measures of (r).

B. Investment Equation—Structures

1. The dependent variable—Investment (I)

(I_s) represents investment expenditures, in constant 1967 dollars, per year in structures. The nominal dollar data for (I_s) were obtained primarily from company annual reports for each firm and combined as at (4.2). The resulting total (I_s) was then deflated by the input price deflator (q_s). The measure of (q_s) was the GNP Implicit Price Deflator for structures, and was obtained from various issues of The Survey of Current Business. Like (q_e), the 1972 data was rebased to 1967.

2. The relative price term (V)

The relative price term for structures (V_s) is similar in calculation to (V_e). The factor elasticity of
demand (a) and output price variable (p) of the relative price term \( V_s \) remain the same as (4.5). Important differences, however, exist in the calculation of the user cost of capital \( (c_s) \). For structures, the user cost of capital becomes:

\[
\begin{align*}
\quad c_s &= q_s(r+d_s)(1-uz_s)/(1-u) \\
\end{align*}
\]

where the variables are as previously defined, but adjusted to reflect the characteristics of structures.

a) Calculation of \( (c_s) \)

The differences between the user cost of capital for equipment \( (c_e) \) and structures \( (c_s) \) are due primarily to the differences in the price term \( (q) \), the tax variables \( (k,z) \) and the depreciation rate \( (d_s) \). \( (r) \) and \( (u) \) are invariant for equipment or structures.

The tax variables reflect the differing treatment of structures for tax purposes. Most structures do not qualify for the investment tax credit \( (k) \), thus the term does not appear in (4.11). The present value of the depreciation deduction \( (z) \) reflects the limits placed on depreciation methods for structures, and the differing tax lives allowed.

The depreciation method appropriate for structures, based upon Hall and Jorgenson (1971) and an assumption of a
firm maximizing its depreciation deduction, is the 150% declining balance method, which was given at (3.32) as:

$$z_{st} = \left(1/e\right)\left(\frac{1-e^{-\left(r+\left(\Theta/T\right)\right)T'}}{r(T-T')}\right)\left[e^{-rT'}-e^{-rT}\right]$$

(4.12)

where

- $\Theta$ = a fixed proportion of the straight line rate, 150% in this case
- $T'$ = the number of years to the point when it is optimal for the firm to switch from the declining balance to the straight line method.
- and other variables are as previously defined.

The tax life (T) used was 45 years, based upon the ADR for commercial structures. The optimal "switch-over" point was assumed to be 13 years, based on Treasury Department calculations. The resulting ($z_s$) is calculated based upon the alternative measures of ($r$) at (4.7) and (4.8).

The depreciation rate for structures ($d_s$), is based upon the Hulten and Wykoff (1981) study, and assumed to be a constant .0361 for the sample period.

C. Investment Equation-Timber

1. The dependent variable-Investment ($I_f$)

($I_f$) represents investment expenditures, in constant 1967 dollars, per year in timber. The nominal dollar data for ($I_f$) was obtained primarily from company annual
reports. All companies were combined to obtain industry totals as at (4.2). The nominal dollars are deflated by the input price deflator \((q_f)\). Unlike \((q_e)\) or \((q_s)\), sufficiently general price deflators \((q_f)\) were not available. Accordingly an index was developed based upon the input prices faced by the sample firms.

The input price deflator \((q_f)\) was constructed for the sample firms based upon the weighted average stumpage prices faced by each firm. Weighted average stumpage prices \((P_s)\) were constructed for the \((k)\) firm as follows:

\[
P_{sk} = \sum_{v=1}^{N} w_v P_{sv} \tag{4.13}
\]

where

\[w = \text{a weight based upon the proportion of ownership of selected species (v)}\]

\[P_s = \text{stumpage price by specie (v)}\]

The ownership proportion weights \((w)\) of each specie \((v)\) was based upon the firm's proportionate ownership of acreage in a particular region as reflected in their 1981 annual report and assumed constant for the sample period. Certain species tend to be predominant in a region (for example, fir in the Pacific Northwest and pine in the South), thus use of proportional acreage ownership by region seemed to be a reasonable method for estimating the proportion of input attributable to each specie.
Stumpage prices for selected species ($p_s$) were obtained from U.S. Forest Service (1981) data. After $(P_{sk})$ was calculated, an index with 1967 as the base year was constructed for each firm according to its use of a particular input species:

$$q_{fk} = \frac{P_{skt}}{P_{sk1967}} \quad (4.14)$$

An average input price index ($q_f$) for the sample industry was obtained by averaging ($q_{fk}$) across firms as follows:

$$q_f = \frac{\sum_{k=1}^{N} q_{fk}}{N} \quad (4.15)$$

2. The relative price term ($V$)

The relative price term for timber is similar to that of equipment or structures. The factor elasticity of demand ($a$) and output price variable ($p$) remain the same. Important differences, however, exist in the determination of the user cost of capital. The user cost of capital ($c_f$) for the appreciating asset, timber, as developed in Chapter Three is given as:

$$c_f = \frac{q_f(r-d')/(1-u')}{(1-u')} \quad (4.16)$$

where

- $d'$ = the appreciation rate of timber
- $u'$ = the statutory tax rate reduced by the capital gain benefit ($cg$)

and other variables are as previously defined.
a) User cost of capital-financing cost ($r$).

A measure of ($r$) was given at (4.7) as:

$$r = [DE(1-u)i+p] + (1-DE)e$$  \hspace{1cm} (4.7)

As previously noted, the calculation of the cost of equity ($e$) at (4.7) required that the measure of (EPS) by conventional accounting methods be adjusted for inflationary effects (see 4.9). An additional adjustment is required in the case of timber for unrealized income (holding gains) that are not reflected in conventional (EPS). The effect of holding gains on conventional (EPS) is particularly important for firms in the timber industry. As Table 4-1 previously indicated, the historical cost accounting principle does not necessarily reflect the changes in current value of timber, and accordingly the resulting measure of income used in conventional income statements does not include holding gains.

The annual increment in value of timber holdings represents income in the Haig (1921), Simons (1938), and Tresttrail (1969) analyses. Tresttrail noted that the unrealized appreciation of timber value represents income that the owner elects to reinvest in the timber stand until an optimal cutting time$^{15}$. The conventional (EPS) would appear, a priori, to require this adjustment to properly reflect economic income.
Thus, the cost of equity \( e \) at (4.9) for the timber income case would be restated as follows:

\[
e_A = \frac{(\text{EPS}_H + \text{PGLS} - \text{DEPADJ} + \text{ADJTI})}{\text{STKP}}
\]

where

\[
\text{ADJTI} = \text{the adjustment for unrealized timber income}
\]

and other variables are as previously defined.

The adjustment for the timber appreciation income consists of three components, which may be represented as follows:

\[
\text{ADJTI} = \text{TA} + \text{CHTP} - \text{RETI}
\]

where

\[
\text{ADJTI} = \text{the adjustment for timber income}
\]

\[
\text{TA} = \text{income due to the annual growth in volume (see 4.19)}
\]

\[
\text{CHTP} = \text{income due to the effects of price changes (see 4.21)}
\]

\[
\text{RETI} = \text{realized timber income already recognized in (EPS) (see 4.23)}
\]

Income from the holding of timber then consists of two elements; appreciation of the physical volume due to annual growth (TA), and the changes in prices of the value of the timber (CHTP). However, conventional (EPS) recognizes this income when the timber is cut (realized). Thus some measure of timber income is already reflected in
To avoid double counting of income, the (EPS) adjustment should not include the realized element already in (EPS), and is thus subtracted from (ADJTI).

The measurement of the elements of (ADJTI) was difficult due to inadequate data. However, meaningful estimates could be made. Although some measurement error may exist, the values derived at least capture the important relationship of recognizing accrued economic timber income, instead of only realized income. As will be noted in the subsequent section concerning parameter estimation, the model using a timber adjusted (r) performed better than the model omitting this adjustment. Thus, use of (ADJTI) appears warranted although a conservative approach should be employed in deriving the variables to minimize the effect of measurement error.

1) Timber income adjustment (ADJTI)-annual growth (TA)

The calculation of (TA), income due to annual growth in volume, was performed as follows:

\[ TA = (A \times ANNGRO) P_s \]

where (4.19)

\( A \) = U.S. timber acres owned (in thousands of acres)

\( ANNGRO \) = annual growth in volume per acre

\( P_s \) = stumpage prices, as calculated at (4.20)
The first term of the right hand side of the equation measures the appreciation in physical volume due to growth of total timber holdings for each firm\(^{(17)}\). U.S. timber acres owned \((A)\) is the total acres for the sample firms, and includes acreage controlled under cutting contracts in the U.S. This information was obtained from company annual reports and from Moody's Industrial Manual and then summed for all companies. For any missing observations, the values were assumed to be represented by a linear change between observed beginning and end points.

\(\text{ANN\text{NGRO}}\) was calculated on a firm specific basis and then averaged for the sample firms based upon proportionate acreage ownership. This procedure was used in an attempt to minimize aggregation bias in the measurement process. This bias could be pronounced because different firms own various species of timber in differing proportions. The different species have markedly different rates of growth. The growth rate by species was assumed to be approximated by the growth rates in cubic feet of timber in particular geographical regions. This information was available in 1974 U.S. Forest Service statistics. The growth rate per firm was then calculated as a weighted average of the growth rates by region. The weights were based upon the proportion of acreage owned in each region. Ownership
proportions were per each firm's 1981 annual report. Thus, the calculation of (ANNGRO) assumes that the proportion of species ownership in 1981 and the growth rates based on 1970 information are constant for the sample period. The resulting calculation was a constant 51.5 cubic feet/acre per year. Since stumpage prices are stated $/MBF (MBF = thousand board feet), the results in cubic feet were then adjusted to a MBF scale.

Once the total amount of timber appreciation has been calculated (A*ANNNGRO), the remaining step in calculating (TA) is to transform the appreciation from a physical scale to a monetary one. This is performed by multiplying the total physical growth, in MBF, by the price of the timber. Timber prices are represented by the average of beginning and ending weighted average stumpage prices ($). ($) is determined by averaging the weighted average stumpage prices scale constructed for each firm ($ at 4.13), or:

\[ P_s = \frac{\sum_{k=1}^{N} P_{sk}}{N} \]  

ii) Timber income adjustment (.DJTI)-price changes (CHTP)

(TA) represents the change in volume times price. (CHTP) is calculated as the change in price times volume. These two terms separate the total change in value of timber holdings between appreciation due to growth and
changes due to price differentials. The \((\text{CHTP})\) income is given as:

\[
\text{CHTP} = \dot{P}_s \times ST \quad (4.21)
\]

where

\[
\dot{P}_s = \text{annual change in stumpage prices } ((P_s) \text{ as previously calculated at (4.20))}
\]

\[
ST = \text{volume of timber owned in MBF per (4.22)(ST) was not available for specific firms, so aggregate estimates were used. (ST) was represented as:}
\]

\[
ST = (A/67.3) \times 1167.6 \quad (4.22)
\]

Total acreage for the sample firms \((A)\) was previously determined at (4.19). The 67.3 constant is the total U.S. acreage owned by all firms in the forest industry according to 1974 U.S. Forest Service data. These statistics also provided the constant 1167.6, which represents the forest industry's share of the inventory of the growing stock (converted to MBF) in the U.S. The 1970 amount of forest industry acreage and the inventory of growing stock is assumed constant for the sample period. Thus, the total of the sample firms' stock of timber in physical units is assumed to be proportional to the total industry stock depending on the ratio of acreage owned to total forest products industry acreage.
The combination of (TA) and (CHTP) represents what might be considered as annual economic income provided by the timber investment. As previously noted, timber income is recognized in conventional (EPS) when the timber is cut. Accordingly, any adjustment must remove the realized timber income element if (EPS) plus (TA+CHTP) (on a per share basis) is to approximate economic income.

iii) Timber income adjustment (ADJTI)-realized income (RETI)

Financial information for firms did not indicate the amount of timber income realized (RETI), but this can be estimated based upon the tax savings provided by the I.R.C. section 631 (a) election. (See Appendix A for an example of how tax is calculated under this method). The percentage reduction in the statutory tax rates due to the savings provided by capital gains taxation is provided in the footnotes of a firm's financial statements. Since the capital gains tax is based upon the value of timber when cut, the estimated value of income realized when the timber is cut can be derived for the (k) firm by the following (18):

\[
\text{RETI}_k = \text{DL} + \left[ \left( \text{TE} / \left(100u''\right) \right) \times \left( 100 \text{CG} / (u-\text{AT}) \right) \right]
\]

(4.23)

where

DL = depletion deduction, based on cost

TE = tax expense
\( cg = \text{percentage reduction in statutory tax rate due to capital gains tax} \)
\( u = \text{statutory tax rate, as a percentage} \)
\( u'' = \text{effective tax rate based on conventional accounting income, as a percentage} \)
\( AT = \text{alternative tax rate, as a percentage} \)
\( 100 = \text{a constant to scale amounts to a percentage scale} \)

\((DL), \ (TE), \ (cg) \) and \((u'')\) were from firms' financial statements. Where \((u'')\) observations were missing, it was assumed \((u'') = (u)\). Missing \((cg)\) observations were estimated based on either production information in the reports, or were assumed to represent a linear extrapolation of observed values of \((cg)\). \((A)\) and \((u)\) were provided by the Internal Revenue Code.

iv) Timber income adjustment \((ADJTI)\)-summary

Once \((TA), \ (CHTP)\) and \((RETI)\) had been calculated, \((ADJTI)\) was determined per (4.18). \((ADJTI)\) was then scaled to a per share basis (number of shares outstanding for each firm was obtained from Value Line Investor's Service) and the result combined with the per share inflation adjustment to arrive at an adjusted \((EPS)\) that more closely approximates an economic income concept for the timber case. This adjusted \((EPS)\) divided by stock price then provided the
cost of equity adjusted for unrealized timber income ($e_A$) for use in calculating ($r_A$).

b) User cost of capital—the appreciation rate ($d'$)

Since timber is an appreciating asset, an appreciation rate ($d'$) was used in the calculation of ($c'_f$). ($d'$) represents a percentage rate of growth in the value of the capital stock or standing timber per year. The rate used was .036 and was assumed constant for the sample period. The rate was calculated as a weighted average of growth rates by region. The information was provided by 1974 U.S. Forest Service statistics.

c) User cost of capital—the tax variable

The investment credit ($k$) is not available for timber investment(19). No depreciation deduction ($z$) is available since timber is an appreciating asset. This annual appreciation in value is not taxed until the timber is cut, thus no adjustment for an appreciating value of ($z$) is necessary. The tax variable, ($u$), is reduced by ($cg$) (the percentage reduction in the statutory rate due to the capital gains provision for timber), since the benefit of the capital gain tax provision reduces the effective tax rate on timber income. ($cg$) was obtained in the same manner previously discussed in the (RETI) section, then averaged for the sample firms.
After the previous adjustments are made, the user cost of timber capital was estimated per (4.16) and the relative price term \( (V_f) \) calculated using alternative measures of \( (r) \).

The data resulting from the previous estimations provide the sample information and data base necessary for applying the various models. The results of the model application are presented in the following chapters.
FOOTNOTES

1. Examples of investment demand studies using annual observations would be Borneuf (1964), Grunfeld (1960), Hickman (1965), Jorgenson and Siebert (1968), and Kuh (1963).

2. The investment demand literature indicates a wide range of lag periods for investment expenditures, from approximately two years (Hickman, 1965 for paper industry) to four years (Kuh, 1963 for sixty manufacturing firms).

3. An exception is statistical information classified by form of ownership of timberland published by the U.S. Forest Service.


5. As previously noted, Bischoff's specification of the investment demand function does not use lagged values of actual capital stock in the equation. He noted (1971b, p. 93, footnote 55) that inclusion of a capital stock term added nothing to the explanatory power of the equation. Preliminary estimates of the model in this study yielded the same result; i.e., inclusions of a capital stock variable did not substantially improve the results.

6. The financial statements of individual firms were often restated to reflect changes in accounting policies or changes in ownership structure. Accordingly, the most recent financial summaries and statements were used, and any necessary adjustments made so that the information would be as comparative as possible during the sample period. An example would be Champion International. This company resulted from the merger of U.S. Plywood Corp. and Champion Papers, Inc. The financial information for both companies for 1967 (pre-merger) was combined so that the 1967 data would be comparable with other years.


8. In the original Bischoff (1971b) specification, a technical change parameter (h) was introduced to represent equipment-augmenting technological change. An assumption
was arbitrarily made that the change was represented by a smooth time trend, and he noted that the estimated coefficients associated with the parameter should not be interpreted as a technical change parameter, but as an offset to trends in other variables. Rather than make this arbitrary assumption, an equally arbitrary but simplifying assumption that h=0 is made (h=0 implies that all technical change is other-factor augmenting). Such a simplifying assumption was also made by Bischoff in another study (1971a).

9. Studies indicating a price elasticity of factor demand close to unity are provided by Bischoff (1971b), Ando et al (1974), various studies noted in Jorgenson (1979), and Feldstein (1980).

10. Results of Bischoff (1971b), Gordon and Jorgenson (1976) and Gravelle (1982) were used for estimating the effective rates of (k).

11. STKP was year-end prices except for early years when the data was not available. In those cases, the average of the annual high and low STKP as provided by Moody's was used.

12. Such texts as Hendriksen (1982) or Davidson, Stickney and Weil (1982) provide excellent discussions of the limitations of the historical cost concept in accounting reports.

13. The method used to value inventory can also affect the measurement of income during inflationary periods. As previously noted, the use of LIFO by most firms mitigates this effect.

14. For assets placed in service in 1981, the Accelerated Cost Recovery System allowed an even more rapid write-off of asset costs. Most of the equipment purchased by the sample firms would have qualified for a 5 year tax life instead of the 10 used for this study. Adjustment was not made in this study for the use of this system in 1981 because:

a) The law was not passed until August, 1981 and due to much uncertainty surrounding the bill, it is doubtful that the announcement effect was pronounced or that significant anticipatory spending occurred in 1981 in response to the bill; and

b) Since the method employs a 1/2 year convention and 150% declining balance method of depreciation, the resulting present value does not seem to be
significantly different from that calculated by SYD.

15. It should be noted that this choice is not available until trees reach a merchantable age. Thereafter, the decision of when to cut the timber becomes an optimizing problem. The consensus of most theorists is that the timber is cut when the marginal increase in value (marginal revenue) equals the marginal cost of holding the timber one more period (marginal cost). Thus, the annual increase in value can be conceptually equated as a measure of income.

16. An argument might be presented that for a firm practicing sustained yield forestry, where the volume cut equals the volume grown, there would be no ADJTI because the timber income (from growth) approximately equals the realized income (from cutting). However, this argument fails to consider the economic importance of the cutting decision. As previously noted (footnote 15), optimal cutting occurs when MR = MC. Thus, cutting will not occur as long as MR > MC, implying that expected growth in timber value for the uncut trees is exceeding the value of the trees that are cut (realized).

17. The physical growth is assumed to be net of disease, fire and other losses. The growth information provided by U.S. Forest Service statistics are also net of such losses.

18. The fair market values employed in assigning the value of timber cut is the value at the beginning of the tax year, thus timber cut late in the year may be using dated prices. The overall effect, however, of this timing difference appears to be minimal.

19. An investment credit and amortization provision directed toward small timberowners are available for timber on a limited basis. The limit on the amount of qualified investment is $10,000, thus of little importance to the firms in this study.
CHAPTER FIVE
DISCUSSION AND INTERPRETATION
OF RESULTS

This chapter will present the results of the application of the previously developed model to investment expenditures in each asset category. The initial results reported will be those of the preliminary exploration of the parameter space which defined certain structural attributes of the model. The assumptions employed in the model will then be evaluated in an attempt to determine the sensitivity of the model and the stability of the coefficients. The third section presents the statistical results of the final model. The final sections will estimate the effective tax rates of specific assets and the industry. Conclusions as to the implications of these results for the specific research issues presented in Chapter One will be discussed in the following chapter.

I. Preliminary Exploration of the Parameter Space for Determining the Structural Form of the Modified GSNIM

This section discusses the preliminary exploration of the parameter space that was conducted to estimate or determine certain characteristics of the model. First, experiments were conducted to obtain the estimating equation for
each category of investment. Then, the most appropriate lag patterns of investment \( I \), relative prices \( V \), and output \( Q \) were selected for each asset category. An evaluation was also made to consider the effect of additional determinants to, or alternative specifications of, the modified model. Thus, this section will provide the structure and form of the estimating equations derived from the modified GSNIM that will be used in subsequent sections.

A. Estimating Equations

The modified GSNIM was given at (3.8) as:

\[
I_t = \sum_{i=1}^{n} b_i V_{t-i} Q_{t-i}
\]

where

- \( t = \) time period

The formulations (3.91) through (3.95) indicated the variety of estimating equations derived from the GSNIM. Based upon this variation and upon previous studies in the literature, no a priori reason suggested that the estimating equations for the different categories of investment should be the same. Accordingly, initial experiments were conducted to determine the specification of \( V \) and \( Q \) that most closely approximated the relationship of the variables in the model. The criteria for selection of the "best" estimating equation was "goodness-of-fit" represented by the highest \( R^2 \) (adjusted for degrees of freedom), and minimi-
zation of the standard error of the estimate (SEE). In addition, an (F) statistic was calculated to determine if the (V) and (Q) values should enter separately or multiplicatively. The null hypothesis was that allowing (V) and (Q) to enter separately would not significantly improve the explanatory power of the model.

Using the previously described selection criteria and (F) test results, the following estimating equations were obtained:

\[
\text{Equipment: } I_e = \sum_{i=1}^{N} b_i V_{t-i} Q_{t-i} \tag{5.1}
\]

\[
\text{Structures: } I_s = \sum_{i=1}^{N} b_i V_{t-i} + \sum_{j=1}^{N} b_j Q_{t-j} \tag{5.2}
\]

\[
\text{Timber: } I_t = \sum_{i=1}^{N} b_i V_{t-i} Q_t \tag{5.3}
\]

As indicated above, the manner in which the relative price (V) and output (Q) terms are stated in the model differ for structures when compared with timber and equipment. The null hypothesis of no significant improvement in explanatory power was rejected in the case of structures, allowing (V) and (Q) to enter separately.\(^{(1)}\) The resulting relationships are not inconsistent with the neoclassical investment theory, and accordingly, were used to estimate the lag structures of the variables.

B. Time Structure of Investment Expenditures

The neoclassical theory of investment specifies that net investment induced by some relevant determinant or
change will occur over a series of time periods, thus a lag structure of the investment process must be estimated. The estimating equation in the form of a distributed lag, employing the Almon technique for assigning polynomial weights to each period, was used to estimate the lag pattern of investment expenditures. Trials were conducted using various numbers of lag periods (one year in length) and differing degrees for the polynomials. The results for each category of investment are presented at Table 5-1. Using the highest $R^2$ and the lowest standard error of the estimate as criteria for the selection, the following were considered as providing the "best fitting" estimates of the time pattern of investment expenditures:

- **Equipment:** Number of lagged periods = 3, order = 2.
- **Structures:** Number of lagged periods = 3, order = 2.
- **Timber:** Number of lagged periods = 5, order = 2.

C. Lag Specification of Relative Price and Output Variables

The consensus of most theorists, such as Eisner (1979), is that it is the expected values of the determinants of demand that influence investment. Due to measurement difficulties, however, most empirical studies use past values as proxies for expected future values. Accordingly, the same approach will be used in this study. Although it
### TABLE 5-1

Summary Statistics for Alternative Lag Specifications of Investment Expenditures

<table>
<thead>
<tr>
<th>Lag of I</th>
<th>Order</th>
<th>$\bar{R}^2$</th>
<th>$F$</th>
<th>SEE</th>
<th>$\rho$</th>
<th>D-W</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equipment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>2</td>
<td>7966</td>
<td>16.7</td>
<td>83.9</td>
<td>-.33</td>
</tr>
<tr>
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<td>4</td>
<td>2</td>
<td>8185</td>
<td>20.5</td>
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<td>-.09</td>
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<tr>
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<td>81.7</td>
<td>.05</td>
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<td>8182</td>
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<td>89.5</td>
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</tr>
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<td>1</td>
<td>8226</td>
<td>38.1</td>
<td>87.8</td>
<td>-.07</td>
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<td><strong>Structures</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>8578</td>
<td>13.1</td>
<td>5.6</td>
<td>-.66</td>
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<td></td>
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<td>8456</td>
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<td>5.8</td>
<td>-.34</td>
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<td>2</td>
<td>8275</td>
<td>12.2</td>
<td>6.4</td>
<td>.01</td>
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<td>4248</td>
<td>3.8</td>
<td>11.6</td>
<td>.02</td>
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<td><strong>Timber</strong></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
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<td>2181</td>
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<td>21.4</td>
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<tr>
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<td>2</td>
<td>5895</td>
<td>6.7</td>
<td>33.7</td>
<td>.15</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>2</td>
<td>8698</td>
<td>29.9</td>
<td>18.4</td>
<td>.04</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>2</td>
<td>1412</td>
<td>1.8</td>
<td>46.5</td>
<td>-.15</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>2</td>
<td>*</td>
<td>.7</td>
<td>49.9</td>
<td>.33</td>
</tr>
</tbody>
</table>

Lag periods represent one year

* $= \bar{R}^2 < .1$
might be argued that use of past information to predict future values would probably follow some form of a continuous weighted average of more than one year, for simplicity it will be assumed that expectations are based upon discrete, one year intervals. With the assumption that expected values of \( V \) and \( Q \) are determined based upon current and past annual interval values, estimates were made of the time variables \( (i) \) and \( (j) \). The results of the various trials for each category of investment are presented at Table 5-2.

Using "goodness-of-fit" and minimization of \( \text{SEE} \) as selection criteria, Table 5-2 indicates that a lag of 1 period for \( V \) and \( Q \) is the most appropriate for equipment and structures,\(^2\) however, use of \( (V_1Q_0) \) provides a slightly improved fit for timber. A lag of 0 represents sales up to one year, thus reaction time within the lag period is possible.

D. Comparison of Alternative Measures of the Rate of Return

The appropriate measure of the rate of return \( (r) \) is important in the calculation of the user cost of capital \( (c) \). As indicated in Chapter Four, various methods exist for calculating \( (r) \). Some studies calculate \( (r) \) as a
TABLE 5-2
Summary Statistics for Alternative Lag Specifications of Price and Output Variables

<table>
<thead>
<tr>
<th>Lag of (V)</th>
<th>Lag of (Q)</th>
<th>$R^2$</th>
<th>F</th>
<th>SEE</th>
<th>rho</th>
<th>D-W</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 0</td>
<td>0 0</td>
<td>0.7882</td>
<td>18.4</td>
<td>96.4</td>
<td>-0.11</td>
<td>2.03</td>
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<td>1 0</td>
<td>0 0</td>
<td>0.7760</td>
<td>17.2</td>
<td>99.2</td>
<td>0.05</td>
<td>1.80</td>
</tr>
<tr>
<td>1 1</td>
<td>0 0</td>
<td>0.8480</td>
<td>27.0</td>
<td>81.7</td>
<td>0.05</td>
<td>1.80</td>
</tr>
<tr>
<td>0 1</td>
<td>0 0</td>
<td>0.8293</td>
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<td>86.6</td>
<td>-0.20</td>
<td>2.25</td>
</tr>
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<td>0 0</td>
<td>0.7348</td>
<td>13.9</td>
<td>107.9</td>
<td>0.01</td>
<td>1.82</td>
</tr>
<tr>
<td>1 2</td>
<td>0 0</td>
<td>0.8245</td>
<td>22.9</td>
<td>87.8</td>
<td>-0.09</td>
<td>2.00</td>
</tr>
<tr>
<td>2 2</td>
<td>0 0</td>
<td>0.7486</td>
<td>14.9</td>
<td>105.1</td>
<td>-0.16</td>
<td>1.97</td>
</tr>
</tbody>
</table>

Equipment $I_e = \sum_{i,j} b_{i,j} V_{t-i} Q_{t-j}$

<table>
<thead>
<tr>
<th>Lag of (V)</th>
<th>Lag of (Q)</th>
<th>$R^2$</th>
<th>F</th>
<th>SEE</th>
<th>rho</th>
<th>D-W</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 0</td>
<td>0 0</td>
<td>0.8466</td>
<td>13.9</td>
<td>6.0</td>
<td>0.43</td>
<td>0.96</td>
</tr>
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<td>6.7</td>
<td>0.12</td>
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<tr>
<td>1 1</td>
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<td>0.8275</td>
<td>12.2</td>
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<td>1.93</td>
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<td>6.5</td>
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<td>1.84</td>
</tr>
<tr>
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</table>

Structures $I_s = \sum_{i} b_{i} V_{t-i} + \sum_{j} b_{j} Q_{t-j}$

TABLE 5-2 continued on next page
### TABLE 5-2 continued

<table>
<thead>
<tr>
<th>Lag of</th>
<th>( (V) )</th>
<th>( (Q) )</th>
<th>( R^2 )</th>
<th>( F )</th>
<th>( \text{SEE} )</th>
<th>( \rho )</th>
<th>( D-W )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timber</td>
<td>( I_f = \sum_{i=1}^{N} \beta_i V_{t-i}Q_t )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>*</td>
<td>.6</td>
<td>53.5</td>
<td>.04</td>
<td>1.91</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>.8698</td>
<td>29.9</td>
<td>18.4</td>
<td>.04</td>
<td>1.90</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>.8609</td>
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<td>.07</td>
<td>1.80</td>
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<td>1</td>
<td>*</td>
<td>.6</td>
<td>53.7</td>
<td>.05</td>
<td>1.90</td>
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<tr>
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<td>5.7</td>
<td>35.4</td>
<td>.13</td>
<td>1.67</td>
<td></td>
</tr>
</tbody>
</table>

Note: A lag of 0 periods = the current period

\( * = \bar{R}^2 < .1 \)
combination of internal and external finance costs. The
cost of internal finance is represented by the earnings of
the firm relative to the market price of its stock.
Measurement difficulties exist, however, for the earnings
used in the calculations. Accordingly, (r) was calculated
using alternative measures of earnings in the cost of inter-

nal finance. These measures are represented at Table 5-3
as (r_H), (r_I), and in the case of timber, (r_A). In
addition, (r) as represented by the cost of external
finance only (r_E) is also presented.

Using $R^2$ and minimization of (SEE) as selection
criteria, Table 5-3 indicates that the measurement of (r)
differed for each asset category. The discount rate for
evaluating equipment investment seems to be best represen-
ted by the cost of external finance only (r_E). The appro-

priate discount rate for structures, however, seems to be
(r_I), measured as a weighted average external and inter-

nal finance cost using inflation adjusted earnings. The
discount rate for timber investment (r_A) required even
further adjustment for the unrealized timber income in the
calculation of the earnings portion of the cost of internal
finance costs. As discussed in the previous chapter, the
use of differing estimates of (r) for different asset cate-
gories is not inconsistent with neoclassical investment
TABLE 5-3

Summary Statistics for Alternative Measures of Rate of Return

<table>
<thead>
<tr>
<th>Alternative Measure (r)</th>
<th>$R^2$</th>
<th>F</th>
<th>SEE</th>
<th>rho</th>
<th>D-W</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equipment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$r_H$</td>
<td>.6790</td>
<td>10.9</td>
<td>118.7</td>
<td>.33</td>
<td>1.26</td>
</tr>
<tr>
<td>$r_I$</td>
<td>.6775</td>
<td>10.8</td>
<td>119.0</td>
<td>.24</td>
<td>1.37</td>
</tr>
<tr>
<td>$r_E$</td>
<td>.8480</td>
<td>27.0</td>
<td>81.7</td>
<td>.05</td>
<td>1.80</td>
</tr>
<tr>
<td><strong>Structures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$r_H$</td>
<td>.5175</td>
<td>3.5</td>
<td>10.6</td>
<td>.15</td>
<td>1.65</td>
</tr>
<tr>
<td>$r_I$</td>
<td>.8275</td>
<td>12.2</td>
<td>6.4</td>
<td>.01</td>
<td>1.93</td>
</tr>
<tr>
<td>$r_E$</td>
<td>.6793</td>
<td>5.9</td>
<td>8.7</td>
<td>-.29</td>
<td>2.53</td>
</tr>
<tr>
<td><strong>Timber</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$r_H$</td>
<td>.1294</td>
<td>1.6</td>
<td>47.7</td>
<td>-.20</td>
<td>2.38</td>
</tr>
<tr>
<td>$r_I$</td>
<td>*</td>
<td>1.1</td>
<td>50.4</td>
<td>.17</td>
<td>1.60</td>
</tr>
<tr>
<td>$r_A$</td>
<td>.8698</td>
<td>29.9</td>
<td>18.4</td>
<td>.04</td>
<td>1.90</td>
</tr>
<tr>
<td>$r_E$</td>
<td>*</td>
<td>.9</td>
<td>51.5</td>
<td>.09</td>
<td>1.79</td>
</tr>
</tbody>
</table>

$r_H$: measure of (r) using a historical cost accounting estimate of (e) at (4.7)
$r_I$: $r_H$ plus the inflation adjustment for (e) as specified at (4.9)
$r_A$: $r_I$ plus the timber income adjustment for (e) per (4.18)
$r_E$: measure of (r) as represented by real long-term interest rates only per (4.8)
*: $R^2 < .1$

- 141 -
theory, but merely recognizes the measurement difficulties encountered.

E. Alternative Specification of the Modified GSNIM

It was previously noted that the variable \((K_{t-1, j})\), the existing level of capital stock of the \((j)\) asset at the beginning of the period, was not used in the estimating equations. (See Chapter Three's discussion of Bischoff's argument that inclusion of the capital stock variable in the GSNIM is a redundant term). Table 5-4 presents comparative summary statistics of the results of the modified GSNIM and the modified GSNIM with the capital stock term, \((K_{t-1})\), included. The variable \((K_{t-1, j})\) was represented by the sum of amounts reported in the sample firms' financial statements, then restated in 1967 dollars by use of the appropriate implicit price deflator \((q_j)\). In the case of timber, an alternative measure of \((K_{t-1})\) was used, \((USFS)\). \((USFS)\) represents the volume of timber allowed to be cut on U.S. Forest Service managed land. This measure was included because it could be argued that the competitive firm internalizes a share of the Forest Service timber supply available for cutting and treats it as a potential form of capital stock to which it has access.

- 142 -
| TABLE 5-4 |
| Summary Statistics for Alternative Specification of Modified GSNIM Model |

<table>
<thead>
<tr>
<th>&quot;t&quot; value for added variable</th>
<th>$R^2$</th>
<th>F</th>
<th>SEE</th>
<th>rho</th>
<th>D-W</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equipment</strong> $I_e = \sum b_{i,t}V_{t-i}Q_{t-i}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modified GSNIM</td>
<td>N/A</td>
<td>.8480</td>
<td>27.0</td>
<td>81.7</td>
<td>.05</td>
</tr>
<tr>
<td>Adding $(K_{t-i,e})$</td>
<td>1.07</td>
<td>.8498</td>
<td>20.8</td>
<td>81.2</td>
<td>-.24</td>
</tr>
</tbody>
</table>

| **Structures** $I_s = \sum b_{i,t}V_{t-i} + \sum b_{j,t}Q_{t-j}$ |       |    |     |     |     |
| Modified GSNIM               | N/A   | .8275 | 12.2 | 6.4  | .01 | 1.93 |
| Adding $(K_{t-l,s})$         | 1.19  | .8360 | 11.2 | 6.2  | -.35 | 2.69 |

| **Timber** $I_f = \sum b_{i,t}V_{t-i}Q_t$ |       |    |     |     |     |
| Modified GSNIM               | N/A   | .8698 | 29.9 | 18.4 | .04 | 1.90 |
| Adding $(K_{t-l,f})$         | .36   | .8573 | 20.5 | 19.3 | .03 | 1.90 |
| Adding (USFS)                | .47   | .8584 | 20.7 | 19.2 | -.02 | 1.98 |
Inclusion of the additional explanatory variables improved the "goodness-of-fit" and reduced the (SEE) for some assets, however, the capital stock terms do not appear significant in any of the equations (see "t" scores). These results are consistent with Bischoff's (1971b) findings (p.93). Accordingly, inclusion of the capital stock variable does not appear warranted in this case.

This section has addressed various issues of the characteristics and structure of the modified GSNIM. The lag pattern of (I), (V) and (Q) were determined, and the appropriate methods of measuring the discount rate were selected. The role of certain additional explanatory variables was evaluated and found not to be significant. The results of these trials indicate that investment occurs via a distributed lag pattern over a period of years, and is based on either current or past values of (V) and (Q). Also, the modified version of GSNIM with inflationary expectations in (r) appears to capture the relationship of investment demand and the relative price and output variables.

II. Evaluation of Assumptions

The prior sections discussed the determination of the structural form of the model. The purpose of this section is to evaluate certain assumptions employed in estimating
the resulting model, and to determine the sensitivity of the model's results to their use. The suppositions to be reviewed concern the measurement technique for inflation expectations and the unitary price elasticity assumptions.

A. Alternative Estimates of Inflation

The appropriate adjustment for inflation expectations was discussed in prior chapters. The measure of inflation expectations employed in estimating the model was assumed to be a ten year moving average of past rates of price changes in the CPI-U. An argument could be made that due to the high rates of inflation experienced during the sample period, inflation expectations would be formed by more recent rates. To evaluate the stability of the coefficients to the method of measuring inflation expectations, an alternative method was developed and the model re-estimated. The alternative method arbitrarily assumed that inflation expectations were based on a 4 year weighted average of past rates of inflation. The weights selected were declining rates of .4, .3, .2 and .1 for the respective preceding years. Table 5-5 presents the summary statistics that were obtained when the model used the assumed 10 year moving average, and when it was re-estimated using a 4 year weighted average.
### TABLE 5-5
Summary Statistics of Alternative Estimates of Inflation

<table>
<thead>
<tr>
<th></th>
<th>$R^2$</th>
<th>$F$</th>
<th>SEE</th>
<th>rho</th>
<th>D-W</th>
<th>$\Sigma b$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equipment</strong> $I_e = \sum_{i=1}^{n} b_i V_{t-i} Q_{t-i}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 year</td>
<td>.8480</td>
<td>27.0</td>
<td>81.7</td>
<td>.05</td>
<td>1.80</td>
<td>.0074</td>
</tr>
<tr>
<td>4 year</td>
<td>.7884</td>
<td>18.4</td>
<td>96.4</td>
<td>-.07</td>
<td>2.00</td>
<td>.0067</td>
</tr>
<tr>
<td><strong>Structures</strong> $I_s = \sum_{i=1}^{n} b_i V_{t-i} + \sum_{j=1}^{m} b_j Q_{t-j}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 year</td>
<td>.8275</td>
<td>12.2</td>
<td>6.4</td>
<td>.01</td>
<td>1.93</td>
<td>1.90(V)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.013(Q)</td>
</tr>
<tr>
<td>4 year</td>
<td>.7441</td>
<td>7.8</td>
<td>7.7</td>
<td>.31</td>
<td>1.31</td>
<td>1.89(V)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.010(Q)</td>
</tr>
<tr>
<td><strong>Timber</strong> $I_f = \sum_{i=1}^{n} b_i V_{t-i} Q_{t}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 year</td>
<td>.8698</td>
<td>29.9</td>
<td>18.4</td>
<td>.04</td>
<td>1.90</td>
<td>.0017</td>
</tr>
<tr>
<td>4 year</td>
<td>.8240</td>
<td>21.3</td>
<td>21.4</td>
<td>.20</td>
<td>1.57</td>
<td>.0015</td>
</tr>
</tbody>
</table>

10 year = 10 year moving average
4 year = 4 year weighted average
The summary statistics indicate that the 10 year moving average provides a better "fit" and lower (SEE) for all asset categories. The total effect reflected in \( \sum b_{ii} \) does not appear to be significantly different between the two measures. Since the difference in the total impact on investment is small and since the alternative model's summary statistics do not provide a substantial improvement, the original model's 10 year moving average method will be used.

B. Unitary Price Elasticity (a) Assumption

The issue of the unitary price elasticity assumption has been controversial, even with the (CES) function employed in the GSNIM. Accordingly, trial estimates of the modified model were made relaxing the assumption that the price elasticity of demand = 1. The range of the estimates was from .2 to 2.0. The model was estimated for each asset category by assigning the alternative elasticities to both the (p) and (c) variables that comprise (V). The results of the trials, including the trial with the unitary elasticity assumption, are presented in Table 5-6.

The results for timber investment indicate that the elasticities tend to converge around a value between 1.0 and 1.25. Although one might argue that the elasticity exceeds 1.0, the resulting improvement in the model's
TABLE 5-6

Summary Statistics of
Alternative Price Elasticity Estimates

<table>
<thead>
<tr>
<th>Elasticity Value</th>
<th>$R^2$</th>
<th>F</th>
<th>SEE</th>
<th>rho</th>
<th>D-W</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equipment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.2</td>
<td>.8528</td>
<td>28.0</td>
<td>80.4</td>
<td>-.30</td>
<td>2.17</td>
</tr>
<tr>
<td>.5</td>
<td>.8677</td>
<td>31.6</td>
<td>76.2</td>
<td>-.19</td>
<td>2.15</td>
</tr>
<tr>
<td>.8</td>
<td>.8559</td>
<td>28.7</td>
<td>79.5</td>
<td>-.03</td>
<td>1.92</td>
</tr>
<tr>
<td>1.0</td>
<td>.8480</td>
<td>27.0</td>
<td>81.7</td>
<td>.05</td>
<td>1.80</td>
</tr>
<tr>
<td>1.25</td>
<td>.8401</td>
<td>25.5</td>
<td>83.8</td>
<td>.11</td>
<td>1.67</td>
</tr>
<tr>
<td>1.5</td>
<td>.8344</td>
<td>24.5</td>
<td>85.3</td>
<td>.16</td>
<td>1.59</td>
</tr>
<tr>
<td>2.0</td>
<td>.8275</td>
<td>23.4</td>
<td>87.0</td>
<td>.21</td>
<td>1.47</td>
</tr>
<tr>
<td><strong>Structures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.2</td>
<td>.7805</td>
<td>9.3</td>
<td>7.2</td>
<td>.04</td>
<td>1.88</td>
</tr>
<tr>
<td>.5</td>
<td>.7996</td>
<td>10.3</td>
<td>6.8</td>
<td>.03</td>
<td>1.89</td>
</tr>
<tr>
<td>.8</td>
<td>.8170</td>
<td>11.4</td>
<td>6.5</td>
<td>.02</td>
<td>1.91</td>
</tr>
<tr>
<td>1.0</td>
<td>.8275</td>
<td>12.2</td>
<td>6.4</td>
<td>.01</td>
<td>1.93</td>
</tr>
<tr>
<td>1.25</td>
<td>.8394</td>
<td>13.2</td>
<td>6.1</td>
<td>-.01</td>
<td>1.96</td>
</tr>
<tr>
<td>1.5</td>
<td>.8499</td>
<td>14.2</td>
<td>5.9</td>
<td>-.03</td>
<td>1.99</td>
</tr>
<tr>
<td>2.0</td>
<td>.8664</td>
<td>16.1</td>
<td>5.6</td>
<td>-.08</td>
<td>2.07</td>
</tr>
</tbody>
</table>

*TABLE 5-6 continued on next page*
<table>
<thead>
<tr>
<th>Elasticity Value</th>
<th>$\frac{R^2}{n}$</th>
<th>F</th>
<th>SEE</th>
<th>rho</th>
<th>D-W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timber $I_f = \sum b_{i,t} V_{t-i} \Delta Q_t$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.2</td>
<td>.0588</td>
<td>1.3</td>
<td>49.6</td>
<td>.31</td>
<td>1.35</td>
</tr>
<tr>
<td>.5</td>
<td>.6902</td>
<td>10.7</td>
<td>28.4</td>
<td>.15</td>
<td>1.63</td>
</tr>
<tr>
<td>.8</td>
<td>.8333</td>
<td>22.7</td>
<td>20.9</td>
<td>.07</td>
<td>1.82</td>
</tr>
<tr>
<td>1.0</td>
<td>.8698</td>
<td>29.9</td>
<td>18.4</td>
<td>.04</td>
<td>1.90</td>
</tr>
<tr>
<td>1.25</td>
<td>.8670</td>
<td>29.2</td>
<td>18.7</td>
<td>-.24</td>
<td>2.47</td>
</tr>
<tr>
<td>1.5</td>
<td>.8605</td>
<td>27.7</td>
<td>19.1</td>
<td>-.31</td>
<td>2.62</td>
</tr>
<tr>
<td>2.0</td>
<td>.8505</td>
<td>25.7</td>
<td>19.8</td>
<td>-.41</td>
<td>2.82</td>
</tr>
</tbody>
</table>
statistics does not appear significant. This outcome is similar to that of Bischoff (1971b) and Feldstein (1980). Since use of an alternative elasticity would produce little improvement, the original assumptions will be maintained for timber investment.

The results, however, for equipment and structures investment presented at Table 5-6 do not tend to support the unitary price elasticity assumption. The elasticities providing the "best fit" and minimum (SEE) were .5 and 2.0 for equipment and structures, respectively. A non-unitary price elasticity differing across asset types is consistent with other studies employing a neoclassical formulation, such as Bischoff (1971a). Subsequent sections discussing the results of the model estimations and policy simulations will present the results from employing both unitary and other than unitary price elasticity assumptions.

III. Model Results

This section will discuss the results of the modified GSNIM. The model was applied to the data for each investment category by the ordinary least squares (OLS) method, and employed those parameters discussed in the previous sections.
A. Equipment

The results are presented at Table 5-7 for the unitary price elasticity model and at Table 5-8 for the model with the unitary price elasticity assumption relaxed. In either model, the (F) score is significant which allows rejection of the null hypothesis:

\[ H_0: \text{relative prices (V) and output (Q) have no effect on (I_e)} \]

The (t) scores for each regressor are significant (at the 10% level) except for the second lag period. The significance of the coefficients allows rejection of the null hypothesis that the value of the regressor equals zero. The signs of the coefficients are positive as theoretically predicted except for \((b_3)\). The negative sign of \((b_3)\) is difficult to interpret and not consistent with the neoclassical theory. No attempts were made, however, to constrain \((b_3)\) to be non-negative and re-estimate the equation.

Having established the statistical significance of the (VQ) variables, the predictive ability of the model can be evaluated. Graph 5-1 provides a comparison of the observed values of \((I_e)\) and the values predicted by the unitary elasticity model and the non-unitary elasticity model. The
TABLE 5-7

Model Results - Unitary Elasticity Assumption
("t" statistics in parenthesis)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>( I_e = 111.5 + 0.0044V_0 + 0.0070V_1 + 0.0031V_2 + 0.0071V_3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( (1.50) (2.04) (3.09) (1.73) (-2.09) )</td>
</tr>
<tr>
<td></td>
<td>( R^2 = 0.8480 )</td>
</tr>
<tr>
<td></td>
<td>( D-W = 1.80 )</td>
</tr>
<tr>
<td></td>
<td>( SEE = 81.7 )</td>
</tr>
<tr>
<td></td>
<td>( \rho = 0.05 )</td>
</tr>
<tr>
<td></td>
<td>( F(3,11) = 27.0 )</td>
</tr>
<tr>
<td></td>
<td>( \sum b_{ii} = 0.0074 )</td>
</tr>
<tr>
<td></td>
<td>Critical ( F(3,11) ): 5% level of significance = 3.59</td>
</tr>
<tr>
<td></td>
<td>Critical ( t(11) ): 10% level of significance = 1.79</td>
</tr>
<tr>
<td></td>
<td>(based upon a two-tailed test)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Structures</th>
<th>( I_s = -60.6 - 1.33V_0 - 0.07V_1 + 1.11V_2 + 2.2V_3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( (-1.61) (-1.97) (-1.12) (2.09) (2.73) )</td>
</tr>
<tr>
<td></td>
<td>( + 0.03V_0 + 0.0007V_1 + 0.01V_2 - 0.007V_3 )</td>
</tr>
<tr>
<td></td>
<td>( (3.87) (1.16) (-2.52) (-1.05) )</td>
</tr>
<tr>
<td></td>
<td>( R^2 = 0.8275 )</td>
</tr>
<tr>
<td></td>
<td>( D-W = 1.93 )</td>
</tr>
<tr>
<td></td>
<td>( SEE = 6.4 )</td>
</tr>
<tr>
<td></td>
<td>( \rho = 0.01 )</td>
</tr>
<tr>
<td></td>
<td>( F(6,8) = 12.2 )</td>
</tr>
<tr>
<td></td>
<td>( \sum b_{ii} = 1.90 )</td>
</tr>
<tr>
<td></td>
<td>( \sum b_{jj} = 0.013 )</td>
</tr>
<tr>
<td></td>
<td>Critical ( F(6,9) ): 5% level of significance = 3.58</td>
</tr>
<tr>
<td></td>
<td>Critical ( t(8) ): 10% level of significance = 1.86</td>
</tr>
<tr>
<td></td>
<td>(based upon a two-tailed test)</td>
</tr>
</tbody>
</table>

TABLE 5-7 continued on next page
TABLE 5-7 continued

Timber

\[ I_f = 53.9 + 0.00052V_0Q_0 + 0.00028V_1Q_1 + 0.00015V_2Q_2 \]

\( (5.91) \quad (3.22) \quad (2.35) \quad (1.60) \)

\[ + 0.00012V_3Q_3 + 0.00020V_4Q_4 + 0.00039V_5Q_5 \]

\( (1.79) \quad (4.95) \quad (8.70) \)

\[ R^2 = .8698 \quad D-W = 1.90 \]

\[ \text{SEE} = 18.4 \quad \rho = .04 \]

\[ F(3,10) = 29.9 \quad \sum b_{ii} = .0017 \]

Critical \( F(3,10): 5\% \text{ level of significance} = 3.71 \)

Critical \( t(10): 10\% \text{ level of significance} = 1.81 \)

(based upon a two-tailed test)
TABLE 5-8  
Model Results - Relaxing  
Unitary Price Elasticity Assumption  
for Equipment and Structures  
("t" statistics in parenthesis)

<table>
<thead>
<tr>
<th>Equipment</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$I = -161.4 + .021V_0Q_0 + .030V_1Q_1 + .013V_2Q_2 - .031V_3Q_3$</td>
<td></td>
</tr>
<tr>
<td>(-1.76) (2.24) (3.42) (1.71) (-2.37)</td>
<td></td>
</tr>
<tr>
<td>$\bar{R}^2 = .8677$</td>
<td>$D-W = 2.15$</td>
</tr>
<tr>
<td>SEE = 76.2</td>
<td>rho = -.19</td>
</tr>
<tr>
<td>F(3,11) = 31.6</td>
<td>$\sum b_{ii} = .033$</td>
</tr>
<tr>
<td>Critical F(3,11): 5% level of significance = 3.59</td>
<td></td>
</tr>
<tr>
<td>Critical t(11): 10% level of significance = 1.79</td>
<td>(based upon a two-tailed test)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Structures</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_s = -48.7 - .063V_0 + .0008V_1 + .053V_2 + .093V_3$</td>
<td></td>
</tr>
<tr>
<td>(-1.72) (-2.42) (.04) (2.54) (3.37)</td>
<td></td>
</tr>
<tr>
<td>+ .028Q_0 + .0008Q_1 - .01Q_2 - .006Q_3</td>
<td></td>
</tr>
<tr>
<td>(4.56) (.23) (-2.80) (-1.06)</td>
<td></td>
</tr>
<tr>
<td>$\bar{R}^2 = .8664$</td>
<td>$D-W = 2.07$</td>
</tr>
<tr>
<td>SEE = 6.0</td>
<td>rho = -.08</td>
</tr>
<tr>
<td>F(6,8) = 16.1</td>
<td>$\sum b_{ii} = .084$</td>
</tr>
<tr>
<td>$\sum b_{jj} = .012$</td>
<td></td>
</tr>
<tr>
<td>Critical F(6,8): 5% level of significance = 3.58</td>
<td></td>
</tr>
<tr>
<td>Critical t(8): 10% level of significance = 1.86</td>
<td>(based upon a two-tailed test)</td>
</tr>
</tbody>
</table>
GRAPH 5-1

COMPARISON OF OBSERVED
AND PREDICTED VALUES OF I_e

Millions of I_e

--- observed value
-- predicted value (unitary)
○ predicted value (nonunitary)

YEARS 19-
models predicted the values of \( (I_e) \) relatively well, considering the somewhat volatile nature of \( (I_e) \).

The interpretation of the results is the stage at which the difference in the relative price elasticity assumptions becomes accentuated. If the unitary price elasticity of demand assumed in many studies is correct, then a 1% change in \( (VQ) \) would generate \$.0074 \) million of investment in the current period and three succeeding years. However, if investment behavior is actually represented by \( (V)^{-5} \), a 1% change in \( (VQ) \) would generate \$.033 \) million of investment, or over 4 times as much as the unitary elasticity assumption. In both cases, the investment occurs as an initial burst, which increases and then declines, or the familiar "inverted j" pattern.

B. Structures

Tables 5-7 and 5-8 present the results of the unitary and alternative price elasticities models. In both estimations, the \( (F) \) scores are significant and allow rejection of the null hypothesis:

\[ H_0 = \text{relative prices} (V) \text{ and output} (Q) \text{ have no effect on} (I_s) \]

The \( (t) \) scores for each regressor are also significant (at the 10% level of significance) except for \( (V_1) \) and \( (Q_1) \) and \( (Q_3) \). Like \( (I_e) \), negative signs are associa-

- 156 -
ted with some coefficients and are difficult to interpret. The signs were not constrained to a non-negative condition. Graph 5-2 presents a comparison of the observed and predicted values of \( I_s \) using the differing price elasticity estimates.

The alternative specification of the relative price term as either a unitary value or \( V^2 \) is also significant for interpretation purposes. If the assumption of a unitary price elasticity of demand is appropriate, then a 1 unit change in \( V \) will increase \( I_s \) $1.9 million over the lag period, and a 1% change in \( Q \) will increase \( I_s \) $0.013 million. However, if \( V^2 \) is the correct specification, the impact of a 1 unit change in \( V \) is reduced to $0.084 million change in \( I_s \), while \( Q \) is approximately the same. Like \( I_e \), the correct specification of \( V \) appears crucial, particularly for analyzing the impact of various policy instruments.

In both cases, investment responds in the manner predicted by the "putty-clay" hypothesis when the price and output variables enter the equation separately. The response to \( V \) starts out rather sluggish and slowly increases. The response to \( Q \) is with the initial burst that later tapers off slowly.

- 157 -
GRAPH 5-2
COMPARISON OF OBSERVED
AND PREDICTED VALUES OF $I_s$

Millions of $I_s$

--- observed value
--- predicted value (unitary)
--- predicted value (nonunitary)

YEARS 19-
C. Timber

Referring to Table 5-7, the (F) score of 29.9 allows rejection of the null hypothesis:

\[ H_0 = \text{relative prices (V) and output (Q) have no effect on (I_f)}. \]

Except for the second and third lags, the (t) scores for each regressor are also significant (at the 10% level). The coefficients are of a positive sign as theoretically predicted by the modified model. Having established the statistical significance of the (VQ) variables, the predictive ability of the model can be evaluated. Graph 5-3 provides a comparison of the observed values of (I_f) and the values predicted by the model.

The model indicates that a one-time change of 1% in (VQ) will generate $0.0017 million of investment in timber over the current and five succeeding years. The investment will start as a burst in the current period, tapering off for the intermediate periods, then increasing in later periods as the firm fills the gap between actual and desired capital stock. Thus, the pattern of investment behavior would be "U" shaped with a mean lag of 2.3 years.

Alternatively, it could be viewed that (I_f) is a result of the current value of (VQ), plus a weighted portion of the values of (VQ) of the past five years. The
GRAPH 5-3
COMPARISON OF OBSERVED
AND PREDICTED VALUES OF $I_f$

Millions
of
$I_f$

--- observed value
--- predicted value (unitary)

(YEARS 19- )

- 160 -
GRAPH 5-3
COMPARISON OF OBSERVED
AND PREDICTED VALUES OF $I_f$

Millions
of
$I_f$

- - - - observed value
- - - - predicted value (unitary)

YEARS 19-81

- 160 -
heavier weights would be assigned to the most recent and most distant periods.

IV. Estimation of Effective Tax Rates

The model results and estimates of selected variables also provide information for calculating effective tax rates (ETR). Calculation of effective tax rates provides a means for comparing relative tax rates by asset categories and by industries. This type of comparison is useful for assessing the composition effect issue, the relative industry taxation issue and the effects of alternative taxation schemes. This section will provide a description of how the rates are calculated, and the results of those calculations by asset category and for the industry.

A. Estimating Procedure

The method of calculating the effective tax rates (ETR) for each asset category is similar to that employed by Gravelle (1982) and Sunley (1976b). The measure of (ETR) is derived from the neoclassical theory of measuring the cost of capital, and is given as:

\[ u' = \frac{(r' - r)}{r} \]

(5.4)

where

\[ u' \] = the estimated effective tax rate
\[ r' \] = real pretax rate of return, defined below
\[ r \] = real after-tax discount rate
and

\[ r' = \frac{(r+d)(1-uz-k)}{(l-u)} \] for equipment \hspace{1cm} (5.51) \]
\[ r' = \frac{(r+d)(1-uz)}{(l-u)} \] for structures \hspace{1cm} (5.52) \]
\[ r' = \frac{(r-d)/(l-(u-cg))}{d'} \] for timber \hspace{1cm} (5.53) \]

where all additional variables are as previously defined in Chapter Four.

Estimates of \((u')\) were made using two alternative measures of \((r)\). In the first case, \((r)\) was assumed to be the average \((r)\) for the sample period that was employed in the estimating equations at (5.1), (5.2) and (5.3). Those values were .12, .016 and .231 for equipment, structures and timber, respectively. The alternative measure of \((r)\) was assumed to be a constant .055 as was used by Gravelle (1982)(3). This measure was used so that comparisons between the two studies could be made. Using the alternative measures of \((r)\) and the relationship of (5.4) and (5.5j), \((u')\) was calculated with the following results.

B. Estimates by Asset Category

1. Current tax regime

The effective tax rates under the current tax regime are presented at Table 5-9. The current tax provisions reflected use of average values for the sample period of .476, .07 and .09 for \((u), (k)\) and \((cg)\), respectively.

- 162 -
TABLE 5-9
Estimates of Effective Tax Rates (ETRs)
By Asset Category: Alternative Tax Conditions

Estimates of (ETR) using (r) from estimating equations:

<table>
<thead>
<tr>
<th>Asset Category</th>
<th>Current Tax Regime</th>
<th>No ITC</th>
<th>1979 Rate Reductions</th>
<th>No cg</th>
<th>Tax Accrued Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment</td>
<td>.200</td>
<td>.627</td>
<td>.124</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>Structures</td>
<td>.633</td>
<td>NC</td>
<td>.613</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>Timber</td>
<td>.351</td>
<td>NC</td>
<td>.331</td>
<td>.438</td>
<td>.557</td>
</tr>
</tbody>
</table>

Estimates of (ETR) using an assumed value of (r) = .055:

<table>
<thead>
<tr>
<th>Asset Category</th>
<th>Current Tax Regime</th>
<th>No ITC</th>
<th>1979 Rate Reductions</th>
<th>No cg</th>
<th>Tax Accrued Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment</td>
<td>.267</td>
<td>.444</td>
<td>.238</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>Structures</td>
<td>.522</td>
<td>NC</td>
<td>.504</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>Timber</td>
<td>.179</td>
<td>NC</td>
<td>.169</td>
<td>.240</td>
<td>N/A</td>
</tr>
</tbody>
</table>

ITC = Investment tax credit - average of .07 for sample period

1979 rate reductions were from average of .476 to .460

cg = Reductions in tax rates attributable to capital gains- average of .09 for sample period

NC = No change
Values of \( (z) \) were averaged for the sample period and recalculated for the \((r) = .055\) case. Values for \((d)\) and \((d')\) were as given in previous sections.

The results are segregated for estimates using \((r)\) from the estimating equations and for the constant value case. The magnitude of the estimates change under the two methods, however the ranking of each asset by \((ETR)\) is invariant except in the case of timber. Using the constant \((r)\), the \((ETR)\) for timber becomes the lowest of the group.

2. Varying tax policies

The effective tax rates were recalculated under varying assumptions for tax policies. In a static manner, \((5.4)\) and \((5.5j)\) were altered for the tax policy in question, and \((u')\) recalculated. The tax policies of interest were the investment tax credit, the 1979 reduction in corporate tax rates, the capital gains provisions for timber income, and the accrued income tax for timber income. The results are presented at Table 5-9 using the alternative measures of \((r)\).

C. Estimates for the Industry

1. Current tax regime

Estimates of \((ETR)\) were also made for the forest products industry as represented by the sample firms. The estimate was based on a weighted average of \((ETRs)\) for each
asset category. The weights for the \( j \text{th} \) asset represented that asset's capital stock as a proportion of the total capital stock, averaged for the sample period. The weights for each asset category, and the results using the alternative measures of \((r)\) are presented at Table 5-10.

2. Varying tax policies

Table 5-10 also presents the results of estimates of \((\text{ETRs})\) for the industry under various assumptions for tax variables. The estimates, as previously determined, are weighted averages of the different asset categories, using the tax adjusted \((\text{ETRs})\).

V. Concluding Comments

This chapter has presented the results of estimating the modified GSNIM for each asset category and the estimates of effective tax rates for each asset and the industry. Some interpretations of the results were also made, but any concluding comments were intentionally deferred. The conclusions that can be made concerning the research issues based upon these results will be addressed in the following chapter.
<table>
<thead>
<tr>
<th>Tax Condition</th>
<th>(ETR) (2)</th>
<th>(ETR) (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current tax regime (1)</td>
<td>.261</td>
<td>.282</td>
</tr>
<tr>
<td>After 1979 rate reductions</td>
<td>.197</td>
<td>.256</td>
</tr>
<tr>
<td>Assuming no (ITC)</td>
<td>.592</td>
<td>.420</td>
</tr>
<tr>
<td>Realized income taxed at ordinary rates</td>
<td>.272</td>
<td>.289</td>
</tr>
<tr>
<td>Tax on accrued income at ordinary rates</td>
<td>.293</td>
<td>.335</td>
</tr>
</tbody>
</table>

(1) = The current tax regime is given as one that includes the (ITC), corporate tax rates and (cg) provisions. Values for these tax variables were averaged for the sample period.

(2) = (ETR) estimated average (r) from estimating equations.

(3) = (ETR) estimated using an assumed value of (r) = .055.

(ITC) = Investment tax credit.

Weights used for each asset:

- equipment: .78
- structures: .10
- timber: .12
- Total: 1.00
FOOTNOTES

1. The (F) statistic was calculated as:
   \[(\Delta RSS/V-1)/(ESS/N-V)\]
   where
   \(RSS\) = Regression sum of squares
   \(ESS\) = Residual sum of squares
   \(V\) = Number of explanatory variables
   \(N\) = Number of observations

   For a discussion of this approach, see Pindyck and Rubinfeld (1976). The resulting (F) statistics for \(I_e\), \(I_s\) and \(I_f\) were .2, 4.22 and 1.32, respectively. The critical (F) score at a 5% level of significance for \(I_s\) was 3.69 for F(5,8), thus allowing rejection of the null hypothesis that the alternative specification of \(V\) and \(Q\) entering separately did not significantly improve the explanatory power of the model.

2. In the case of structures, the decision criteria of highest \(R^2\) and lowest (SEE) was modified in determining the appropriate lag patterns for investment and the \(V\)(\(Q\)) variables. This modification was made because the other patterns appeared to be influenced to a higher degree by autocorrelation of the error terms. An (F) test similar to that in Footnote 1 indicated that using lag periods which strictly met the decision criteria, instead of those selected, did not significantly improve the model's explanatory power.

3. The constant rate of .055 more closely approximates the average \(r_g\) estimated in this study. However, as previously noted, \(r_H\) is a measure based upon historical cost accounting concepts.
CHAPTER SIX
CONCLUSIONS

The purpose of this study was to conduct an empirical analysis of the effects of taxation on investment expenditures and tax parity in the forest products industry. The results and underlying analytical framework could then be used to evaluate specific analytical and policy issues. The previous chapters have presented the work performed in the study, including the results indicated in Chapter Five. This chapter will initially provide some concluding comments on the contribution of the findings to the issues submitted in Chapter One. The subsequent section will address some of the more general questions or issues germane to the results and relate them to the existing literature. The chapter will conclude with a discussion of suggested directions for future research in the area.

I. Specific Analytical and Policy Issues

Chapter One presented five specific issues for purposes of this study: the investment demand issue, the neutrality effect issue and related issues of interindustry tax parity, alternative taxation methods, and the policy effectiveness of different tax incentives.
A. Investment Demand Issue

The investment demand issue addressed whether taxes affected investment decisions, and if so, what the expected magnitude of any such effects would be.

1. Significance of alternative tax variables

a) Initial test of price/output variables

The initial test in Chapter Five of the significance of the relative price \((V)\) and output \((Q)\) terms allowed rejection of the null hypothesis that these variables were not significant determinants of investment expenditures. This conclusion applied to all categories of investment expenditures. Although some lagged regressors were negative in sign, overall the results were consistent with the neoclassical theory: i.e., relative prices and output have a positive effect on investment expenditures. The findings support those neoclassical based studies which stress the role of relative prices and output in explaining long-run investment behavior (and capital/output ratios). However, this support is qualified by the smaller magnitudes of induced investment in some cases.

b) Test of the tax factors

The test for significance of the tax factors is an indirect test. Rejecting the null hypothesis of insignificant affects of \((V)\) and \((Q)\) provides the avenue for evalua-
ting tax effects. The tax variables enter \((V)\) in a theoretically constrained manner, and thus are subsumed in the test of \((V)\). If the indirect method of testing is accepted, then the results indicate that certain tax factors or features do tend to increase investment expenditures on a sustained basis. The results indicate that the degree to which a given tax will increase investment depends upon the mix of tax instruments used, and the specification of certain assumptions in the neoclassical model. Overall, however, it seems that the selected tax features are statistically significant, and have a measurable effect on investment expenditures by the selected firms during the sample period. Estimates of the magnitude of the tax effects provide evidence of the relative importance of different types of taxing methods, and also the affect of model specification of the results.

2. Estimates of the magnitude of tax effects

The results indicate that the modified GSNIM can account for a major portion of the variation in investment expenditures over the sample period. \((R^2)\), as a measure of explained variation was .848, .828 and .870 for equipment, structures and timber, respectively. By using the fitted equations (obtained through a separate estimation process) in tax simulations, direct estimates
can be made of the magnitude of the effects of different tax factors in the modified GSNIM. The method of estimation employed is consistent with the approach used by most partial equilibrium investment demand studies. The first step is to predict investment in a particular asset \( \hat{I}_j \) using the estimated coefficients of the model with the tax provisions in effect at a particular time. Then the tax variables in the cost of capital are varied, with all other parameters unchanged. \( \hat{I}_j \) is again predicted with the alternative tax variable, but using the coefficients of the model as originally estimated. This new magnitude can be labeled as tax-adjusted estimated investment, and is denoted as \( \hat{I}'_j \). The difference in \( \hat{I}_j \) and \( \hat{I}'_j \) represents the estimated magnitude of tax induced investment attributable to the tax variable with a notation of \( \Delta \hat{I}_j \). The results of these estimates are presented at Table 6-1.

a) Investment tax credit

The results suggest that the investment tax credit provisions stimulated investment expenditures in equipment to a statistically significant degree for the sample period. Table 6-1 indicates that the tax incentive accounted for over 9% of equipment investment and 7.8% of total investment in the sample period. The stimulative effect
TABLE 6-1

Estimates of Direct Effects of Alternative Tax Instruments on Investment Expenditures—
By Asset Category for the Sample Period 1967-1981

<table>
<thead>
<tr>
<th>Tax Variable</th>
<th>$\hat{i}_j$</th>
<th>$\hat{i}_j'$</th>
<th>$\Delta\hat{i}_j$ $/ \hat{i}_j$</th>
<th>$\Delta\hat{i}_j$/I_tot</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITC (k):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment - U</td>
<td>9853.2</td>
<td>8875.9</td>
<td>977.3</td>
<td>9.9</td>
</tr>
<tr>
<td>Equipment - NU</td>
<td>9853.2</td>
<td>9005.6</td>
<td>847.6</td>
<td>8.6</td>
</tr>
<tr>
<td>1979 Rate Reduction:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment - U</td>
<td>9853.2</td>
<td>9840.6</td>
<td>12.6</td>
<td>*</td>
</tr>
<tr>
<td>Equipment - NU</td>
<td>9853.2</td>
<td>9813.7</td>
<td>39.5</td>
<td>*</td>
</tr>
<tr>
<td>Structures - U</td>
<td>1156.6</td>
<td>1170.0</td>
<td>-13.4</td>
<td>1.1</td>
</tr>
<tr>
<td>Structures - NU</td>
<td>1156.6</td>
<td>1157.4</td>
<td>-0.8</td>
<td>*</td>
</tr>
<tr>
<td>Timber</td>
<td>1487.6</td>
<td>1492.9</td>
<td>-5.3</td>
<td>*</td>
</tr>
<tr>
<td>Capital Gains:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timber</td>
<td>1487.6</td>
<td>1391.5</td>
<td>96.1</td>
<td>6.5</td>
</tr>
<tr>
<td>Accrued Timber Income:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxed at STR</td>
<td>1487.6</td>
<td>1114.4</td>
<td>373.2</td>
<td>25.1</td>
</tr>
<tr>
<td>Taxed at ATR</td>
<td>1487.6</td>
<td>1223.5</td>
<td>264.1</td>
<td>18.1</td>
</tr>
</tbody>
</table>

* percentages, when rounded, were 1% or less

$I_j = \text{sum of observed investment expenditures in the (jth) asset category for 1967-1981, per Table 1-1}$

$I_{tot} = \text{total of observed investment, all asset categories for 1967-1981 per Table 1-1}$

$\hat{i}_j = \text{sum of fitted values for 1967-1981 resulting from estimating equations (5.1) through (5.3)}$

$\hat{i}_j' = \text{simulated (}\hat{i}_j\text{) but with the tax factor varied}$

$U = \text{unitary elasticity assumption}$

$NU = (U) \text{ relaxed, (} V^5 \text{) for (} I_e \text{) and (} V^2 \text{) for (} I_s \text{)}$

$STR = \text{taxed at statutory tax rates; ATR = taxed at alternative tax rates}$
was particularly noticeable after the statutory rate was increased from 7% to 10% in 1975. Relaxing the unitary elasticity assumption affects the simulated results. As indicated at Table 6-1, the amount of \((I_e)\) attributable to \((k)\) is reduced from $977.3 million to $847.6 million for the sample period. The reduced amount, however, still accounts for over 8% of \((I_e)\) and 6.8% of total investment for the sample period (with the percentage as high as 12.3% in 1978).

b) Tax rate reduction

As summarized at Table 6-1, the reduction in corporate tax rates from 48 to 46% in 1979 appears to have had very little influence with regard to stimulating additional investment in any category of assets. Intuitively, one might argue that a decrease in tax rates should lower the cost of capital, thereby increasing investment expenditures. The problem, however, is that the tax rates enter the cost of capital via numerous avenues with conflicting or offsetting results. In the simplest case, reducing tax rates reduces \((c)\). The effect becomes more complicated, however, when the effects of the tax rate on the calculation of after-tax interest costs in \((r)\) and the taxation-inflation interaction are considered. As noted by Nickell (1978) and Hall and Jorgenson (1967), differences
between economic and tax depreciation will also confuse the results. Thus, the effects tend to offset and results are usually data specific. Accordingly, it is difficult to conclude that, overall, the reduction in the tax rates stimulated any significant amount of additional investment for the sample period. The results of a limited impact of rate reductions are consistent with studies such as Hall and Jorgenson (1967) and Bischoff (1971b).

c) Capital gains tax provisions

The controversial capital gains tax provisions do appear to have some stimulative effect on investment expenditures. The effect was more pronounced in the early years of the sample period, then began to have less influence. Overall, the influence on total investment expenditures was relatively small at .8%. In relation to timber investment expenditures only, the influence is more evident. The results at Table 6-1, indicate that the capital gains provisions had encouraged an additional $96.1 million or 6.5% of timber investment expenditures, for the sample period.

d) Summary comments

The conclusions on the investment demand issue are that, within the constructs of the neoclassical theory, certain taxes can affect the level of aggregate business investment by a statistically significant magnitude. A
caveat would be in order, however, that the estimation is within a partial equilibrium framework, and that the results are based on a somewhat limited sample size. Given this qualification, the investment credit was found to be the most stimulative of the alternative tax incentives, with little effect attributable to the tax rate reduction. These results support the findings of Jorgenson, Bischoff and other studies employing a neoclassically formulated analysis.

Although the results indicate a tax induced investment response, support is also provided for researchers such as Eisner and Bischoff. They stress the sensitivity of the model to specification of the price variables, which in turn affects the estimated magnitude of any tax induced investment. The price elasticity of factor demand is a case in point. The unitary elasticity assumption employed by Jorgenson (various studies) and Feldstein (1980) is not confirmed by this study for the cases of equipment and structures. Although the assumption served as a justifiable starting point in the model development reflected in Chapter Four, subsequent results indicated the assumption was not representative of observed behavior. The lack of evidence supporting unitary elasticity is
consistent with Eisner and Nadiri (1968) and Bischoff (1971a).

The effect of the correct specification of the price variable is evident in the case of the investment tax credit. The magnitude of the effect increases from 6.8% of total expenditures for \( V^5 \) to 7.8% if the unitary elasticity assumption is employed. This represents an increase of approximately 15% due to the assumption made concerning price elasticities. Thus, care must be exercised in assessing the impact of particular tax instruments.

It can also be concluded that the reaction of timber investment expenditures to tax variables, particularly capital gains, is consistent with neoclassical theory. The magnitude of the response of timber investment to capital gains is not as large as the response of equipment investment to the investment credit. However, \( (cg) \) induced timber investment is greater in magnitude than that resulting from the reduction in tax rates.

B. The Neutrality Issue

The basic issue of the composition effect was whether taxes will affect the choice or composition of investment assets given the level of investment. Chapter One, Table 1-1 indicated that the composition of total investment
expenditures by the sample firms had changed during the sample period as indicated by the shift from timber to equipment. The proportion of investment in structures remained relatively constant. Although nontax factors could influence such behavior, the extent to which tax variables were non-neutral, or created a bias to a particular asset, could be interpreted as a potential reason for such shifts.

1. **Neutrality of tax features in terms of differential magnitude effects**

The previous section presented estimates of the magnitude of any tax induced effect on investment expenditures. The magnitude effect could also be used to evaluate the degree to which a given tax factor may encourage investment in one asset category relative to another. The results of the model, after the adjustments indicated in Chapter Three, are presented at Table 6-1. They indicate that the investment credit does encourage investment in short-lived, depreciating assets such as equipment. This bias results, to some degree, from tax law requirements that structures and timber generally do not qualify for the credit. The magnitude of the additional equipment investment resulting from the investment tax credit indicates a definite bias in the use of investment dollars to this asset group.

- 177 -
Similar reasoning applies to the capital gains provisions, however, the bias is to the long-lived appreciating asset, timber. Equipment and structures do not benefit to the same extent as timber from this tax variable. This tax provision has encouraged observed investment dollars to be allocated to the timber asset category.

The results of the tax rate reductions are less clear. In this case, all three asset categories are subject to the rate reduction, thus any bias cannot be attributed simply to the fact that a particular tax mix or regime affects only one asset category relative to others. If the unitary elasticity assumptions are relaxed, Table 6-1 indicates that equipment responds more to the rate reductions than other classes of assets. Thus, it would seem that the rate reduction did create a bias, however, the magnitude of the bias is small relative to the other tax variables.

2. Neutrality of tax factors in the context of effective tax rates

The neutrality of a given tax provision can also be evaluated in terms of the impact on pretax rates of return. The change in pre- and post-tax rates of return, on a given investment, is a measure of the effective tax rate (ETR) for that asset. The neutrality of a tax using the (ETRs) as a criterion can be applied in the context of the
current tax environment by comparing the (ETR) of the different assets. Alternatively, the relative effects of a given tax on (ETRs) of different assets can be compared as an indication of neutrality.

a) (ETR) of asset groups under current tax system

The information from Table 5-9 can be useful in evaluating whether the current tax regime creates a bias toward a particular asset, as measured in the (ETRs). The results of calculations for alternative measures of (r) indicate that structures (long-lived, depreciating assets) tend to be the most heavily taxed, thus indicating a bias away from these assets. Alternatively, the results could be interpreted that structures require a higher pre-tax (r') to attract capital to that investment category.

The relative (ETRs) of timber or equipment depend upon the measure of (r). If the (r) resulting from the estimating equation is used, then equipment has the lowest (ETR). However, if a constant value of (r) is used, timber then would provide the lowest (ETR) relative to other assets. In either event, the current tax system does seem to create a disproportionately lower (ETR) for timber and equipment relative to structures.
b) Effect of selected tax variables on (ETR) of different assets

An alternative approach to evaluating the neutrality of tax effects on different classes of investment is to consider the effects of each tax variable on the (ETR) of each asset. Table 6-2 is useful for this type of analysis. This table measures the percentage reduction in (ETR) attributable to a particular tax factor. As the table indicates, none of the three tax variables in question affect the (ETR) of the different assets proportionally. The investment tax credit and corporate tax rate reduction decrease (ETR) for equipment to a greater degree than structures or timber. The capital gains provisions reduce the (ETR) of timber only. Thus, specific tax variables seem to have discriminatory effects on the (ETRs) of different asset groups.

3. Summary comments

An analysis of any tax induced composition effects using an (ETR) criterion indicates that the current tax system is non-neutral. The current tax regime creates a bias away from structures and toward either timber or equipment. Cet. par., specific tax variables encourage the bias to particular assets. The investment credit significantly reduces the equipment (ETR), thus creating a bias toward
### TABLE 6-2

Estimates of Alternative Tax Policies on Effective Tax Rates (ETRs): By Asset Category

#### Estimates of (ETR) using \((r)\) from estimating equations:

<table>
<thead>
<tr>
<th>Asset Category</th>
<th>ITC</th>
<th>Rate Change</th>
<th>cg</th>
<th>Realized Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment</td>
<td>68.1</td>
<td>38.0</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>Structures</td>
<td>NC</td>
<td>3.2</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>Timber</td>
<td>NC</td>
<td>5.7</td>
<td>19.9</td>
<td>37.0</td>
</tr>
</tbody>
</table>

#### Estimates of (ETR) using an assumed value of \((r)\) of .055:

<table>
<thead>
<tr>
<th>Asset Category</th>
<th>ITC</th>
<th>Rate Change</th>
<th>cg</th>
<th>Realized Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment</td>
<td>39.9</td>
<td>10.7</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>Structures</td>
<td>NC</td>
<td>3.5</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>Timber</td>
<td>NC</td>
<td>5.5</td>
<td>25.4</td>
<td>N/A</td>
</tr>
</tbody>
</table>

ITC = Investment tax credit  
Rate Change = Change from average of .476 to .460  
cg = Reductions in tax rates attributable to capital gains  
NC = No change
short-lived, depreciating assets. This conclusions supports the findings of Jorgenson (various studies), Hall (1981) Mauskopf and Conrad (1981) and Gravelle (1982). The almost fifty percent increase in the rate from seven to ten percent in 1975 could also account for a portion of the shift in investment toward equipment relative to timber in the mid-seventies.

A similar bias toward short-lived, depreciating assets occurs in the case of the tax rate reductions. Such is not the case, however, for the capital gains provisions. In this case, the incentive is toward long-lived, appreciating assets such as timber. However, the bias does not seem to be as strong as the investment credit case. Accordingly, based upon the empirical evidence, it would appear that selected tax features in the current tax regime have an effect on the composition of investment expenditures that is discernible from other effects such as inflation. Thus, the regime can be judged non-neutral which implies a presumption that excess burden or ineffective resource use exists.

C. Interindustry Tax Parity

Table 5-10 indicates an estimated (ETR) of .261 for the industry in the current tax environment that allows the use of the (ITC) and (cg) provisions (.282 for the constant
(r) case). Average values of the tax variables for the sample period were used in the estimation. The industry specific (ETR) varies depending on the measure of (r) used, but either measure yields an (ETR) for forest products substantially below the average (ETR) calculated by Gravelle (1982) or Rosenberg (1969) for the manufacturing sector (.375 or .466, respectively). The rate more closely approximates that obtained by Rosenberg for the related industry classification of lumber and wood products (.278). The rate for the sample group differs from Gravelle's average because the proportion of equipment is considerably higher than that used in Gravelle's average, and because of the substantial portion of income taxed at the capital gains rate.

The results indicate that the investment credit has the most substantial impact in lowering the forest products industry (ETR) from a pre-change value of .592 to .261. This result is not surprising when the relatively heavy weight for equipment is considered. Also, the 1979 tax rate reduction seemed to have an impact on the industry (ETR), though not as much as the (ITC). The (cg) provisions, however, did not appear to induce a major change in the (ETR) for the selected firms (less than 5% under either assumption of the discount rate). Thus, the
industry group used in this study does not appear to be taxed at similar (ETRs) as other industries. Instead, the present general (or baseline) tax system seems to favor the forest products industry relative to other industries, even without considering the preferential (cg) provisions. This is due primarily to distortions in the taxation of particular types of assets and types of income. These results would support the position of Sunley, while casting doubt on the arguments of Condrell.

D. Effects of Alternative Taxation Methods

The discussion of previous issues recognized the effects of alternative tax policies on the magnitude and composition of investment and on the (ETR). This section explicitly addresses two alternative means of taxation that have created controversy in the timber tax literature: the capital gains tax provisions, and the taxing of accrued timber income.

1. Capital gains tax provisions

Previous discussions of results have indicated that the capital gains tax provisions have a stimulative effect on investment expenditures in timber, and slightly reduces (ETR) for both the asset (timber) and the industry. Estimates were made in an attempt to simulate a "world" where the (cg) provisions were not available; i.e., taxation of
realized income at ordinary rates. The results were then compared with the previous findings.

The results of this alternative are presented at Tables 5-9, 5-10 and 6-1. Table 6-1 indicates that in the absence of (cg), the magnitude of timber investment for the sample period was simulated to be over $96 million (over 6%) less than actual expenditures. The absence of (cg) is also translated into slightly higher (ETRs) both for timber and the industry.

Table 5-9 reflects that the (ETR) for timber increases to either .438 or .240 depending upon the measure of (r) used, however, the relative ranking with equipment and structures does not change. In ranking investments by (ETR), timber remains higher than equipment but lower than structures when using the estimated (r), and remains the lowest of the three categories when using a constant (r).

The limited effect of (cg) on timber (ETR) is also reflected in the industry (ETR). Table 5-10 indicates a slight increase in the industry (ETR) in a "world" with no (cg) for timber income; i.e., applying the general corporate tax system of taxing realized income at ordinary tax rates. Using estimated (r), the (ETR) increases from .261 to .272, or approximately 4%. If a constant value (r) is used, (ETR) increases from .282 to .289, or
approximately 2.5%. The resulting higher industry (ETR) due to no (cg) for timber income is still below the manufacturing sector average. Thus, although the (cg) variable is significant as a determinant of investment, the effect on the magnitude of investment and on (ETR) is not substantial. This point will be emphasized in the subsequent discussion of tax incentive policy effectiveness.

2. Taxing accrued timber income

Many theorists argue that timber income should be taxed as it accrues instead of when it is realized. Estimates of the magnitude effect and effect on (ETR) of taxing accrued income as opposed to the current system of taxing realized income are provided in Tables 5-9, 5-10 and 6-1. The estimates of the magnitude effect of taxing accrued income at Table 6-1 is calculated under alternative tax assumptions. In the first case, it is assumed that the accrued timber income will be taxed at the capital gains rates in a similar method as the current tax provisions for realized income. In the alternative case, it is assumed that accrued timber income is taxed at the statutory rate (STR). In either case, Table 6-1 indicates a dramatic reduction in timber investment in response to the accrued income tax as opposed to the current realized income
method. If taxed at (STR), the results indicate that (I_f) would have been reduced from $1487.6 million to $1114.4 million, or approximately 25%, for the sample period. If taxed at the lower capital gains rate (ATR), the reduction was estimated to be over $250 million, or approximately, 18% for the sample period.

This result is also supported by the (ETR) of timber at Table 5-9. It is estimated that the current method of taxing realized income tax reduces the (ETR) for timber by approximately 37%, or from a rate of .557 in the hypothetical accrued case to .351 under the current system. Taxing accrued timber income would continue to result in the (ETR) for timber occupying the same relative position as under the current system; however, the rate would be appreciably closer to that of the long-lived, depreciating asset, structures.

The effect of the use of an accrued income tax for timber income on the industry (ETR) is presented at Table 5-10. The alternative tax condition is expanded to include not only the accrued tax, but also the elimination of the capital gains provisions. The resulting estimate of the industry (ETR) reflects increased rates when compared with the current system. Using estimated (r), the (ETR) increases approximately 12.3%, from .261 to .293. In the constant
(r) case, (ETR) increases approximately 15.8%. In either case, the increase is pronounced, due primarily to the taxing of accrued income. The resulting estimates, however, are still less than Gravelle's estimated average (ETR) for the manufacturing sector, and substantially less than the statutory rates.

These results do not resolve the controversy of whether an accrued or realized income tax method is the most efficient since the theoretical optimum is not estimated. It does, however, provide empirical evidence as to the relative tax burden of using a realized income concept. The implications are that the present system of a realized income tax has created a shift in capital toward longer-lived assets such as timber. This shift has been accentuated by the additional feature of taxing the realized income at the capital gains rates. These results are supportive of authors such as Gaffney, Chisholm and Sunley; i.e., a realized income concept is non-neutral and creates a presumably inefficient bias to long-lived assets. Such implications are particularly significant in view of the controversy that special tax treatment (realized income taxed at capital gains rates) is not necessary to achieve or restore parity in the taxation of timber.
E. Tax Incentive Policy Effectiveness

The purpose of this section is not to address global issues such as the welfare cost of capital misallocation, or the issue of measuring "costs" and "benefits" for use in making socio-political decisions. Certain aspects of this study, however, can provide some information for making tax policy decisions. Specifically, monetary amounts can be provided for comparison of costs and benefits for assessing the effectiveness of tax incentive policies.

The monetary comparison of costs and benefits is often referred to as the "bang-for-buck" issue in the taxation literature. The measure of costs for this study is limited to the tax expenditure or revenue loss to the Treasury due to the tax provision. For purposes of this study, the measure of benefits is limited in definition to the estimated additional investment generated by the tax variable. Costs or benefits external to the firm are not considered, nor are indirect effects that would be present in a more general model.

Within this limited framework, a comparison of costs and benefits can be made for two selected tax variables: the investment tax credit and the capital gains provisions. The results of the comparison are presented at Table 6-3. The benefits, in the form of tax induced investment expedi-
TABLE 6-3
Comparison of Tax Cost and Tax Induced Investment Expenditures

<table>
<thead>
<tr>
<th>Year</th>
<th>Alt. 1</th>
<th>Alt. 2</th>
<th>Tax Cost of (ITC)</th>
<th></th>
<th>Tax Cost of (cg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1967</td>
<td>28.7</td>
<td>29.8</td>
<td>20.8</td>
<td>12.4</td>
<td>37.0</td>
</tr>
<tr>
<td>1968</td>
<td>32.9</td>
<td>33.8</td>
<td>34.2</td>
<td>9.8</td>
<td>50.7</td>
</tr>
<tr>
<td>1969</td>
<td>37.6</td>
<td>37.9</td>
<td>14.4</td>
<td>28.5</td>
<td>74.7</td>
</tr>
<tr>
<td>1970</td>
<td>26.1</td>
<td>27.7</td>
<td>0.0</td>
<td>7.7</td>
<td>56.9</td>
</tr>
<tr>
<td>1971</td>
<td>6.6</td>
<td>4.5</td>
<td>15.8</td>
<td>3.6</td>
<td>34.0</td>
</tr>
<tr>
<td>1972</td>
<td>-16.2</td>
<td>-5.3</td>
<td>44.8</td>
<td>6.9</td>
<td>58.9</td>
</tr>
<tr>
<td>1973</td>
<td>36.9</td>
<td>39.9</td>
<td>86.7</td>
<td>3.4</td>
<td>131.5</td>
</tr>
<tr>
<td>1974</td>
<td>82.8</td>
<td>76.3</td>
<td>83.7</td>
<td>7.3</td>
<td>114.4</td>
</tr>
<tr>
<td>1975</td>
<td>78.6</td>
<td>68.2</td>
<td>99.5</td>
<td>3.1</td>
<td>91.7</td>
</tr>
<tr>
<td>1976</td>
<td>80.2</td>
<td>66.4</td>
<td>134.3</td>
<td>1.6</td>
<td>138.7</td>
</tr>
<tr>
<td>1977</td>
<td>100.2</td>
<td>84.5</td>
<td>159.8</td>
<td>6.6</td>
<td>152.7</td>
</tr>
<tr>
<td>1978</td>
<td>130.4</td>
<td>106.5</td>
<td>192.3</td>
<td>1.9</td>
<td>164.6</td>
</tr>
<tr>
<td>1979</td>
<td>134.5</td>
<td>101.5</td>
<td>223.0</td>
<td>1.2</td>
<td>228.0</td>
</tr>
<tr>
<td>1980</td>
<td>128.6</td>
<td>96.7</td>
<td>175.2</td>
<td>.9</td>
<td>179.1</td>
</tr>
<tr>
<td>1981</td>
<td>96.4</td>
<td>79.3</td>
<td>119.3</td>
<td>1.2</td>
<td>126.0</td>
</tr>
<tr>
<td>Total</td>
<td>977.3</td>
<td>847.6</td>
<td>1403.8</td>
<td>96.1</td>
<td>1638.9</td>
</tr>
</tbody>
</table>

Alt. 1 is based on a unitary elasticity assumption in the estimating equation, which is relaxed under Alt. 2

$\Delta I_j$ as calculated per Table 6-1

Investment ($I_j$) in millions of 1967 dollars; (cg) and (ITC) in millions of nominal dollars
tures, were obtained from the previous results of the magnitude effect (see Table 6-1). The tax costs (TC) or benefits utilized by the sample firms of the industry were estimated by the following algorithm based upon information in each (kth) firm's published financial statements for each year:

\[
TC(cg)_k = \left(\frac{TET}{ETR \times 100}\right) \times (cg\% \times 100) 
\]

\[
TC(ITC)_k = \left(\frac{TET}{ETR \times 100}\right) \times (ITC\% \times 100) 
\]

where

TET = reported tax expense

ETR = effective tax rate based upon conventional accounting measures (TET/income before tax)

cg\% = percentage reduction from nominal rate to (ETR)
due to capital gains provisions

ITC\% = percentage reduction from nominal rate to (ETR)
due to investment tax credit utilized

100 = normalizing factor for percentages

and

\[
TC(cg) = \frac{\sum_{k=1}^{N} TC(cg)_k}{N} 
\]

\[
TC(ITC) = \frac{\sum_{k=1}^{N} TC(ITC)_k}{N} 
\]

where

k = (kth) firm of N sample firms

Although it could be argued that these estimates of tax costs may be subject to some degree of measurement
error, it is doubtful that the error would significantly alter the "cost benefit" relationship exhibited in Table 6-3. In order to determine if the degree of measurement error was substantial, the results were compared with other studies that utilized Treasury Department statistics. Sunley (1976) noted that the five largest firms in the industry accounted for 53% of the corporate capital gain benefits, based upon 1971 data. A similar comparison for the sample firms in this study indicated an average of 51% for the 1977 through 1981 period.

The comparison at Table 6-3 indicates that the tax costs in terms of lost revenue, exceed the additional investment attributable either to the investment credit or the capital gains provisions. In particular, the tax cost of the (cg) provisions drastically exceed the tax induced investment. These results are similar in nature to those of Coen (1971) in which the tax structure was found to stimulate investment, however, the tax cost greatly exceeded the additional investment (benefits). The findings also provide evidence to support Sunley's questioning of the effectiveness of the (cg) variable in inducing additional investment in timber.
F. Summary Conclusions-Specific Research Issues

In summary, the empirical evidence suggests that tax factors do affect investment expenditures by the selected firms in the industry. The investment tax credit and capital gains tax provisions do seem to encourage some additional investment expenditures. However, the results do not appear conclusive with respect to the 1979 reduction in corporate tax rates. The stimulative effect of the tax variables differentiates between asset types, and appears to affect the composition of investment. The investment tax credit creates a bias to short-lived, depreciating assets, such as equipment. A bias also results from the capital gains tax; however, the bias is to the long-lived, appreciating asset case. The two effects are offsetting, with the investment credit being the dominant effect over the sample period.

A comparison of (ETRs) for each asset group provides additional evidence of differential taxation among types of assets, with the current tax system seeming to favor short-lived, depreciating assets. Due to the relatively large proportion of equipment, plus the substantial investment in timber, the (ETRs) for the industry were accordingly lower than the average (ETR) for manufacturing industries reflected in other studies. The resulting lower (ETRs) and
the increased investment attributable to tax variables, however, is not without a cost in terms of forgone tax revenues. A comparison of the monetary costs of the tax provisions with the stimulated investment may pose a question as to the effectiveness of tax incentives for encouraging additional investment.

II. Comments on Industry Specific Taxation Issues

The purpose of this section is to address some of the more general questions raised in this study. An initial question was whether the unique investment characteristics of the industry require special or preferential tax provisions to accomplish predetermined policy objectives. Alternatively, the question would be whether the regular tax provisions create a bias or induce a disincentive for the industry, thus indicating a need for tax preferences. Although the normative issue will not be addressed, certain observations of a positive nature can be made.

The empirical evidence presented in this study does not support the contention that either the industry or the asset, timber, are excessively taxed under the current tax regime, or would be in the absence of the existing preferential (cg) tax provisions. Calculations of (ETRs) under varying assumptions also have not supported the argument of an excessively taxed industry. Table 5-10 indicates that
even without the preferential capital gains benefits, neither timber nor the industry are excessively taxed relative to other assets or industries; i.e., (ETR) would go from .272 to .289, but the (ETR) would still be commensurate with the average (ETR) of all industries of .386 (averaged from the Gravelle (1982), Rosenberg (1969) and OTA (1978) studies). At the industry level, addition of an accrued income tax would increase the (ETR), however, the evidence does not support an assertion that the industry would thereby be taxed substantially greater than the present average for the manufacturing sector. Thus, arguments raised in 1943 in support of the (cg) preferential tax treatment would seem to rely heavily on the "most favored taxpayer" theory, as suggested by Sunley (1972).

An additional question was raised whether restructuring or reducing taxes could significantly affect investment behavior. The evidence seems to support the contention that certain tax variables can affect the magnitude and composition of investment expenditures. The evidence also raises the question of whether the use of tax policy to encourage the investment would be worth its costs. In the selected cases in this study, the tax costs (i.e., foregone revenues) greatly exceeded the benefits of additional
investment expenditures. Accordingly, the decisions to use tax policy, specifically the use of preference provisions to encourage investment, must be based upon factors in addition to the empirical evidence presented in this research.

III. Direction for Future Research

The issue of taxation and investment in the forest products industry is far from being an exhausted area for research. The remainder of this section suggests possible future directions that would provide additional insights into the timber taxation area.

A. Alternative Hypotheses for the Capital/Output Ratio Decline

Chapter One presented the declining trend over time in the ratio of total industry investment expenditures allocated to timber. This also translates into a decline in the capital/output (K/O) ratio for timber. As previously discussed, the empirical evidence in this study does not support the argument that the present federal income tax provisions have discouraged investment in timber of a magnitude that would prevent maintaining a higher level of capital stock, even in the absence of some of the industry tax preferences. It could be argued that the (ITC) provisions have created a shift to short-lived, deprecia-
ting assets, however, research into alternative explanations for the (K/O) decline would prove interesting. Three potential research areas for this issue would be the measurement techniques of the capital variable, the role of technological change and the interaction of other capital inputs in the production function.

1. Measurement of (K)

The measurement of the capital stock variable has been a major problem for numerous investment demand studies, but it is perhaps even more pronounced for timber. The use of most conventional monetary measures record the timber asset in original cost terms. (Improvements and depletion are recorded in historical cost terms also.) The appreciation component is usually not reflected in most measures of timber capital stock. Accordingly, alternatives using some capacity measure or physical units may provide insight. But even physical or capacity measures will require care in estimating, for the production methods of using the stock have changed over time. The measure of (K) then should incorporate some adjustment for the technological change in resource use over time which affects capital (or labor) productivity. There may be a trend to substitute capital for labor regardless of changes in the tax environment.
2. **Technological change**

The impact of technological change in the forest products industry during the post-World War II period has been pronounced. More effective use is being made of the tree, producing not only lumber or paper, but numerous by-products. More efficient production methods are employed so there is less waste. Silviculture and genetic research are producing strains of trees that produce more in much shorter time periods, a very important consideration for timber. The effects of technological change, unfortunately, do not behave in a simple, linear fashion, thus modeling the relationship may be somewhat difficult. But, the role of technological change for both determining the production function and in measuring the capital stock seems to be a very important factor for evaluating arguments concerning the taxation of timber income.

3. **Relative price of labor input**

This study, like most partial equilibrium studies, holds labor input and relative prices constant. Some evidence suggests that relative prices of labor can account for some shift in capital among asset categories, thus affecting the relative \((K/O)\) for different assets. Also, if labor costs are increasing during the sample period, \((K/O)\) may respond to the change in relative input prices,
regardless of tax treatment. Such a study would require an expanded analysis of the production function of the firm. The results could be of benefit in attempting to explain changes in investment behavior and the interactive effects of tax instruments.

B. Complete Models for the Industry

The partial equilibrium approach employed in this study still leaves unanswered several questions of a general equilibrium nature. For example, if all the tax money saved from the investment credit, capital gains benefits and the 1979 tax cut were not invested in additional capital stock, for what purpose was it used? In an open economy, what effect does the mortgage interest rate (monetary policy) have on output and investment decisions? How will alternative U.S. Forest Service timber sale policies affect the investment demand for timber? What effect do tax policies have on output prices? What are the interactive effects of the different classes of capital stock? Questions such as these can only be answered with a more complete model that incorporates the financing, investment, dividend and production decisions of the firm within a macroeconomic framework. Consideration of the various feedback effects could provide important information on the
secondary effects of taxation in the forest products industry.

C. Measurement of Timber Income

As noted in this study, conventional measures of timber income may not provide sufficient economic information for decisionmakers given the effects of changes in prices. The problem was recognized by the accounting profession in FASB #40 (1980) when it was suggested that further research was needed for measuring income in the industry. This research estimated a measure of timber income that would be consistent with what many would argue to be a concept of economic income. Such measurement is difficult and the potential for error does exist, particularly in view of the technological changes occurring in the industry. Thus, it would seem that more research in this area, such as on a case by case basis for particular firms, could provide useful data for refining the measurement of income for firms with extensive timber holdings.

In addition, a speculative question might be posed concerning the income measurement issue. If the management of firms respond to market perceptions of the reported net income of their firm, would inclusion of the accrued but unrealized timber income for the period encourage more
efficient forestry practices and conservation efforts (the policy objectives of the timber tax provisions) as management attempted to report a more favorable income image?

D. Effects of Inflation

Adjustments were made for the inflation-taxation interaction in calculating the rates of return (r) for the industry. A study devoted specifically to analyzing the effects of the inflation-taxation interaction would appear to be of particular interest due to the composition of capital stock. The role of expectations, taxation, composition effects and resulting shifts in the debt-equity ratio could be pursued in such a study.

These suggested areas could provide some additional information concerning a complex topic that is often the center of theoretical and policy controversies.
APPENDIX A

A REVIEW OF THE FEDERAL CORPORATE INCOME TAX
PROVISIONS AFFECTING FIRMS IN THE FOREST PRODUCTS
INDUSTRY: AN INSTITUTIONAL PERSPECTIVE

The purpose of this appendix is to review the major federal income tax provisions that affect the large, vertically integrated firms selected for this study. The emphasis will be on the institutional or structural characteristics of the various taxes, thus providing background information for the theoretical issues discussed in other sections.

I. General Comments

The authority to levy the corporate income tax is found in the 16th Amendment to the U.S. Constitution, which was ratified in 1913. Since that time, Congress has passed numerous laws governing the specific manner by which income of a corporation will be taxed. These provisions are contained in the Internal Revenue Code (IRC)(1), and represent the primary source of income tax law. Additional sources of tax law are found in the Treasury Department regulations which interpret the IRC, rulings by the Internal Revenue Service on the application of the IRC to more specific issues, and decisions of various courts.
A. Tax Computation

The corporate income tax is computed by applying the statutory corporate income tax rates (STR) specified in IRC Section 11 to taxable income (TI). (TI) is computed basically in the following manner:

$$RI - EXP - SD = TI \quad (A-1)$$

where

RI = realized income

EXP = deductible expenses

SD = special deductions

The corporate tax rates (STR) increase in a step-wise fashion for different levels of (TI). Since all companies in the study generally have (TI) subject to the highest rate levied, this rate will be used as the tax variable (u) which represents the marginal tax rate.

Special deductions (SD) would include deductions for net operating losses and dividends received. Deductible expenses (EXP) are those associated with producing (RI), and include operating expenses such as salaries, rent, depreciation, depletion, insurance and certain taxes. Of particular interest for the forest products industry is that (EXP) not only includes expenses associated with realized income but with unrealized or accrued income (AI) as well. For a discussion of the mismatching of income and
expense when (EXP) associated with (AI) is deducted prior to the recognition of income, see footnote (7) of Chapter 2. Examples of (EXP) associated with (AI) would be property taxes on standing timber; fire, disease and pest control; and interest expense on timber loans and mortgages.

B. Income Concepts

The distinction between (RI) and (AI) is important both for tax purposes and for analyzing arguments in the timber taxation literature. Under the (RI) concept, income is not recognized until it is received, either in cash or other assets, as the result of a taxable exchange. The (AI) concept, however, recognizes income as it is earned or accrued. Income would be earned when an increase in wealth has occurred as in the Simon (1938) approach.

The difference in these two methods is dramatized in the case of timber income. If the tax is based on (RI), income is not recognized for tax purposes until the timber is cut or sold. With (AI), however, income would be recognized each year as the timber increases in value. The important difference is the timing of the recognition of income, either in a lump sum at the end of the holding period, or incrementally as the value of the timber increases prior to disposal. When the time value of money is
considered, this timing difference of income recognition becomes an important factor.

Income for tax purposes is recognized using the (RI) concept. This concept was concluded by the U.S. Supreme Court, in Eisner v. Macomber, to be most consistent with the 16th Amendment's meaning of income. In this case, the court emphasized the difference between the two concepts as follows:

"Here we have the essential matter: not a gain accruing to capital, not a growth or increment of value in the investment; but a gain, a profit, something of exchangable value proceeding from the property, severed from the capital..., being... received... by the recipient... for his separate use...; that is income derived from property. Nothing else answers the description [of income as used in the 16th Amendment]." Eisner v. Macomber (1920).

Subsequent court cases and interpretations have consistently followed the (RI) concept in determining when income is subject to tax.

II. Investment Incentive Provisions

Tax laws are not only used to raise revenue, but also to aid in accomplishing economic and social objectives. Numerous tax laws have been enacted to influence the nation's economy, particularly in the area of investment incentives. The investment incentives of interest for this study are the investment tax credit (ITC), the depreciation
provisions (capital consumption allowances), and capital gains taxation.

A. Investment Tax Credit

IRC Section 38 allows a credit against a taxpayer's tax liability based upon expenditures in qualifying property. IRC Sections 46-50 provide the rules for computing the tax credit, limitations on its use, credit recapture in the event of early disposition of the property and other rules. Basically, the credit is a percentage of the cost of qualifying property. The percentage will be determined by the asset life used for tax depreciation purposes. Qualifying property generally is depreciable property other than real estate, however, numerous exceptions permit various specialized real structures to qualify. The following is a simplified example of the calculation of (ITC), based upon 1980 rules:

Example: The XYZ Co. purchased new machinery in 1980 at a total cost of $220,000. Of this, machinery costing $120,000 had a useful life for tax depreciation purposes of 5 years, and the reminder had a useful life of 8 years. The company's tax liability before ITC was $100,000.
<table>
<thead>
<tr>
<th>Useful Life</th>
<th>Cost</th>
<th>Useful Life %</th>
<th>Qualifying Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 YRS.</td>
<td>$120,000</td>
<td>66.67%</td>
<td>$80,000</td>
</tr>
<tr>
<td>8 YRS.</td>
<td>$100,000</td>
<td>100.00%</td>
<td>$100,000</td>
</tr>
<tr>
<td>Total</td>
<td>$220,000</td>
<td></td>
<td>$180,000</td>
</tr>
</tbody>
</table>

Using the data in this example, all of the ITC could be utilized in the current period. The ITC limitation does not apply, thus there will be no carryback or carryforward of unused ITC. The company's tax liability will be reduced by the ITC from $100,000 to $82,000.

Except for a temporary suspension, the ITC has been in effect since 1962 with the rates of credit varying from a maximum of 7% to 10%. Initially, the credit reduced the cost of the asset that could be depreciated. This requirement was dropped in 1964 but re instituted to a limited degree in 1983.

**B. Depreciation**

IRC section 167 (and 168 starting in 1981) provide for the tax free recovery of capital expenditures by allowing a deduction for depreciation expense in calculating taxable income. Depreciation expense for tax purposes allows a write-off of the original acquisition cost of the asset over its physical useful life and does not purport to reflect the economist's concept of depreciation. Depreciation expense can be calculated using various methods, selection of which depends upon the type of
asset and its useful life. The varying methods differ in the time pattern over which the original cost can be deducted. The time pattern for deducting depreciation expense is important when the time value of money is considered. The greater the amount of expense that can be deducted in earlier periods, the greater the present value of the benefit.\(^4\)

The flexibility in depreciation calculations has not always been part of the IRC. Prior to 1954, only "straight line" depreciation could be used, and useful lives were relatively fixed by IRS rulings. In 1954, alternative methods of calculating depreciation were allowed such as declining balance. Additional major changes were made to the depreciation rules in 1962, 1969 and 1971 that were designed to simplify the estimation of useful lives or to allow use of shorter lives. The use of a shorter useful life allows a more rapid write-off of the asset. The concept of a more rapid write-off of the asset cost, either via accelerated depreciation methods or shorter useful lives, was reflected in the Economic Recovery Tax Act of 1981. This act classified assets into one of four recovery periods (3, 5, 10 or 15 years) and calculated depreciation expense with an accelerated method.
C. Alternative Tax on Capital Gains

IRC Section 1201 allows corporate taxpayers with long-term capital gains to use an alternative method of calculating their tax if it results in a tax savings. Basically, the calculation would be as follows:

1. Calculate the regular income tax (TX_R):
   \[ TX_R = TI \times STR \]  
   (A-2.1)

2. Segregate TI into the ordinary income portion and the net long-term capital gain portion:
   \[ TI = TI_O + TI_C \]  
   (A-2.2)

3. Calculate the alternative tax (TX_A) using ordinary rates for TI_O and the alternative tax rates (ATR) for TI_C:
   \[ TX_A = (TI_O \times STR) + (TI_C \times ATR) \]  
   (A-2.3)

4. Select the lesser of TX_R or TX_A.

For companies with significant long-term capital gains, the tax savings can be substantial\(^{(5)}\). In effect, income is shifted from the 46% rate to a 28% rate (based on 1980 rates). This method is particularly important for the forest products industry due to the capital gain treatment for timber under IRC Section 631. A numeric example of the application of the alternative tax will be provided in the subsequent section under the discussion of IRC Section 631.

III. Additional Tax Considerations for Timber Companies

In addition to the corporate tax provisions previously discussed, additional tax factors must be considered for firms in the forest products industry because of their
timber holdings. For purposes of this study, the most important additional considerations are the issues of capital gains, expense versus capitalization and depletion. The subsequent presentation will provide a review of these issues. For a more detailed discussion, see analyses such as Briggs & Condrell (1978) or Arthur Andersen (1980).

A. Capital Gains

Timber ownership or contract rights in timber may allow the owner/holder to treat certain income as capital gains. Capital gains may be obtained by selling the timber outright and qualifying under IRC Section 1221. Alternatively, capital gains could be obtained by cutting the timber and qualifying under IRC Section 631(a), or by selling the rights to cut the timber and retaining an economic interest per IRC Section 631(b).

1. IRC Section 1221:

Timber sold outright may qualify for capital gains treatment if it meets the definition of being a capital asset. Section 1221 applies an exclusionary principle in defining capital assets. It states that any asset is a capital asset except for certain classes of property. The classes excluded from capital asset status most likely to affect timber companies would be:
1) assets held primarily for sale to customers in the ordinary course of business; and
2) real or depreciable property used in a trade or business.

A gain/loss from the sale of assets in category 2) above is considered IRC Section 1231 gain/loss and will be subsequently discussed. Gains/losses from sale of assets in category 1) will produce ordinary gains/losses. For an outright sale of timber to receive capital gain treatment then, it must not be considered to be category 1) property.

When determining if assets are held primarily for sale to customers in the ordinary course of business, the courts consider various factors. One important factor considered in Belcher v. Commissioner and Scott v. U.S. was whether the timber sales were frequent and continuous as opposed to infrequent and isolated. Another important factor considered in Broadhead v. Commissioner, Kirby Lumber Co. v. Commissioner and Scott v. U.S. was whether significant development and substantial sales activity had occurred in disposing of the property. Also important is the term "primarily". In some cases, the IRS successfully argued that "primarily" meant substantially, thus a dual purpose in holding property would defeat capital gain treatment (Rollingwood Corp. v. Commissioner and American Can Co. v.
Commissioner). In the more recent Municipal Bond and Molat cases, however, "primarily" was interpreted to mean "principally" or "of first importance". These definitions are more flexible for determining capital asset status.

2. IRC Section 631:

Timberowners can obtain capital gain treatment without selling their entire interest by operation of IRC Section 631. IRC Section 631 (formerly Section 117(k) of the 1939 IRC) became law with the passage of the 1943 Revenue Act. President Roosevelt vetoed this act initially, however Congress overrode the presidential veto and this section became law in 1944. The benefit of Section 631 is that it allows any 631 gains or losses to be treated as IRC Section 1231 gains or losses. If all Section 1231 gains and losses result in a net gain when combined, then the gains/losses are treated as long-term capital gains which would qualify for use of the lower alternative tax. If all Section 1231 gains and losses result in a net loss, then the net loss is treated as ordinary and deductible in full. This is important for corporations since corporate capital losses are not deductible against ordinary income. This taxation relationship is presented in Diagram 1.

The application of Section 631 is illustrated in Charts A and B of Diagram 2, which was adapted from Mead
DIAGRAM 1
APPLICATION OF I.R.C. SECTIONS 631 AND 1231

Section 631 Gains → Add to other Section 1231 Gains

Section 1231 Gains

Net Section 1231 Gain or Loss

Net Section 1231 Gain = LTCG
Net Section 1231 Loss = Deductible as Ordinary Loss

LTCG = Long Term Capital Gain
## DIAGRAM 2

**APPLICATION OF I.R.C. SECTION 631**

### CHART A

<table>
<thead>
<tr>
<th>O.C.</th>
<th>All cost of carrying, developing and operating timber to maturity</th>
<th>PR.</th>
<th>All logging, manufacturing and other costs beyond stumpage</th>
<th>PR.</th>
<th>Other Business Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>C</td>
<td></td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### CHART B

<table>
<thead>
<tr>
<th>Depletion Basis</th>
<th>Fair market Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>O.C. *</td>
<td>Capital Gain</td>
</tr>
<tr>
<td>A</td>
<td>B B'</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

O.C. = Original cost of timber  
PR. = Profit  
D = Present value of stumpage  
F = Selling price of final product  
* = Other capital cost
(1959). Chart A shows the earnings process of a company which uses timber as a raw material input for production of a final product such as lumber and plywood. Chart B shows the taxation of this earnings process. The depletion base, B', does not include all cost of carrying the timber to maturity (the distance B-C in Chart A) because many of these expenses can be deducted against ordinary income, thus they are included in D'-F' of prior tax years. Due to the ability to expense some of the carrying costs, the gain for capital gains taxation (via Section 631) increases from C-D to B'-D'. Also, the gain subject to ordinary tax rates, E-G, is reduced to F'-G.

Timberowners can elect these taxation provisions depending upon whether the timber qualifies under IRC Section 631(a) or Section 631(b). IRC Section 631(a) allows taxpayers who have owned timber (or a contract right to cut the timber) for over one year, and who cut the timber for sale or use in their trade or business, to treat the cutting as a sale or exchange of a Section 1231 asset. Gain is recognized as the difference in the fair market value (FMV) and its original cost basis. (FMV) is measured as of the first day of the tax year in which the timber is cut. This gain is taxed in the year it is cut regardless of whether or not the timber or its final product is sold. The important
factor initiating taxable income is the cutting of the timber, not its sale or use. Thereafter, the (FMV) of the timber becomes the "cost" of timber, such as for inventory and cost of goods sold purposes.

The assumption implicit in Section 631(a) is that the owner cut and sold the timber and then repurchased it at the sales price. In effect, the owner sold himself the timber at its (FMV). Since, in most cases, the 631(a) gain will produce a lower tax, and since determination of (FMV) is subjective or judgmental, the tendency might be to inflate (FMV) so that B'-D' (Diagram 2) is increased. Accordingly, as one would expect, the issue of (FMV) has been a heavily litigated issue in the courts. The most recent, and perhaps most explanatory, case addressing (FMV) is Martin. This case summarized many of the factors considered important for determining (FMV), such as sales prices of similar parcels, market conditions, location of the timber and the quality of the timber. Expert testimony can also be important, such as in the Deer Park Pine case. Unfortunately, different courts place emphasis on different factors for determining (FMV).

(FMV) is not an issue for application of IRC Section 631(b). This subsection of Section 631 applies to a taxpayer who has owned timber for over one year and who disposes
of the timber under a cutting contract yet retains an economic interest. The critical issue in this section is whether an economic interest is retained in the contract. In order to retain an economic interest in the cutting contract, basically the lessor's payments must be dependent upon the severance of the resource (see Dyal v. U.S. and Crosby v. U.S. for the importance of the requirement that the lease payments be directly related to the volume of timber cut). When an economic interest in the timber contract is not retained, lease payments are considered to be rental income and taxed at the ordinary rates. This section has limited application for the timber companies selected for this study, and will not be considered further.

The following is an example of the taxation of Section 631(a) transactions:

A corporate taxpayer cut timber in the taxable year 1980. The timber had a fair market value of $1,000,000 as of January 1, 1980. The adjusted basis for depletion was $100,000. The taxpayer did not use the timber for lumber production until 1981. During 1981 the timber was converted into lumber. Production costs, such as labor, were $900,000 and the sales price of the lumber was $2,000,000. The company had no other Section 1231 or 1221 transactions.
## No Section 631(a) Election:

<table>
<thead>
<tr>
<th></th>
<th>1980</th>
<th>1981</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>0</td>
<td>$2,000,000</td>
</tr>
<tr>
<td>Costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Depletion</td>
<td>0</td>
<td>(100,000)</td>
</tr>
<tr>
<td>-Production</td>
<td>0</td>
<td>(900,000)</td>
</tr>
<tr>
<td>Taxable Income</td>
<td>0</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>Regular Tax</td>
<td>0</td>
<td>$440,750</td>
</tr>
</tbody>
</table>

## Section 631(a) Elected:

<table>
<thead>
<tr>
<th></th>
<th>1980</th>
<th>1981</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>$1,000,000</td>
<td>$2,000,000</td>
</tr>
<tr>
<td>-Capital Gain</td>
<td>1,000,000</td>
<td>0</td>
</tr>
<tr>
<td>Costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Depletion</td>
<td>(100,000)</td>
<td>(1,000,000)</td>
</tr>
<tr>
<td>-Production</td>
<td>0</td>
<td>(900,000)</td>
</tr>
<tr>
<td>Taxable Income</td>
<td>900,000</td>
<td>100,000</td>
</tr>
<tr>
<td>Regular Tax</td>
<td>$394,750</td>
<td>$26,750</td>
</tr>
<tr>
<td>Alternative Tax</td>
<td>$252,000</td>
<td>$N/A</td>
</tr>
</tbody>
</table>

If IRC Section 631(a) is elected, tax must be paid in 1980, the year of the cutting, even though the timber has not been sold or used in production. Taxes for 1980 and 1981 would be $252,000 plus $26,750 or $278,750 (assuming the alternative tax is used in 1980) as compared to $440,750 if no election is made, a savings of $162,000. In this example substantial tax savings would result from a Section 631 election(6).

### B. Expense Versus Capitalization

A frequently encountered problem for timber companies is the treatment of costs associated with timber holdings. The basic issue is determining which costs may be deducted in the current period as expenses, and which costs must be
capitalized. If costs are capitalized, they may be recovered either through depreciation (Section 167) or depletion (Section 611) deductions. Some capitalized costs cannot be recovered until the disposition of the asset. The capitalization of expenditures is determined by IRC Section 263 which requires that amounts spent for permanent improvements to property are capital investments and not deductible. Instead they must be capitalized (7). However, IRC Sections 161-162 allow deductions for ordinary and necessary business expenses incurred in carrying on a trade or business. The lack of specificity in the language of these conflicting sections often results in uncertainty as to the proper classification of expenditures and the timing of their deduction.

Various court decisions, Regulations and Revenue Rulings have been issued in an attempt to classify timber related expenditures. The classification usually depends upon the type of costs incurred. Planting and reforestation costs are required to be capitalized and recovered through depletion deductions (Reg. 1.611-3(a)). Maintenance and carrying costs incurred after the trees have been planted, such as fire protection, silviculture, ad valorem taxes and interest are deductible in the year incurred, unless the taxpayer elects to capitalize certain carrying
costs (IRC Sections 265-266). Other costs, such as logging roads, become even more difficult to classify. Logging roads, according to Revenue Ruling 68-281, can either be permanent or temporary in nature. Permanent roads may have depreciable portions, such as bridges or paving, and non-depreciable portions. Temporary roads are amortized over the period of their use. The variation in treatment of timber costs indicates the need for careful analysis when attempting to properly classify them as currently deductible or as capital expenditures.

A. Depletion

The depletion deduction allows timber owners to recover the original cost of their investment as it earns income. Depletion is conceptually similar to depreciation, but it is applicable to natural resources. The timber depletion deduction is permitted by IRC Section 611, and is based upon a recovery of cost principle. Cost depletion for timber should not be confused with percentage depletion available by virtue of IRC Section 613 to certain other natural resources.

The calculation of the depletion deduction (DL) requires information about the dollar amount of the timber investment (exclusive of land), \((INV)^8\), the number of units in the timber holdings (UT), and the number of timber
units cut during the year (CT). With this information, the first step is to calculate the depletion per unit (DL'):

\[
INV / (UT + UT' + CT) = DL' \quad (A-3)
\]

UT' represents the correction of the original estimate of UT. Examples of UT' would include growth since the timber was acquired and errors in scaling or cruising. The regulations also require that any capital improvements or additional acquisitions be included in the above calculations. After determination of DL', DL is computed as follows:

\[
DL = DL' \times CT
\]

subject to: \( DL < INV \) \quad (A-4)

IV. Concluding Comments

The tax laws applicable to corporate timberowners include not only the regular corporate tax provisions but also those unique to the forest products industry. The previous discussion of the structural and institutional characteristics of these laws illustrate both the complexity and the distinctiveness of taxation of timberowners.
1. The Internal Revenue Code (IRC) organizes the various tax laws by chapters and subchapters which include assigned section numbers. References to specific tax laws are usually by section number. The IRC has been revised or reorganized on different occasions, the most recent being in 1954. Thus, a reference such as IRC Section 631 refers to code section number 631 (which deals with timber income) of the 1954 codification of the internal revenue laws.

2. Economists often consider depreciation that reflects the true loss in economic value as the proper depreciation deduction if asset valuations are to be independent of differing tax rates. See Samuelson (1964).

3. For a discussion of the various depreciation methods and rules for their calculation, see taxation texts such as West (1982) or Prentice-Hall (1982).

4. The time pattern of the depreciation expense deduction under varying methods could be illustrated as follows:
   a) straight line: a uniform amount of expense is deducted over the tax life of the asset;
   b) accelerated methods such as declining balance or sum-of-the-years digits: the deductible expense is greater in the earlier years of the asset's tax life relative to later years, with the deduction declining each successive year;
   c) immediate depreciation: the entire cost of the asset is deducted as an expense in the year the cost is incurred;
   d) permanently capitalized: no deduction for depreciation expense is allowed until subsequent disposition of the asset, at which time the entire cost is recovered.

5. Net capital gains are considered a "tax preference" item for purposes of calculating the "add-on" minimum tax for corporate taxpayers. Thus, although the alternative tax can result in tax savings, the benefit may be mitigated to some degree due to the minimum tax. Timber capital gains are allowed additional exemption amounts and other adjustments when calculating the minimum tax to offset the full effect of the "add-on" minimum tax.

6. The Section 631 election does not guarantee substantial tax savings in every case. The relative benefits of the 631
election depend on the mix of ordinary income and capital gain. For examples of the various combinations of capital gain and ordinary income and the tax effects of the Section 631 election, see Arthur Andersen (1980).

7. As a general rule, if the expenditure results in an asset with a useful life of over one year, or extends the life of the existing asset, the expenditure must be capitalized.

8. If an election is made under Section 631(a), the fair market value used for determining the 631(a) gain becomes the cost to be used for depletion purposes.
APPENDIX B
COURT CASES CITED


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