FACTOR SHARES IN THE CANADIAN FOREST INDUSTRIES, 1957-84

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ABSTRACT

This study has investigated time-series data from 1957 to 1984 in order to describe the existing functional income distribution and trends in the Canadian forest industries and its constituent sectors viz. logging industry (SIC 04), wood industries (SIC 25), and paper & allied industries (SIC 27). The functional income distribution in these industries has been measured by relative shares of factor inputs: labour, durable capital, money capital, materials, energy, taxes, and entrepreneurship.

The study has followed a methodology based on an income accounting approach according to which factor incomes were determined on a realization basis. This approach stresses the cost sharing nature of the resulting relative factor shares. The emphasis is on the long-term trends of relative factor shares, real factor prices, and factor productivities, so that the competitiveness of the industries in the use of various factor inputs was discussed.

The principal hypothesis of this study is that: relative factor shares in the forest industries have changed and that the rate of change in a relative factor share is consistent with the difference between the rate of change in real factor price and factor productivity. That is, the observed rate of change in a relative factor share is consistent with the hypothesized rate of change. The results support the principal hypothesis. There is only one exception, that is the observed rate of change in the relative share of stumpage is not consistent with the hypothesized rate of change.

In the forest industries, the relative shares of labour, stumpage, taxes, and profit have declined; and those of durable capital, money capital, materials, and energy have increased. Real labour price has substantially increased, while real materials' price has not significantly changed. These and other changes have encouraged technologies which are labour and timber saving, and capital, energy and materials using. As a result, labour productivity and timber productivity have risen, and productivities of other factor inputs have declined. Trends in various variables in the constitutent sectors differ in some cases from the ones for the forest industries in aggregate.

The resulting functional income distribution in the Canadian forest industries has been compared with that in the Canadian manufacturing sector and the Finnish forest industries. The directions of change in the relative factor shares, real factor prices, and factor productivities in the forest industries are in general agreement with thsoe in the Canadian manufacturing sector. However, functional income distribution in the Finnish forest industries has been found to be different from that in the Canadian forest industries. Finally, some policy implications of the findings of this study have been suggested and some areas for further research identified.

TABLE OF CONTENT

ABSTRACT	ii
LIST OF TABLES	vi
LIST OF FIGURES	ix
ACKNOWLEDGEMENTS	x
1. RESEARCH PROBLEM : AN INTRODUCTION	1
1.1 Introduction	1
1.2 Objectives and Relevance of the Research Problem	2
1.2.1 Nature of the Problem	4
1.2.2 Scope of the Study	6
1.3 Related Literature	6
1.4 Main Assumptions And Research Hypotheses	9
1.4.1 Main Assumptions	9
1.4.2 Main Hypothesis	9
1.5 Organisation of Thesis	10
2. ANALYTICAL FRAMEWORK AND METHODOLOGY	11
2.1 Theoretical Considerations	11
2.2 Analytical Framework	13
2.2.1 Tax Share and Entrepreneurial Income	15
2.2.2 Relative Factor Shares	18
2.2.3 Inter-temporal Changes in Relative Factor Shares	19
2.3 Methodology	23
2.3.1 Trends and Annual Growth Rates	24
2.3.2 Problems in the Methodology	25
2.4 Summary of Data utilized	28
3. CANADIAN FOREST INDUSTRIES : STATISTICAL ANALYSIS	31
3.1 Relevant Literature Review	31
3.1.1 Logging Industry	31
3.1.2 Wood Industries	32

3.1.3 Paper & Allied Industries 33
3.2 Statistical Analysis 34
3.2.1 Aggregation of output 45
3.2.2 Aggregation of factor inputs 47
3.3 Growth Trends in Output Values, Factor Incomes & Prices 56
3.4 Specific Research Hypotheses 57
4. CANADIAN FOREST INDUSTRIES : EMPIRICAL ANALYSIS 58
4.1 Relative Factor Shares 58
4.2 Trends and Growth Rates in Relative Factor Shares 59
4.3 Possible Factor Substitution and Technical Change 69
5. EMPIRICAL RESULTS : DISCUSSED 70
5.1 Interpretation of Results 70
5.1.1 Forest Industries 70
5.1.2 Logging Industry 76
5.1.3 Wood Industries 80
5.1.4 Paper and Allied Industries 84
5.2 Comparison of Empirical Results with other Studies 88
5.2.1 Comparison with Canadian Manufacturing Sector 90
5.2.2 Comparison with Finnish Forest Industries 93
6. EMPIRICAL RESULTS IN PERSPECTIVE 95
6.1 The Problem Addressed 95
6.2 Summary of Results 95
6.3 Some Policy Implication of the Findings 98
6.4 Some Reflections on Areas for Further Research 99
BIBLIOGRAPHY 102
APPENDIX I: CAPITAL MEASUREMENT METHOD 109
APPENDIX II: ADAPTED DATA 112
APPENDIX III: EMPIRICAL RESULTS 127
APPENDIX IV: COMPOSITION OF FACTOR INPUTS 150

LIST OF TABLES

Table 3.1: The Computed Ratios for Standardizing Data in the Logging Industry 43

Table 3.2: Annual Growth Rates in Nominal Values of Output, Factor Inputs and Their Prices, 1957-84 56

Table 4.1: Average Relative Factor Shares in the Forest Industries, 1957-84 58

Table 4.2: Forest Industries: Trends Parameter estimates and Summary Statistics 59

Table 4.3: The Constituent Indusries: Trend Parameters estimates and Summary Statistics 64

Table 4.4: Annual Growth Rates (%/a) of Relative Factor Shares, Real Factor Prices and Factor Productivities in the Forest Industries, 1957-84 65

Table 4.5: Annual Growth Rates (%/a) of Relative Factor Shares, Real Factor Prices and Factor Productivities in the Constituent Industries, 1957-84 66

Table 4.6: Possible Factor Substitution and Technical Change in the forest industries and the Logging Industry, 1957-84 67

Table 4.7: Possible Factor Substitution and Technical Change in the Wood Industries and the Paper & Allied Industries, 1957-84 68

Table 5.1: Average Relative Factor Shares in the Canadian Forest and Manufacturing Industries, and the Finnish Forest Industries, 1957-84 89

Table 5.2: Annual Growth Rates (%/a) of Relative Factor Shares and Other Relevant Variables in the Forest and Manufacturing Industries, 1957-84 91

Table 5.3: Annual Growth Rates (%/a) of Relative Factor Shares and Other Relevant Variables in the Finnish Forest Industries, 1955-83 93

Table II.1: Output Values, Output Indexes, & Price Indexes for the Forest Industries, 1957-84 112

Table II.2: Factor Price Indexes in the Forest Industries, 1957-84 114

Table II.3: Factor Prices Indexes in the Logging Industry, 1957-84 115

Table II.4: Factor Prices Indexes in the Wood Industries, 1957-84 116

Table II.5: Factor Prices Indexes in the Paper & Allied Industries, 1957-84 117

Table II.6: Factor Incomes in the Forest Industries, 1957-84 118

Table II.7: Factor Incomes in the Logging Industry, 1957-84 119

Table II.8: Factor Incomes in the Wood Industries, 1957-84 120

Table II.9: Factor Incomes in the Paper & Allied Industries, 1957-84 121

Table II.10: Indexes of Factor Quantities in the Forest Industries, 1957-84 122

Table II.11: Indexes of Factor Quantities in the Logging Industry, 1957-84 123

Table II.12: Indexes of Factor Quantities in the Wood Industries, 1957-84 124

Table II.13: Indexes of Factor Quantities in the Paper & Allied Industries, 1957-84 125

Table II.14: Annual Growth Rates in Nominal Values of Output, Factor Incomes and Nominal Prices in the Constituent Industries, 1957-84 126

Table III.1: Relative Factor Shares in the Forest Industries, 1957-84 127

Table III.2: Relative Factor Shares in the Logging Industry, 1957-84 128

Table III.3: Relative Factor Shares in the Wood Industries, 1957-84 129

Table III.4: Relative Factor Shares in the Paper & Allied Industries, 1957-84 130

Table III.5: The Forest Industries: Regression Parameter Estimates and Summary Statistics for Annual Growth Rates in Relative Factor Shares, Real Factor Prices and Factor Productivities 131

Table III.6: The Logging Industry: Regression Parameter Estimates and Summary Statistics for Annual Growth Rates in Relative Factor Shares, Real Factor Prices, and Factor Productivities 133

Table III.7: The Wood Industries: Regression Parameter Estimates and Summary Statistics for Annual Growth Rates in Relative Factor Shares, Real Factor Prices, and Factor Productivities 135

Table III.8: The Paper & Allied Industries: Regression Parameter Estimates and Summary Statistics for Annual Growth Rates in Relative Factor Shares, Real Factor Prices, and Factor Productivities 137

Table III.9: The Forest Industries: Regression Parameter Estimates and Summary Statistics for Annual Growth Rates in Ratios of Relative Factor Shares, Factor Prices, and Factor-Factor 138

Table III.10: The Logging Industry: Regression Parameter Estimates and Summary

Statistics for Annual Growth Rates in Ratios of Relative Factor Shares, Factor Prices and Factor-Factor 140

Table III.11: The Wood Industries: Regression Parameter Estimates and Summary Statistics for Annual Growth Rates in Ratios of Relative Factor Shares, Factor Prices, and Factor-Factor 142

Table III.12: The Paper & Allied Industries: Regression Parameter Estimates and Summary Statistics for Annual Growth Rates in Ratios of Relative Factor Shares, Factor Prices, and Factor-Factor. 144

LIST OF FIGURES

Figure 2.1: Demand and Supply Schedules for Factor Inputs 12

Figure 2.2: Indifference Curve Analysis for Entrepreneurial and Contractual Components of a Factor Input 17

Figure 3.1: Indexes of Output Values of the Forest Industries, 1957-84 35

Figure 3.2: Indexes of Output of the Forest Industries, 1957-84 36

Figure 3.3: Indexes of Output Prices in the Forest Industries, 1957-84 37

Figure 3.4: Indexes of Factor Prices in the Logging Industry, 1957-84 38

Figure 3.5: Indexes of Factor Prices in the Wood Industries, 1957-84 39

Figure 3.6: Indexes of Factor Prices in the Paper & Allied Industries, 1957-84 40

Figure 3.7: Indexes of Factor Prices in the Forest Industries, 1957-84 41

Figure 3.8: Indexes of Factor Incomes in the Logging Industries, 1957-84 42

Figure 3.9: Indexes of Factor Incomes in the Wood Industries, 1957-84 49

Figure 3.10: Indexes of Factor Incomes in the Paper & Allied Industries 50

Figure 3.11: Indexes of Factor Incomes in the Forest Industries, 1957-84 51

Figure 3.12: Indexes of Factor Quantities in the Logging Industry, 1957-84 52

Figure 3.13: Indexes of Factor Quantities in the Wood Industries, 1957-84 53

Figure 3.14: Indexes of Factor Quantities in the Paper & Allied Industries 54

Figure 3.15: Indexes of Factor Quantities in the Forest Industries, 1957-84 55

Figure 4.1: Relative Factor Shares in the Logging Industries, 1957-84 60

Figure 4.2: Relative Factor Shares in the Wood Industries, 1957-84 61

Figure 4.3: Relative Factor Shares in the Paper & Allied Industries, 1957-84 62

Figure 4.4: Relative Factor Shares in the Forest Industries, 1957-84 63

Figure III.1: Deviations of Relative Factor Shares from Their Means in the Forest Industries, 1957-84 146

Figure III.2: Deviations of Relative Factor Shares from Their Means in the Logging Industry, 1957-84 147

Figure III.3: Deviations of Relative Factor Shares from Their Means in the Wood Industries, 1957-84 148

Figure III.4: Deviations of Relative Factor Shares from Their Means in the Paper & Allied Industries, 1957-84 149

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1. RESEARCH PROBLEM : AN INTRODUCTION

1.1 INTRODUCTION

Income is an important determinant of social welfare. It is created in the 'production process' and is simultaneously distributed amongst the economic agents that produce it. Therefore, the theories of 'production' and 'distribution of income' occupy an important place in the discipline of economics. Theories of production are concerned with the decision-making processes of the firms which transform resources into the goods and services desired by society. Firms in an industry use an optimum mix of resources, or inputs, in order to produce that amount of output which will maximize their profits. These inputs are called 'factors of production' or simply 'factors' and are traditionally classified as: labour, land, capital and entrepreneurship.

Theories of 'income distribution' are primarily concerned with the distribution of the value of gross output (or that of value added) among various production factors as a payment to them for the use of their services. In the process of production, each factor receives a certain share. Thus, labour receives *wages* (including salaries & other compensations); land-based resources receive *rent;* capital receives *interest*; and the residual goes to the entrepreneur in the form of *profit.* Such a distribution of income amongst various production factors is called 'functional income distribution'[1]. This income distribution is the outcome of an intricate economic process (Pen, 1971).

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[1]Another notion of 'income distribution' is 'personal income distribution' which means distribution of national income amongst various individuals (Craven, 1979). Personal income distribution is a function of factor ownership and prevailing factor prices. This concept has grown with concern for the alleviation of poverty and the stimulation of growth in the less developed countries (Johnson, 1973). This study focuses on the functional income distribution which has a bearing on the personal income distribution (Denison, 1954). In this respect, distribution theory is closely related to welfare economics (Craven, 1979; Ferguson, 1969). It is, therefore, highly relevant from the point of view of public policy.

1.2 OBJECTIVES AND RELEVANCE OF THE RESEARCH PROBLEM

In analyzing the problem of income distribution, two questions must be addressed: (1) how to separate the shares earned by various factors of production; and (2) how to explain the shares earned by each factor of production. These questions have always remained key issues in economics. In fact, some economists have described them as the 'principal problem' in a political economy (Sraffa, 1960). This is still an important problem which is yet to be finally settled (Samuelson, 1980).

Recently, attempts have been made to determine how the value of output of specific industries is distributed. Ovaskainen (1986) has described functional income distribution in the Finnish forest industry from 1955 to 1983. Mutti & Morgan (1983) have studied the Western coal industry in Wyoming, U.S. and have examined the effect of changing energy prices on the economic rent in the industry. To date, however, no studies of this type have addressed the forest industry sector in Canada.

This study, therefore, investigates functional income distribution in the Canadian forest industries from 1957 to 1984. It is an important research topic for a number of reasons. First, such studies describe the distribution of income amongst various production factors employed in a given industry. Second, they explain changes in industrial structure in terms of changes in the product-mix and changes in input-use over time. Third, such studies form a basis for growth models (Johnson, 1973).

This study of the Canadian forest industries also has immediate relevance in helping to address some current policy problems. It may provide insights into such issues as:

1. How relative factor shares have changed over time.

   When more than one factor is employed in a production process, it is not explicitly known how relative shares of each factor change over time. In fact, inter-temporal changes in relative factor shares depend upon a number of variables including changes in production technology, elasticity of substitution amongst various factors and prices of input factors and output.

2. How real factor prices have changed over time.

   Changes in real factor prices are influenced by the same variables which cause changes in real factor shares. In fact, this issue may be considered corollary to the one mentioned above.

3. How factor productivities have changed over time.

   Factor productivity may be defined as total output divided by total factor input, that is, the output attributable to one unit of a factor. Changes in factor productivities are affected by changes in real factor prices, the level of output produced and technical changes (Singh & Nautiyal, 1986).

Studies such as this may be further extended to examine other issues as follows. This study will, however, only deal with these issues superficially:

1. Are all factors of production in an industry earning returns equivalent to their opportunity cost?

   To be employed and retained in the forest industries, a factor must be paid at least as much as it can earn in its best possible alternative employment. This minimum payment to the factor is called its transfer earnings or opportunity cost. If it is assumed that factor and output markets are perfectly competitive and factors are priced according to their marginal product, each factor will be paid as much as its opportunity cost. Ideally, a factor share will then be equal to the quantity of factor employed multiplied by its marginal product.

2. Are factors earning some 'economic rent'?

   A payment made to a factor in excess of its opportunity cost is a surplus and is called 'economic rent'. For example, if the supply of a factor is fixed, its price is solely determined by the demand for it. In such a circumstance, a factor may earn more than its opportunity cost. This excess income earned by the factor may be viewed as economic rent.

3. Is stumpage charged by the Crown equal to its true economic rent?

   Stumpage or the payment for standing timber is an important charge on forest industries. Whether the price paid for Crown timber is equal to its economic rent, or whether a part of this rent is captured by the forest industries, is a controversial issue which is of considerable significance in public forest policy.

1.2.1 NATURE OF THE PROBLEM

The investigation of income distribution in a particular industry may be divided into two parts: (i) describe the existing income distribution in the industry and observe trends and anomalies, if any; and (ii) explain observed trends and investigate causes of any anomalies in the income distribution.

If Pf and Pq are the prices for a factor and output, respectively, and F & Q are quantities of factor employed and output produced, then the absolute share of the factor, or factor share, may be defined as price of the factor multiplied by its quantity (i.e. Pf x F). Relative factor share may then be defined as 'factor share' divided by the value of gross output (i.e. (Pf x F)/(Pq x Q)) where (Pq x Q) is the value of gross output. Following this definition, real factor price is defined as the ratio of nominal factor price to nominal output price, that is, (Pf/Pq). The problem of income distribution, therefore, reduces mainly to the problem of factor pricing. But it is also influenced by other variables such as production technology; technical progress; factor productivities and the degree of substitution between factors.

The price of a factor is the result of interaction between the demand for the factor and its supply. The demand for a factor is usually a derived demand (i.e. the demand for a factor is derived from the demand for 'final' output, for the production of which the factor is required). Also, factor demands in the Canadian forest industries are actually interrelated, i.e. a disequilibirium in the demand for an input creates compensating adjustments in the demand for other inputs (Singh & Nautiyal, 1986). Thus, demand for a factor depends, inter-alia, upon the price of the output; the prices of other factors; the degree of substitutability amongst different factors; and factor productivity. Similarly, the supply of a factor is also influenced by a number of considerations such as the demand for the factor by other industries; existence of resource cartels (e.g. labour unions etc.); and other institutional constraints.

There are three approaches to the determination of income distribution. The first approach is that of 'general equilibirium analysis'. In this approach, the problem of factor pricing is considered as a part of general price theory which can be solved by applying 'general equilibirium analysis' to a given industry.

The second approach is to use a macro-model for income distribution (Ferguson, 1980; Lydall, 1979). This involves specification of an aggregate 'production function' (or its dual aggregate 'cost function') which describes the relationship between the output of the given industry and the inputs or factors employed by the industry. The aggregate production function or aggregate cost function is then analyzed to estimate 'real factor prices' and 'relative factor shares'.

The third approach is called the 'social accounting' or 'income accounting' approach. This approach is derived[2] from the second approach and has been used by several empirical researchers (Jorgenson & Griliches, 1967; Ovaskainen, 1986). Jorgenson & Griliches (1967) theorised that if output and inputs were accurately measured, as for national or regional accounting purposes, movement along the production function could be separated from shifts in the production function. In other words, some of the properties of the underlying production function could be captured without specifically estimating it. This study employs the 'income accounting' approach which is explained in detail in the next chapter.

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[2] Refer section 2, chapter 2.

1.2.2 SCOPE OF THE STUDY

This study will investigate time series data from 1957 to 1984 to describe income distributions and their trends in:

- the Canadian forest industries[3].
- the constituent sectors[4] of the forest industries.

The study will also:

- estimate real factor prices and relative factor shares;
- observe trends and anamolies in real factor prices and relative factor shares over time;
- compare the results with those of Ovaskainen (1986); and
- compare the observed trends in functional income distribution in the forest industries with those in all Canadian manufacturing.

Labour, durable capital, entrepreneurship, materials & supplies, and energy are considered factors of production in the forest industries. Timber, which is generally included in 'materials & supplies', will be considered as a separate factor input. Tax share will also be considered as a separate factor input.

1.3 RELATED LITERATURE

The literature is replete with various theories[5] of income distribution and attendant controversies. The marginal productivity theory of income distribution is, however, the mainstay of most of the empirical research in this field. Ferguson

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[3]For the purpose of this study, the forest industries are comprised of the Logging Industry (SIC 04); Wood Industry (SIC 25) and Paper & Allied Industry (SIC 27) where SIC refers to standard industrial classification as per Standard Industrial Classification Code, 1980: Statistics Canada Cat. No. 12-004.

[4]viz. Logging Industry(SIC 04); Wood Industry (SIC 25) & Paper & Allied Industries (SIC 27)

[5]Adam Smith (1776), Ricardo (1951-73), Marx (1867), Clark (1902), Marshal (1920), Hicks (1932), Douglas (1934), Kalecki (1942), Kaldor (1955), Robinson (1960), Pasinetti (1962) and Lydall (1979) all have contributed to the theory of income distribution. Dobb (1973) has surveyed all these theories. Some of these theories have been discussed in Bronfenbrenner (1971), Craven (1979), Johnson (1973) and Lydall (1979).

(1969), Bronfenbrenner (1971), Johnson (1973) and Gould and Ferguson (1980) have expounded this theory.

Various aspects of income distribution have been empirically investigated[6]. The growing theoretical and empirical literature has brought forth a number of controversies. Two of them deserve mention here. The first controversy stems from an apparent observation[7] about *the tendency* of relative factor shares to remain constant over time (Johnson, 1973). For example, Johnson (1954) and others reported constancy of relative factor shares over time. Kravis (1959) concluded that the notion of long-run constancy in relative factor shares was false. Solow (1958) also expressed his skepticism about the reported constancy of relative factor shares. This study hypothesizes that relative factor shares in the forest industries have changed over time and that the change in a relative factor share is consistent with the change in differential between real factor price and partial factor productivity[8].

The second controversy concerns the role of 'social power' and institutional factors in income distribution (Pen, 1971). To be specific, it is generally believed that unions tend to raise labour's share above its marginal contribution and that monopolies reap heavy profits at the cost of other factors. The problem of income distribution, in fact, still presents many open questions.

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[6] Notable empirical studies are: Johnson (1954), who investigated functional income distribution in U.S. economy from 1850 to 1952 and reported constancy of labour share during 1850-1900 and variablity of that share during 1900-1952; Kravis (1959) who studied functional income distribution in U.S. economy during 1900-1957, observed a shift in the distribution in income from property to labour and concluded that the notion of long-run constancy in relative factor shares is false. Solow (1959) also expressed his skepticism about the reported constancy of relative factor shares; Levinson (1954) and Simler (1961) investigated the impact of unoinism on income distribution; Hashimi (1960) studied the impact of inflation on income distribution in U.S. economy during 1929-1957; Denison (1967); Ferguson (1968) and Kendrick & Sato (1963) examined the impact of growth and technical progress on relative factor shares.

[7] See footnote 6.

[8] This will be shown in chapter 2.

Explaining income distribution in a specific sector of an economy is far more difficult than that in the economy as a whole. Research in this direction is still in the nascent stage. Ovaskainen (1986) who studied the functional income distribution in the Finnish forest industry observed a slight increase in the labour share, a decrease in stumpage share and no perceptible trend in the share of profit[9] over time. These observations form the basis for the specification of the research hypotheses of this study.

Although functional income distribution in the forest industries sector in Canada has not yet been studied, the state of technology, in particular the substitution possibilities between various factors and rates of technical change, in some of these industries have been empirically examined[10]. These studies have observed, with the exception of Rao & Preston (1983) and Singh & Nautiyal (1986), limited possibilities for substitution between factors and negative technical change which is generally labour saving and capital and material using in all three industries, viz. logging industries, wood industries, and paper and allied industries.

Rao & Preston (1983) reported positive technical change which is capital and labour saving and material using in all three industries. Singh & Nautiyal (1986) observed decreases in productivities of capital, wood and energy and an increase at the rate of 2.9% per annum in labour productivity in the Canadian lumber industry. They also reported that technical progress was unobservable. Martinello (1985) also reported that the hypothesis that factor shares are independent of factor prices was overwhelmingly rejected for all three industries. This thesis will provide a fresh insight into some of these observations.

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[9] Ovaskainen (1986) used the term profit for the share of capital and enterpreneurship.

[10] Some notable studies are: Woodland (1975), Rao & Preston (1983), Banskota & Phillip (1985), and Martinello (1985) studied the Canadian logging industry; Rao & Preston (1983), Martinello (1985), and Singh & Nautiyal (1986) studied the Canadian lumber industry; and Rao & Preston (1983), Sherif (1983), Martinello (1985), and Singh & Nautiyal (1986) empirically investigated the Canadian paper & allied industries or part thereof; and Martinello (1984) & Constantino (1986) examined lumber industry in B.C.

1.4 MAIN ASSUMPTIONS AND RESEARCH HYPOTHESES

Real world economic problems are too complex and difficult to be analyzed completely. It is, therefore, necessary to reduce these complex problems into simple models incorporating their essential features and discarding undesirable details. This sometimes requires heroic assumptions. This thesis employs the following assumptions which are commonly found in the relevant literature (Johnson, 1973; Ferguson and Gould, 1980).

1.4.1 MAIN ASSUMPTIONS

- The aggregate output of the forest industries is assumed to be homogeneous.
- The forest industries face a competitive product market.
- The factors - labour, durable capital, materials & supplies, energy etc,- are assumed to be homogeneous.
- The forest industries also face competitive factor markets.
- The aggregate production function is assumed to be linearly homogeneous exihibiting constant returns to scale.
- The aggregate production function is further assumed to be continuous and twice differentiable.
- Firms in the forest industsries are assumed to be profit maximizers.

1.4.2 MAIN HYPOTHESIS

The principal hypothesis of this study is that:

> the relative shares of the various factors of production in the forest industries have changed over time and that the change in a relative factor share is consistent with the change in the differential between real factor price and partial factor productivity.

Specific hypotheses about relative shares and real prices of individual factors will be developed in Chapter 3.

1.5 ORGANISATION OF THESIS

Chapter 2 of this study develops the analytical framework and explains the methodology to be used in subsequent chapters. In developing the analytical framework, a number of problems inherent in the proposed study are identified and discussed. The framework also provides the basis for the principal hypothesis to be tested in subsequent chapters.

Chapter 3 includes statistical analysis of the forest industries. In this chapter, relevant literature is briefly reviewed; the important short-comings in the data are highlighted; and the procedure for aggregation of output and factor inputs is briefly explained. Finally, specific hypotheses about expected changes in relative shares and real prices of individual factor inputs are elaborated.

Empirical analysis of the forest industries is given in Chapter 4. The relevant empirical results about the forest industries and each of the constituent industries are summarized in this chapter. These empirical results are detailed in Appendix III.

In Chapter 5, results are discussed in the light of the specific research hypotheses and compared with the results of Ovaskainen (1986) and with those for the Canadian manufacturing sector. Finally, Chapter 6 concludes with a summary of the results and some recommendations for further research.

***

2. ANALYTICAL FRAMEWORK AND METHODOLOGY

2.1 THEORETICAL CONSIDERATIONS

This chapter focuses on three key questions this thesis addresses, that is: (i) how to determine relative factor shares in the Canadian forest industries; (ii) how to discern trends and anomalies in the relative factor shares over time; and (iii) how to use trends and anomalies in the relative factor shares/prices to explain some of the inter-temporal changes in the structure of the Canadian forest industries, such as changes in factor-mix, factor productivities and technological change.

Underlying the formulation of the methodology is the assumption that in order to maximize their profits, firms in the forest industries hire homogeneous factors of production - labour (L), durable capital (K), materials & supplies (M), Timber (TR), energy or fuel (F), and entrepreneurship (E) to produce a homogeneous output (Q)[1]. Firms also pay taxes (tax) which may also be considered a factor of production[2].

Factor shares and relative factor shares depend on the demand for factors by forest industries and the supply of the factors available to these industries. The demand for a factor is a derived demand and depends, in addition to the factor price, on the price of output; the price of other factors; and the degree of

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[1] Recall our assumptions of homogeneity in section 1.4.1 of chapter 1. The symbols L, K, M, TR and F represent both - homogeneous factors of production and their quantities. Similarly, symbol Q represent homogeneous output. The term 'materials & supplies', as used here, does not include timber, that is, M is net of TR. The term 'materials & supplies' is hereafter shortened to 'materials'.

[2] Taxes are justified in a number of ways, two of which need be mentioned here. According to one view, taxes are considered a part of an 'economic surplus' to which society has a right to a portion. In this view, taxes are only a part of pure 'profit'. The second approach is to view taxes as a price for governmental services. In this thesis, the second approach is accepted. Government services are: considered essential for 'production'; hired by the 'firms; and paid for in the form of taxes. In other words, taxes have been considered a factor of production for the purpose of this study.

substitutability between different factors as dictated by available production technology. An industry usually generates a negatively sloping factor demand curve (DD' in figure 2.1).

The supply of a factor to an industry is also influenced by a number of considerations such as the demand on the factor by other industries; existence of resource cartels (e.g. labour unions); and other institutional constraints, for example, annual allowable cut (AAC) restrictions faced by the forest industries in Canada. An industry usually faces a positively sloping factor supply curve (SS' in figure 2.1). The price of a factor (Pf) and the factor quantity (F) employed by the industry, are the result of interaction between the demand for the factor and supply of the factor to that industry. The factor share, or factor income, is then defined as the factor price multiplied by the quantity of the factor employed, that is, (Pf.F).

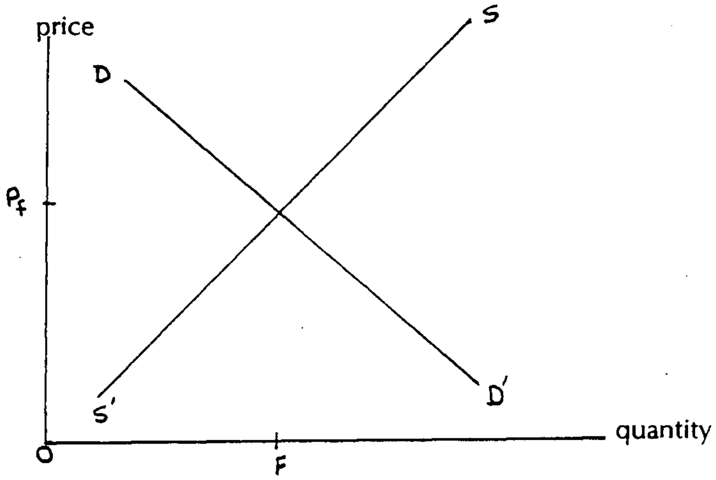

FIGURE 2.1 : Demand and Supply schedules for factor inputs

A profit-maximizing entrepreneur equates the value of the marginal product (VMP) of each factor employed to its price (Gould & Ferguson, 1980)[3]. This implies

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[3]This is true only under the condition of perfectly competitive product and factor markets. If the product market is imperfect, a profit-maximizing enterpreneur will employ that quantity of a variable factor at which the marginal revenue product of the factor equals its price. This study employs the assumptions of the perfectly competitive product and factor markets faced by the forest industries in Canada.

that if the aggregate production function of an industry is known, the factor prices and factor quantities employed can be imputed. Consequently, factor shares and relative factor shares can be determined.

Jorgenson & Griliches (1967) theorised that: (i) if quantities of output and inputs entering the production function are accurately measured, as for social accounting purposes; and (ii) if marginal rates of technical substitution are identified with the corresponding price ratios[4]; then employing data on both quantities and prices, movements along the production function may be separated from shifts in the production function without explicitly estimating the production function. They used this 'social-accounting' approach in explaining changes in productivity in the U.S. economy.

Following this approach, it is theorised here that: (i) if quantities of output and factor inputs entering into the production function are accurately measured; and (ii) if output and input prices are correctly determined; then the value of output may be exactly distributed amongst the relevant factor inputs establishing an 'income identity' which can be employed, without explicitly estimating the underlying production function, to address the questions this thesis raises.

2.2 ANALYTICAL FRAMEWORK[5]

Let the aggregate production function of a forest industry, which describes the relationship between the output (Q) and the factors of production[6] be:

$$Q = f(L, K, M, TR, F) \qquad (1)$$

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[4]To maximize output subject to a given total cost, that is to maximize profit, an entrepreneur must purchase inputs in quantities such that the marginal rate of technical substitution of one factor for another factor is equal to the ratio of price of one factor to that of the other (Gould & Ferguson, 1980).

[5]This section is based primarily on Gould & Ferguson (1980).

[6]For the moment, we ignore factors, entrepreneurship (E) and taxes (tax) which do not explicitly enter into the aggregate production function.

In this expression, Q, L, K, M, TR, and F have preassigned meanings. Let $\delta f/\delta L = f_L$ be the marginal product of labour; $\delta f/\delta K = f_K$ be the marginal product of capital and so on. Then totally differentiating (1), we have:

$$dQ = f_L.dL + f_K.dK + f_M.dM + f_{TR}.dTR + f_F.dF \qquad (2)$$

If all factors are increased by the same proportion λ, then:

$$\lambda = dL/L = dK/K = dM/M = dF/F = dTR/TR \qquad (3)$$

Substituting (3) into (2), multiplying (2) by Q and dividing it by λQ, we get:

$$Q.dQ/(\lambda Q) = f_L.L + f_K.K + f_{TR}.TR + f_M.M + f_F.F \qquad (4)$$

Consider the term $dQ/\lambda Q$, which shows the relative change in output Q attributable to the same relative change in all factors. This is called the function coefficient or the elasticity of the production function (Gould & Ferguson, 1980). It is denoted by ϵ and equation (4) can be written as:

$$Q\epsilon = f_L.L + f_K.K + f_M.M + f_{TR}.TR + f_F.F. \qquad (5)$$

The first problem is now encountered: if each factor is paid according to its marginal product, will total product be completely exhausted? Equation (5) suggests that this will be so if, and only if, $\epsilon = 1$, that is, the aggregate production function exhibits constant returns to scale[7]. This is what is assumed in this model (see section 1.4.1, Chapter 1.).

Let p be the price of output Q. Substituting $\epsilon = 1$ and multiplying (5) by p, the equation (5) can be rewritten as:

$$p.Q = (p.f_L).L + (p.f_K).K + (p.f_M).M + (p.f_{TR}).TR + (p.f_F).F \qquad (6)$$

Recall that a profit-maximizing entrepreneur employs a variable factor to the point at

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[7] This is called the 'adding-up theorem' and is due to Euler (Johnson, 1973).

which the value of its marginal product is equal to its price. Therefore, it is possible to impute labour's wage rate, $w = p.f_L$; rate of return to durable capital, $r = p.f_K$ and so on. Equation (6) can, therefore, be written as:

$$p.Q = w.L + r.K + pm.M + pt.TR + pf.F \qquad (7)$$

or

value of output (p.Q) = labour share (w.L) + capital share (r.K) + share of materials (pm.M) + stumpage share (pt.TR) + fuel share (pf.F)

where pm, pt and pf are respectively the price of materials, stumpage (per unit quantity of timber harvested) and fuel. Equation (7) is central to the further development of the model. However, it must first be modified to incorporate the shares of output captured by taxes and entrepreneurial income (profit).

2.2.1 TAX SHARE AND ENTREPRENEURIAL INCOME

If taxes are considered as payments by firms for desired government services which may be viewed as an 'essential' factors of production, government services may be measured by means of a 'quantity index' and can be explicitly introduced into the production function. Using this assumption, equation (7) can be readily extended to include tax share.

The entrepreneurial factor, however, poses several questions[8]. Without loss of generality, the following three questions must be addressed:

1. what is the 'entrepreneurial' function in the corporate sector which dominates Canadian forest industries?;
2. how is this factor of production rewarded? If each explicit factor of production is paid its VMP, is there anything left for this factor[9]?;

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[8] A good discussion on all these questions is found in Bronfenbrenner (1971), which forms the basis for this subsection.

[9] In other words, is the 'adding-up theorem' consistent with the returns to this factor?

3. how can this factor be measured?

In classical economics, the role of the entrepreneur is perceived as the ultimate decision-maker and uncertainity-bearer. Profit, which is the residual after all explicit and implicit factors of production are paid, is the reward of this factor. This view holds only for unincorporated firms. In the corporate sector, the functions of decision-making and uncertainity-bearing are separated. Decisions are made by the paid management which also organises the production, while risks and uncertainities are borne by the share-holders. Thus, the traditional definition of 'entrepreneur' is of no help in this case.

Following Bronfenbrenner (1971), 'entrepreneur' is defined as that 'factor' which assumes the responsibility for those uncertainities that cannot be transformed efficiently into hedgeable, insurable, or otherwise transferable risks involved in the production process. The risk is assumed in expectation of higher rewards. In a corporation, this role is played by common stock-holders. Enterpreneurial income or profit is the residual after all contractual claims are honoured and paid. This residual may be positive or negative.

The question still remains as to how this residual arises. This is explained as follows. For this purpose, factors of production are divided into two categories: (1) contractual factors, and (2) entrepreneurial factors, depending on how their incomes are determined. A single factor may have both contractual and entrepreneurial components. For example, an investor may invest part of his savings in common stocks and the rest in the contractual interest-bearing debentures of the same firm. Indifference curves can be used to analyze how a firm will allocate its budget for a given factor of production between its entrepreneurial and contractual components.

In figure 2.2, the x-axis represents the quantity of the contractual component of a factor employed at an explicit price and the y-axis represents the quantity of the entrepreneurial component of the same factor employed at an implicit price. No difference in the productivity of each component is assumed. However, the shape of the isoquants Q1, Q2 and Q3 depends on how management perceives uncertainties and risks. For example, management may perceive that excessive employment of an entrepreneurial factor may dilute both control and profits. On the other hand, management may perceive that if too many factor inputs are employed contractually, entrepreneurial factors may suffer unbearable losses specially in bad times.

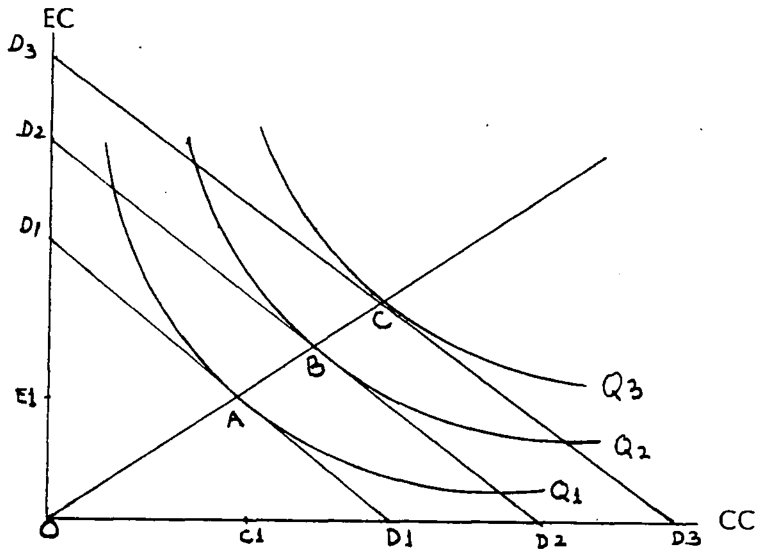

FIGURE 2.2: Indifference curve analysis for entrepreneurial (EC) and contractual (CC) components of a factor input

There is, therefore, a compelling need to arrive at an optimum balance between both types of factor inputs. Let D1, D2 and D3 be the price lines (or the budget lines), the slopes of which depend upon the prices of both the components. The optimum combination of both types of factor inputs is given by the points at which the price lines are tangential to the isoquants, that is, points A, B and C. For example, at point A, the quantity of entrepreneurial component is E1 and that of contractual component C1. Let the price of entrepreneurial component be p1 and that of contractual component be p2. The total outlay on these components at point A is (p1.E1) and (p2.C1) respectively.

Having determined the optimum proportion of entrepreneurial and contractual components of the factor and given the total outlay on the factor, a weighted average price (pr) for the factor can be computed by the formula: pr = (p1.E1 + p2.C1)/(E1+C1). A rational management (or entrepreneur in case of unincorporated firm) would employ that quantity of a factor of production, (E1+C1), at which the VMP of this factor equals its weighted average price (pr), not the contractual price (p1). Management pays only the contract price to the component employed contractually. The balance, that is the difference between the total value of output and total contractual payment, is retained by the entrepreneur.

This exposition not only explains the nature of the residual but also circumvents the problem created by the 'adding-up theorem'. It may be noted that the entrepreneurial factor, so conceived, cannot be empirically measured, however, this abstraction justifies the extension of equation (7) as follows:

$$p.Q = w.L + r.K + pm.M + pt.TR + pf.F + \tau.tax + pr.E \qquad (8)$$

or

value of output = labour share (w.L) + capital share (r.K) + materials' share (pm.M) + stumpage share (pt.TR) + energy or fuel share (pf.F) + tax share (τ.tax) + profit share (pr.E)

where τ and pr are the imputed price for homogeneous government services (tax rate) and the implicit price for entrepreneurial factors, respectively. Equation (8) is called the 'income-accounting' identity. Two problems still remain: (1) the measurements of 'entrepreneurial factor' and 'government services' so that these factors can be explicitly brought into the production function; and (2) the estimation of such a production function.

2.2.2 RELATIVE FACTOR SHARES

A 'relative factor share' may be defined as 'factor share' divided by the 'value of output' and a 'real factor price' may be defined as nominal factor price divided by nominal output price. For example, real labour price, (p_L), may be defined as, (w/p), that is, wage (w) divided by nominal output price (p). The relative labour share (SL) may be defined as labour share (w.L) divided by value of output (p.Q), that is,

$$SL = (w.L)/(p.Q) = (w/p).(L/Q) = (w/p)/(Q/L) \qquad (9)$$

or

$$SL = (\text{real labour wage})/(\text{labour productivity}) \qquad (9a)$$

where (w/p) is defined as the marginal physical product of labour or the real labour wage and (Q/L) is defined as labour productivity.

2.2.3 INTER-TEMPORAL CHANGES IN RELATIVE FACTOR SHARES

How do changes in real factor prices, factor productivities, elasticities of substitution and production technology bring about changes in relative factor shares over time? This problem can be addressed as follows. Total differentiation of the right-hand side of equation (9) yields:

$$d((w/p).(L/Q)) = (L/Q).d(w/p) + (w/p).d(L/Q) \qquad (9b)$$

Dividing (9b) by relative labour share provides an equation for the rate of change in relative labour share, that is:

$$(d((w/p).(L/Q)))/((w.L)/(p.Q)) = ((d(w/p))/(w/p)) + ((d(L/Q))/(L/Q)) \qquad (9c)$$

Since $(d(L/Q))/(L/Q)) = -((d(Q/L))/(Q/L))$, the equation (9c) can be rewritten as:

$$(d((w.L)/(p.Q))/((w.L)/(p.Q))) = ((d(w/p))/(w/p)) - ((d(Q/L)/(Q/L)) \qquad (10)$$

In equation (10), the expressions ((d(w/p))/(w/p)), ((d(Q/L))/(Q/L)), and ((d((w.L)/(p.Q)))/(w.L)/(p.Q)) represent the rate of change in the expressions (w/p), (Q/L), and ((w.L)/(p.Q)) respectively. This equation can, therefore, be restated as follows:

> PROPOSITION I : the rate of change in the relative factor share = the rate of change in real factor price - the rate of change in factor productivity.

In other words, it can be asserted that the change in a relative factor share depends on the difference between the rate of change in real factor price (or marginal product of the factor) and the rate of change in factor productivity. This is the basis for the principal hypothesis enunciated in chapter 1. The long-term changes in factor productivities compared to real factor prices affect the competitiveness of an industry (Singh & Nautiyal, 1986).

Now assume that: (i) there is no technological change in the production technology in the forest industries during the period of analysis; and (ii) there is a change in the price of a factor relative to the price of another. When there is a relative change in factor prices, entrepreneurs search for a new optimal factor combination, that is they adjust the relative quantities of factors employed along the relevant isoquants. They substitute the less expensive factor for the relatively more costly one. The degree of substitutability between different factors depends upon the production technology and is measured by elasticity of substitution.

Allen elasticity of substitution, denoted as σ, measures the responsiveness of the factor ratios to given proportional changes in the marginal rate of technical substitution (MRTS) of one factor for the other (Gould & Ferguson, 1980). For example, if capital (K) and labour (L) are two substitutable factors of production, then elasticity of substitution of capital for labour is defined as:

$$\sigma = ((d(K/L))/(K/L))/((d(MRTS))/(MRTS)) \qquad (10a)$$

It can be shown that MRTS = MP_L/MP_K = (w/p)/(r/p) = (w/r) at the equilibrium point. Substituting this result in 10(a), we get:

$$\sigma = ((d(K/L))/(K/L))/((d(w/r))/(w/r)) \qquad (10b)$$

or

$$\sigma = ((d(K/L))/(d(w/r))).((w/r)/(K/L)) = ((d(K/L))/(d(w/r))).(wL/rK) \qquad (10c)$$

This obviously affects the relative shares of factor employed over time.

However, the effect of elasticity of substitution on the relative factor shares can be shown as follows: let labour (L) and capital (K) be two arbitrarily chosen factors of production. The ratio of the relative labour share (wL/pQ) to the relative share of capital (rK/pQ) is (wL/rK) = (w/r).(L/K). For the purpose of simplification, it is assumed that: $w/r=\phi$ and $(K/L) = \rho$. Then, $(wL/rK) = \phi/\rho$. The change in (wL/rK) with respect to (w/r) is given by differentiating the first expression with respect to the second and substituting the relevant values from (10b) and (10c). That is:

$$d(\phi/\rho)/d(\phi) = ((\rho - \phi . d\rho/d\phi)/(\rho . \rho) = (1 - \sigma)/\rho \qquad (11)$$

It follows from (11) that, for $\sigma < 1$, the ratio of the relative factor shares increases. That is, the labour share increases relative to the capital share. For $\sigma = 1$, the ratio remains the same implying that there is no relative change in the shares of both the factors. If σ is greater than 1, the ratio declines suggesting that the labour share decreases compared to the capital share. This result can be generalized, as follows, for any pair of factors (Gould & Ferguson, 1980):

> PROPOSITION II: Consider a pair of any two substitutable factors of production. The relative factor share of one factor increases, remains the same, or decreases accordingly as the elasticity of substitution of this factor for the other is less than, equal to, or greater than unity.

Now let assumption (i) above be relaxed in order to examine the effect of technological change on relative factor shares. Technological change causes a shift in the production function and can be defined as factor-using, neutral, or factor-saving, depending on whether the marginal rate of technical substitution (MRTS) of one factor for another diminishes, remains unchanged, or increases at the originally prevailing factor ratios[10].

For example, let labour (L) and capital (K) be two arbitrarily chosen factors of production. A technological change will be said to be capital-using, neutral, or

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[10]This definition, due to Hicks, is quoted from Gould & Ferguson (1980)

capital-saving accordingly as the marginal rate of technical substitution (MRTS) of capital for labour decreases, remains the same, or increases given that the capital-labour ratio remains the same. Recall, that at the equalibrium, the marginal rate of technical substitution (MRTS) of capital for labour equals (w/r). Now, if technological progress is neutral, MRTS (= w/r) remains the same given the capital-labour ratio (K/L). This implies that the ratio of the relative shares is not affected. Proposition II suggests that the relative labour share remains unchanged.

If technological change is capital-using, the MRTS of capital for labour decreases, that is, at the equilibrium point, the wage-interest ratio (w/r) decreases given that the capital-labour ratio (K/L) remains the same. This means that r increases relative to w given that (K/L) the same. This implies that the relative share of capital increases and that of labour decreases. By a similar line of reasoning, it may be shown that capital-saving technological change causes the relative share of capital to decline and that of labour to increase. This result can be generalized as:

> PROPOSITION III: the relative share of a factor (compared to another factor) increases, remains the same, or decreases accordingly as technological change is factor-using, neutral, or factor-saving; the opposite relationship holds for the relative share of another factor (Gould & Ferguson, 1980).

Propositions II and III imply that if information about elasticity of substitution and bias of technological change are available, then the directions of the changes in 'relative factor shares' can be deduced. Conversely, if inter-temporal changes in relative factor shares are known, one can deduce the possibilities of substitution between various factors and the bias of technological change. These, in turn, provide insights into the industrial structure.

If, given the underlying production function, the income-accounting identity (8) is correctly constructed, then equations (9), (10) or proposition I, (11) or proposition II and proposition III provide an analytical framework to address the key questions this thesis raises. Direct econometric estimation of such a production function is not necessary. This study follows this approach and concentrates on realized costs of production attributable to various factors, assuming implicit production and cost functions. The next section explains this methodology in detail.

2.3 METHODOLOGY

In the process of production, each factor receives payment for the use of its services. This payment is an income to the factor and a cost to the producer. A 'factor share' is, therefore, a part of the total cost of production. Existing 'factor shares' can be determined on a realization basis, excluding potential capital gains, if any. This approach stresses the cost share nature of the resulting factor shares (Ovaskainen, 1986). The value of gross output and the realized shares of labour, energy, materials, stumpage, and taxes are directly available in various publications of Statistics Canada. The share of durable capital and returns to 'money capital' are imputed. The residual, that is, the difference between the value of gross output and the sum of above mentioned shares, is assigned to the entrepreneurial factor. Thus, income-accounting identity (8) is constructed.

Factor shares divided by the value of gross output yield relative factor shares which are expressed as percentages. Factor prices are imputed by dividing each factor share by the quantity of the aggregated homogenized factor. Factor prices divided by the value of gross output yield the relative factor prices. Output quantity divided by factor input quantities yield factor productivities. Similarly, dividing the relative share of a factor by that of another yields the ratio of one relative factor share to another. Ratios of factor inputs and their prices are obtained in a similar manner. In this way, time-series data on 'factor shares', 'relative factor shares', 'factor prices', 'factor quantities', 'relative factor prices', 'factor productivities', 'factor ratios', 'factor price ratios', and 'relative factor share ratios' are generated and trends are analyzed through regression analysis.

2.3.1 TRENDS AND ANNUAL GROWTH RATES

Linear trends are analyzed using ordinary least-square (OLS) techniques. The time-series data are fitted to the following functional form:

$$y = a + b.t \qquad (12)$$

where y is any of above mentioned dependent variables; t is time, the only explanatory variable; and a and b are parameters to be estimated. The significance of the time variable is tested.

Annual growth rates (expressed as percentages) in the dependent variables are estimated using an exponential functional form, that is: $y=a.\exp(bt)$, or its equivalent logrithmic form: $\ln y = \ln a + b.t$, where exp(bt) is an exponential function, ln is the natural logrithmic function and other symbols have preassigned meanings. The rationale for using either of these equations for estimating annual growth rates is explained in the footnote[11]. This method has been suggested by some empirical researchers including Johnson Jr., Johnson & Buse (1987). Once b is estimated, effective annual rate of growth is given by $g = (\exp(b) - 1)$.

Johnson Jr., Johnson & Buse (1987) observed that, occasionally, applied researchers assume that the estimate of b is the BLUE (Best Linear Unbiased Estimate) of the rate of change. They considered this an erroneous view and suggested that an estimate of b gives continuous rate[12] of change, like an 'instant rate' of interest, and that the appropriate rate of change is given by 'g'.

The problem of autocorrelation was observed while estimating trend regressions and growth rates. 'Autoregressive (AR) error' and 'moving averages (MA)

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[11] The continuous rate of change and percent continuous rate of change in a variable y are given respectively by dy/dt and dy/(y.dt) = b (say). The latter equation can also be written as: $dy/y = b.dt$. Integrating this equation, one gets: $\ln y = \ln a + b.t$, where ln a is the constant of integration and other terms have the meanings as assigned earlier. Taking anti-log on both sides, one gets: $y = a.\exp(bt)$.

[12] see footnote 11.

error' models were used to correct parameter estimates for the problem of autocorrelation. In case of each regression, parsimonious model was selected. Shazam statistical package (White et. al.; 1986) was used for this purpose. It may be mentioned here that reported R^2 may be significantly high because of 'lags' introduced in AR/MA models. Therefore, reported R^2 is required to be interpreted with caution.

2.3.2 PROBLEMS IN THE METHODOLOGY

The problems in this methodology are many. Each industry employs different kinds of each factor and produces a variety of products. For example, forest industries engage different types of energy such as electricity, petroleum and natural gas; different types of capital such as buildings, equipment, machines and other capitalized expenses. Forest industries produce different types of logs, lumber, shingles and shakes, chips, paper and pulp. The first problem, therefore, is that of aggregating output and inputs. This necessitates the use of 'index numbers'.

Diewert (1976) considered (i) the Fisher Ideal, and (ii) the Divisia index numbers as superlative index number formulae in the sense that these indexes are consistent with flexible functional forms for the underlying aggregator function. For this reason, this study employs Divisia index numbers to measure prices and quantities of aggregated output and aggregated homogenized factors. Such index numbers are constructed as follows: let $q_t=(q_{1t}, q_{2t}, .., q_{it},..,q_{nt})$ and $p_t=(p_{1t}, p_{2t},..., p_{it},...,p_{nt})$ be quantity and price vectors in period t that are to be aggregated into scalars. The level of price in period t, relative to period t1 (= (t-1)), in the Divisia formula is:

$$\log D^t=(0.5).\Sigma(s_{it} + s_{it1}). \log(p_{it}/p_{it1}) \quad (13)$$

where $s_{it} = (p_{it}.q_{it})/(p_t.q_t')$, q' is the transform of row vector q, and summation (Σ) is over i=1, 2, 3,.....,n. The Divisia index number (D^t) is chained to the base year (1971).

The second major problem is that of measurement of aggregate durable capital stock and its periodical depreciation. This problem has been addressed by many scholars including Wright (1964), Coen (1976), Diewert (1976), Hulten & Wykoff (1976) and Usher (1980). The aggregate durable capital stock is measured using the revised perpetual inventory method which is detailed in Statistics Canada (1986) catalogue no. 13-211 and 13-522. The main steps of this method are described in Appendix I.

As regards the 'true' economic depreciation, Wright (1964) stated that there was no method available to measure 'true' economic depreciation, and that all the methods used, or proposed, were mere conventions, the choice between them being a matter of convenience. In estimating durable capital stock series, Statistics Canada uses the straight line method of depreciation. This method of depreciation has been used in a number of empirical studies (Constantino, 1986). Therefore, this study also uses the straight line depreciation even though this method does not measure the true 'economic' depreciation in a number of forest industries (Constantino, 1986). Capital stock is the mid-year net stock of capital and the flow of capital services is assumed to be a uniform proportion of the stock of capital.

The next problem is that of imputing returns to 'durable capital' stock and 'money capital'. The determination of the 'interest rate', as the price of capital, has remained a controversial issue. Pen (1971) suggested that capital productivity, savings and liquidity preferences all play a part in the determination of 'interest rate'. The expectations of investors also affect the interest rate. Boadway et. al. (1981) and Martinello (1985) argued that for empirical studies the user cost method is the appropriate method for determining the price of capital. They further suggested that for Canadian tax and financial systems, the true user cost of capital (r) is given by the equation:

$$r = p_K.(i+d-c).((1-x)/(1-u)).(1-ua/(a+i+pi)) \qquad (14)$$

where P_K is an implicit capital price index; i is the real after-tax interest rate (i.e.

$i=I((1-u)-pi)$; I is the nominal interest rate; u is the corporate tax rate; pi is the inflation rate; d is the depreciation rate, c is real capital gains, x is the investment tax credit, a is the percentage of a declining balance capital consumption allowance and the ratio $ua/(a+i+pi)$ is the present value of the capital consumption allowance for one dollar of investment.

This is a very complex formulation for the user cost of capital requiring a lot - of data that are not readily available. Moreover, taxes are being taken as a separate factor of production in the present study while capital gains are ignored. Investment tax credit is also accounted for in taxes. Therefore, equation (16) is simplified as follows, setting u, c and x equal to zero:

$$r = p_K.(I + d - pi) \qquad (15)$$

where the nominal interest rate I is the McLeod, Young, Weir 10 industrials bond yield; P_K is the implicit capital price index; the inflation rate (pi) is derived from the gross national expenditure (GNE) implicit deflator and the depreciation rate (d) is a straight line rate of depreciation derived separately for each component of the capital stock. After the cost (r) and quantity (K) of the capital stock are determined, the capital share (r.K) can be easily computed. Similarly, the return to 'money capital' is imputed assuming that the entire amount of money capital is utilized at mid-year.

Once factor prices, factor quantities, output prices and output quantities are computed from the raw data, the analysis proceeds in accordance with the theoretical framework described above. This is, however, more easily said than done. There are numerous problems associated with the collection and analysis of data. For example, what should be regarded as output for an industry: gross output or value-added? How should desired data be collected? Are the collected data consistent and comparable over the period of analysis? These and other problems associated with the data are briefly addressed in the next section.

2.4 SUMMARY OF DATA UTILIZED

The data used in this study consist of annual observations for each of the industries for the period 1957-1984. The choice of time-period is governed mainly by two considerations:

- In the year 1960, Statistics Canada introduced the following three major changes in reporting data on various industries:

  a. The standard industrial classification code, 1948 was revised and a new SIC code introduced.

  b. A new definition of 'establishment', as an independent production unit which is capable of accounting and reporting the entire desirable data on the principal statistics, was introduced.

  c. In addition to the manufacturing activity, a new concept of 'total activity' was added to the principal statistics.

  These changes greatly modified various 'industry groups' and the format for reporting data. This caused the problem of consistency and comparability in dealing with time-series data. To obviate this difficulty, Statistics Canada revised their reported time-series data for most of the forest industries (except the logging industry for which the revised data is available only for 1963 and onwards) from time to time back to 1957 which is taken as the first year of this study.

- The desired data on all the forest industries are currently available only upto the year 1984, which is the last year of this study.

Almost all the data are collected from the various publications of Statistics Canada's annual census of manufacturers.

What is an appropriate measure of 'output' for the purpose of this study: gross output or value-added? In national economies, the gross national product (GNP) is generally a measure of value-added net of all intermediate products which get cancelled out in the process of measuring GNP. In the case of individual industries, this is not generally true, as an industry may hire a considerable amount of raw materials (the so called intermediate products) from outside the industry. The value of used raw material which is purchased from outside the industry must form a part of the value of output of the industry. However, care must be taken to avoid double-counting. Therefore, an appropriate measure of the output of an industry seems to be the gross output of the industry. Hence, the output of each industry is defined as shipments plus the change in inventories. The value of output (i.e. price x quantity) is the sum of the value of fuel & energy, the value of stumpage, the value of materials, and the total activity value-added. The quantity of output is obtained by dividing the value of output by an index for the price of output, the construction of which is explained in the following chapter.

The labour factor[13] includes all production related workers, other employees and working owners and partners. The labour share comprises all direct payments made to the workforce including paid leave, bonuses, and commissions; imputed payments made to the working owners and partners; and all other obligatory contributions, made by the industries on behalf of their employees, towards workmen's compensation, social welfare, and pension funds. Data on the latter obligatory contributions are not readily available for all forest industries for the entire period of analysis. These data are, however, available for all manufacturing industries and all extracting industries for the entire period of analysis. The missing data are estimated, therefore, as proportions of the values of outputs of the wood industries and the paper & allied industries, respectlively, to that of total manufacturing industries and of the value of output of the logging industries to that of total extracting industries. This is one of the weaknesses of the data employed in this study. As, however, this component is only about 4% of direct payments, errors, if any, are considered insignificant.

Stumpage income is separated from the value of materials and supplies. The rest of the value of materials and services is assigned to the factor - materials, as

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[13]A brief composition of various factor inputs, used in this study, is given in Appendix IV. Care has been taken to avoid double-counting.

defined for the purposes of this study.

The value of fuel includes only the purchased energy which is divided into four different categories - coke, electricity, natural gas, and petroleum. All other energy sources are significantly less and have been added with petroleum products which are more than 50% of the total fuel bill. Energy does not include any energy generated at the establishments and not paid for. This is the second major weakness of the data, as this omission underestimates the fuel consumption in the paper and allied industries. As, however, the data are not available for this energy source, this flaw has to be accepted as unavoidable.

The tax component includes only the federal and provincial corporate income tax, logging tax, wherever applicable, and other local taxes such as property taxes. It does not include sales tax and excise tax. Sales tax is not neccessary for the purposes of this study. However, excise tax is relevant. As data on the excise tax are not readily available, this component has been deliberately ignored.

A major problem with the data is that of disaggregating various cost components for small establishments which report the cost of fuel and electricity, stumpage, and the cost of materials jointly. These costs have been disaggregated assuming the same cost ratios as for big establishments. This seems to be the most reasonable way to deal with this problem.

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3. CANADIAN FOREST INDUSTRIES : STATISTICAL ANALYSIS

3.1 RELEVANT LITERATURE REVIEW

For the purpose of this study, the Canadian forest industries include the Canadian logging industry (SIC 04)[1], the Canadian wood industries (SIC 25) and the Canadian paper & allied industries (SIC 27). This is a very extensive aggregation of a number of widely diverse industries. No study of production technology in the Canadian forest industries at this level of aggregation is readily available. Thus, no guidance is available to form *a priori* expectations about the empirical results for the forest industries. However, the literature on the constituent industries is steadily growing.

3.1.1 LOGGING INDUSTRY

Production technology in the logging industry[2]. has not yet been widely studied. Woodland (1975), Rao & Preston (1983) and Martinello (1985) have published some work in this area.

Woodland (1975) estimated a generalized Leontief cost function using data from 1946 to 1969 and reported very limited possibilities for substitution between various factor inputs. Rao & Preston (1983) estimated a translog cost function using annual data from 1959 to 1979 and reported constant returns to scale and positive technical progress which was capital and labour saving and material using. Martinello (1985) also estimated a translog cost function using annual data from 1963 to 1982 and reported that:

> "...energy and wood are estimated to be complements, while all other inputs are estimated to be substitutes. However, capital and wood are not easily substituted for one another. The technical change is capital, energy and wood using, so the demand for those inputs increases, holding output and factor prices constant. Therefore, capital, energy and wood become less productive over time as a result of technical change. The demand for labour decreases over time as a result of technical change and labour becomes more productive since the technical change is labour saving."

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[1]SIC refers to standard industrial classification as per Standard Industrial Classification Code, 1980.

[2]For the purpose of this study, the logging industry refers to the industry group included in SIC 04.

3.1.2 WOOD INDUSTRIES

The wood industries constitute a significant group of Canadian manufacturing industries. Some of the industries in this group[3] have undergone considerable structural changes during the last thirty years, mainly due to vertical and horizontal integration within the Canadian forest industries. The production technology of this group of industries has not yet been widely studied; nevertheless literature on individual industries is growing. Martinello (1985) and Singh & Nautiyal (1986) have studied the production technology of the lumber industry (SIC 251). Martinello (1984) studied the B.C. wood products industry and Constantino (1986) examined some aspects of the production technology of the B.C. lumber industry. Banskota & Phillips (1985) studied the Alberta saw milling industry. Rao & Preston (1983) examined some aspects of the production technology of the wood industries.

Rao & Preston (1983) estimated a translog cost function using annual data from 1959 to 1979 and reported limited possibilities for substitution between factor inputs; decreasing returns to scale; positive technical change which is capital saving, and labour, energy, and material using. Singh & Nautiyal (1986) also estimated a translog cost function using annual data for the period 1955-82 and reported an increase in labour productivity and decreases in productivities of other factor inputs used in the lumber industry. Martinello (1985) also estimated a translog cost function using annual data from 1963 to 1982 and reported that:

> "...the estimated technology of sawmills and shingle mills shows how much more substitutability between factors than the pulp and paper industry. The estimates show that labour and wood, and capital and energy are used (essentially) in fixed proportions, but all other pairs of inputs are substitutes.
>
> The technical change is labour and wood saving and capital and energy using. The increasing costs and the capital and energy using technical change mean that the demand for capital and energy increases over time, holding output and

----

[3] For the purpose of this study, the wood industries (SIC 25) are comprised of sawmills, planning mills and shingle mills (SIC 251); veneer & plywood mills (SIC 252); sashes, doors and other millwork (SIC 254); wooden boxes & pallets (SIC 256); coffins & caskets (SIC 258); and other wood industries (SIC 259).

> prices constant. The labour-saving technical change outweighs the negative technical change effect so the demand for labour increases as a result of technical change. The technical change is not wood saving enough to outweigh the increasing costs and the demand for wood increases slightly over time. Therefore, labour becomes more productive over time as a result of technical change, while capital, energy, and wood becomes less productive, holding output and factor prices constant.."

3.1.3 PAPER AND ALLIED INDUSTRIES

The production technology of the paper & allied industries[4] has been studied more than that of the wood industries (SIC 25) and the logging industries (SIC 04). However, most of these studies are of recent origin. For example, Denny et. al. (1981) and Rao & Preston (1983) used two-digit data (SIC 27) for this industry. Martinello (1985), Nautiyal & Singh (1986), and Sherif (1983) have studied some aspects of the production technology of pulp and paper mills (SIC 271).

Using two-digit data (SIC 27) from 1961 to 1975, Denny et. al. (1981) estimated a quadratic cost function for which capital, labour, energy and material were taken as factor inputs. They reported long-run, own-price elasticities of less than one for capital, energy, and material and greater than one for labour. Rao & Preston (1983) used data from 1959 to 1979 and estimated a long-run translog cost function with capital, labour, energy, and material inputs. They reported constant returns to scale; and capital and labour saving and energy and material using technical change.

Sherif (1983) studied the pulp and paper industry (SIC 271) from 1956 to 1977 and estimated a long-run translog cost function which specified capital, labour, energy, and wood as factor inputs in the production process. He reported that the input pairs wood-labour and capital-energy were complements, while other pairs of factor inputs were substitutes. However, the degree of substitution between factor

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[4] For the purpose of this study, the paper and allied industries (SIC 27) include pulp & paper mills (SIC 271); asphalt roofing (SIC 272); paper boxes & bags (SIC 273); and other converted paper products (SIC 279).

input pairs was found to be very low. He also reported capital and energy using, and labour and wood saving technical change.

Martinello (1985) also studied pulp and paper mills (SIC 271) using annual data from 1963 to 1982 and estimated a translog cost function specifying four factor inputs: capital, labour, energy, and materials. He reported that there was little substitution between the factors of production when relative prices changed holding output and technical change constant. He also estimated that the pairs of factor inputs - energy-wood and wood-capital were complements and other pairs were substitutes. He further reported that: the technical change was labour saving and capital, energy and materials using, and as a result of this technical change, labour productivity increased and productivities of energy, capital and material decreased. The pulp and paper mills (SIC 271) were also studied by Nautiyal & Singh (1986) who estimated a long-run translog cost function and observed that long-run labour productivity increased and that of material decreased over the period of analysis.

3.2 STATISTICAL ANALYSIS

The collected data for the logging industry, the wood industries and the paper & allied industries suffer from a number of problems and shortcomings. Some of these problems and shortcomings have been already indicated in section 2.4 (Chapter 2). Some others deserve mention here:

1. In the case of the Logging industry, a major problem is that in accordance with the changes introduced by Statistics Canada in 1960, the revised data are available only from 1963 onwards. The data from the period 1957-62 are reported in the old format according to which the value of stumpage is included in the 'net value of production' and is not separately reported. Similarly, the value of 'fuel and energy' and 'materials' are also reported together. Moreover, some of the establishments which were included in this industry prior to the 1960 revision of the SIC code have since been either transferred to the 'saw milling industry' or excluded for some other reasons.

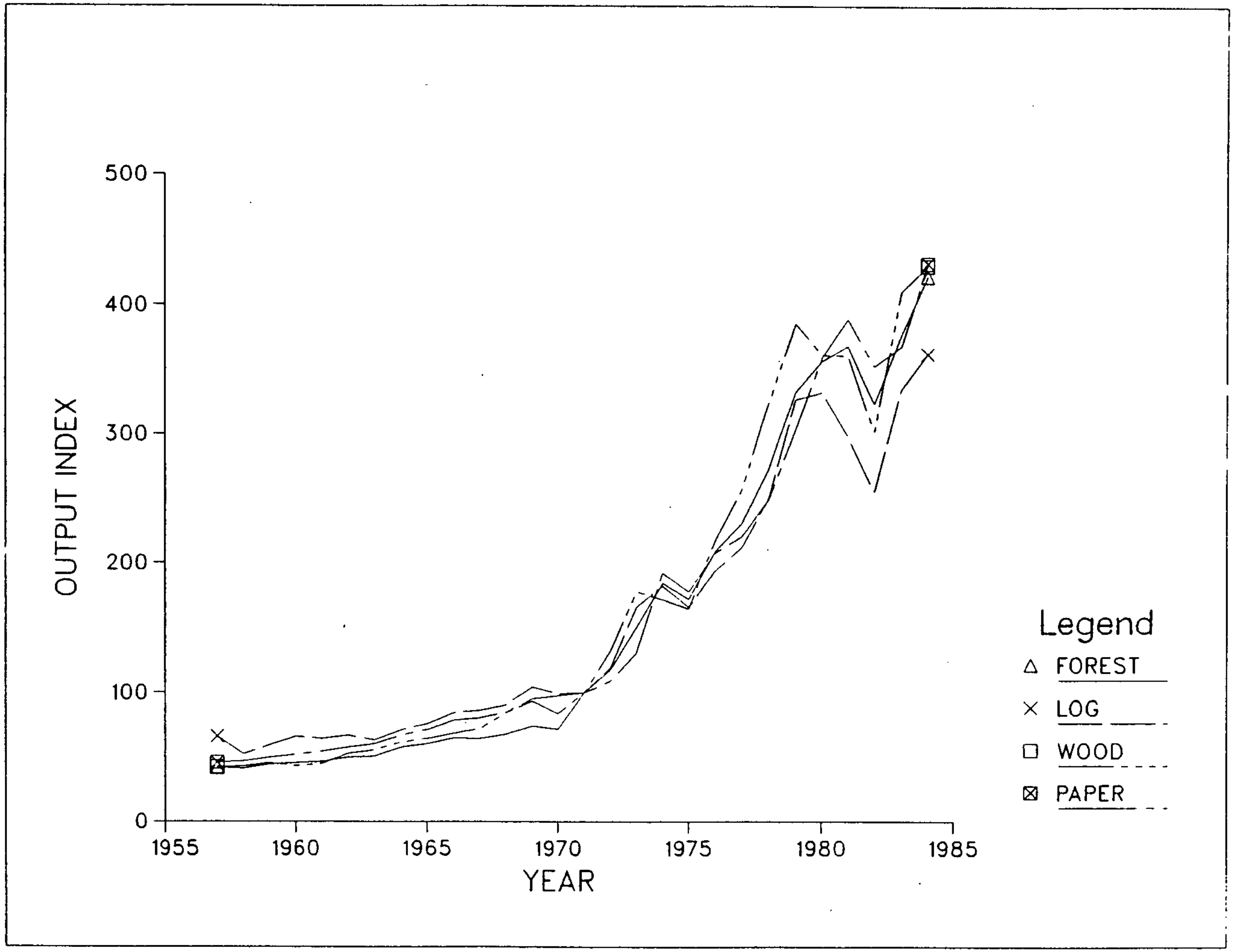

Figure 3.1: Indexes of Output Values of the Forest Industries, 1957-84

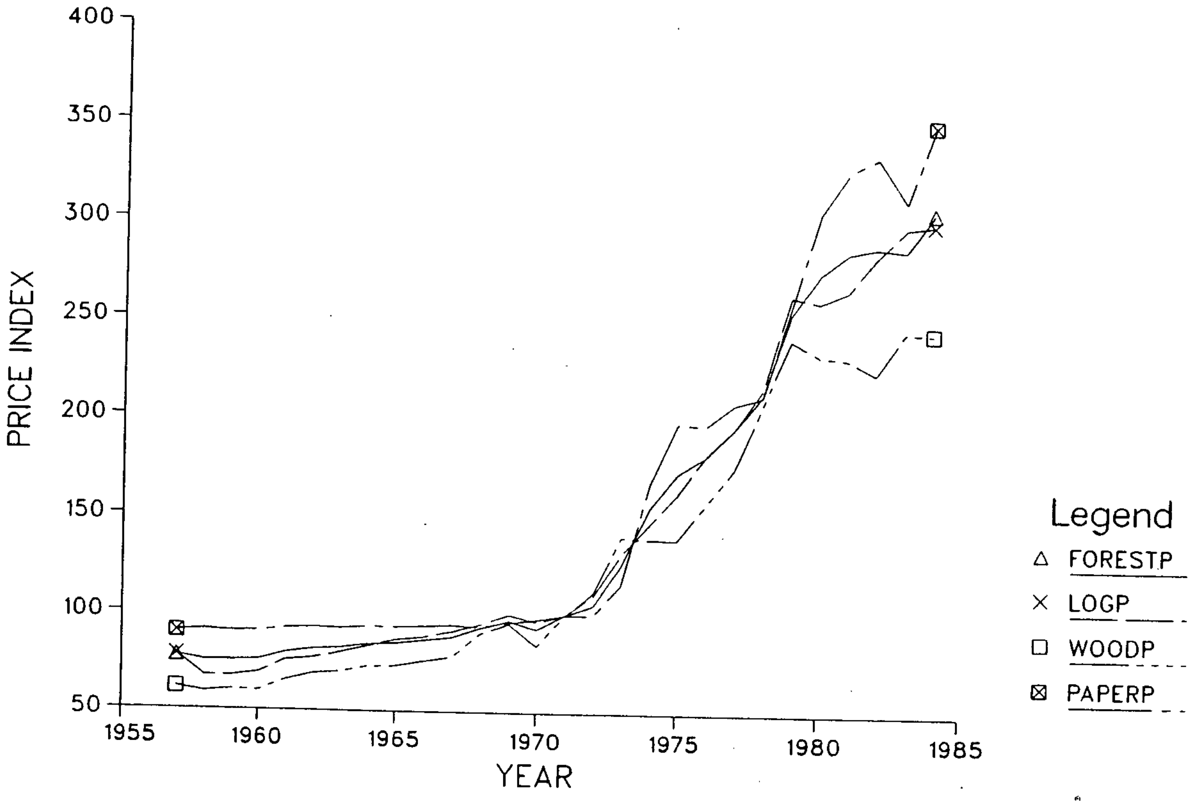

Figure 3.2: Indexes of Output Prices of the Forest Industries, 1957-84

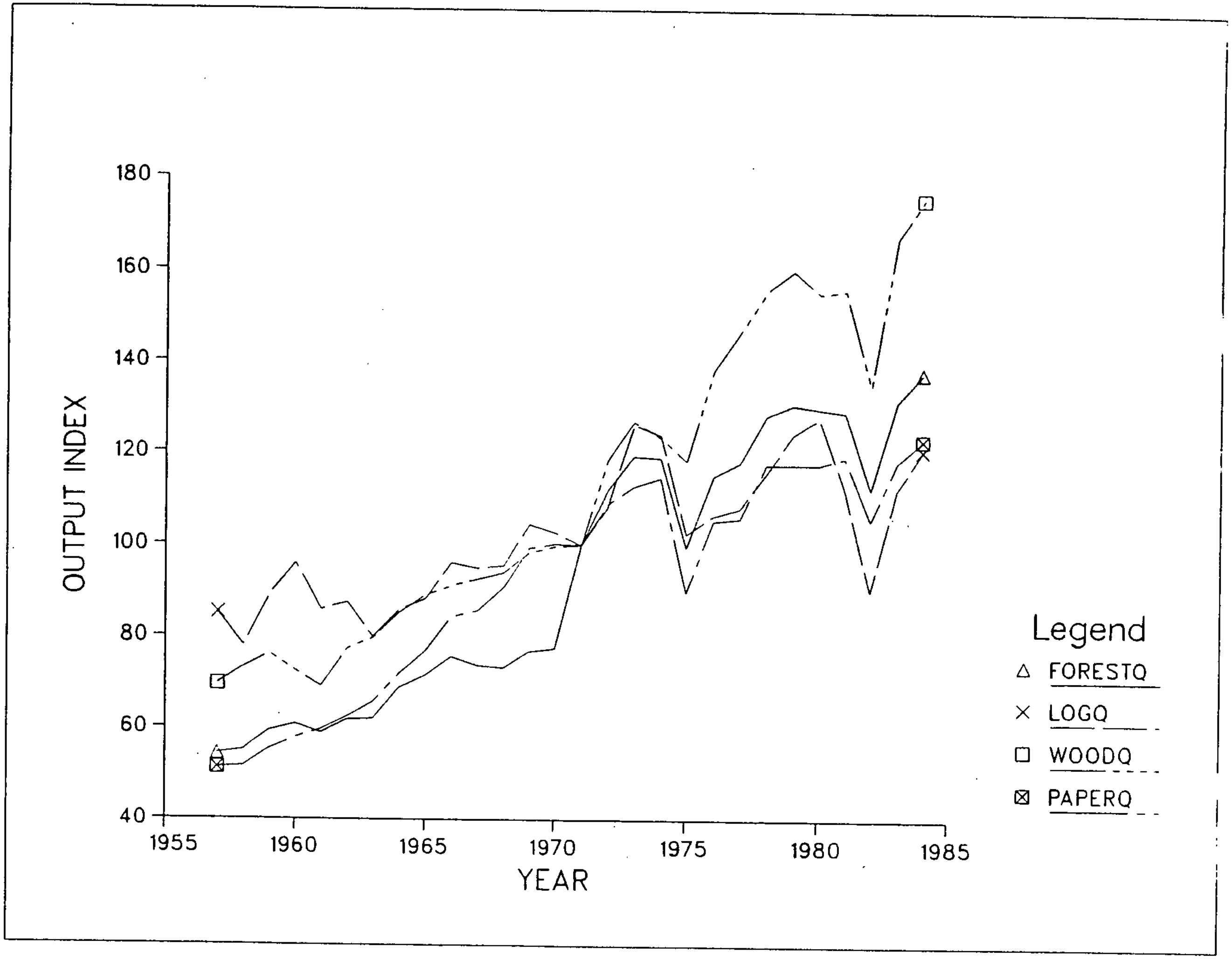

Figure 3.3: Indexes of Output of the Forest Industries, 1957-84

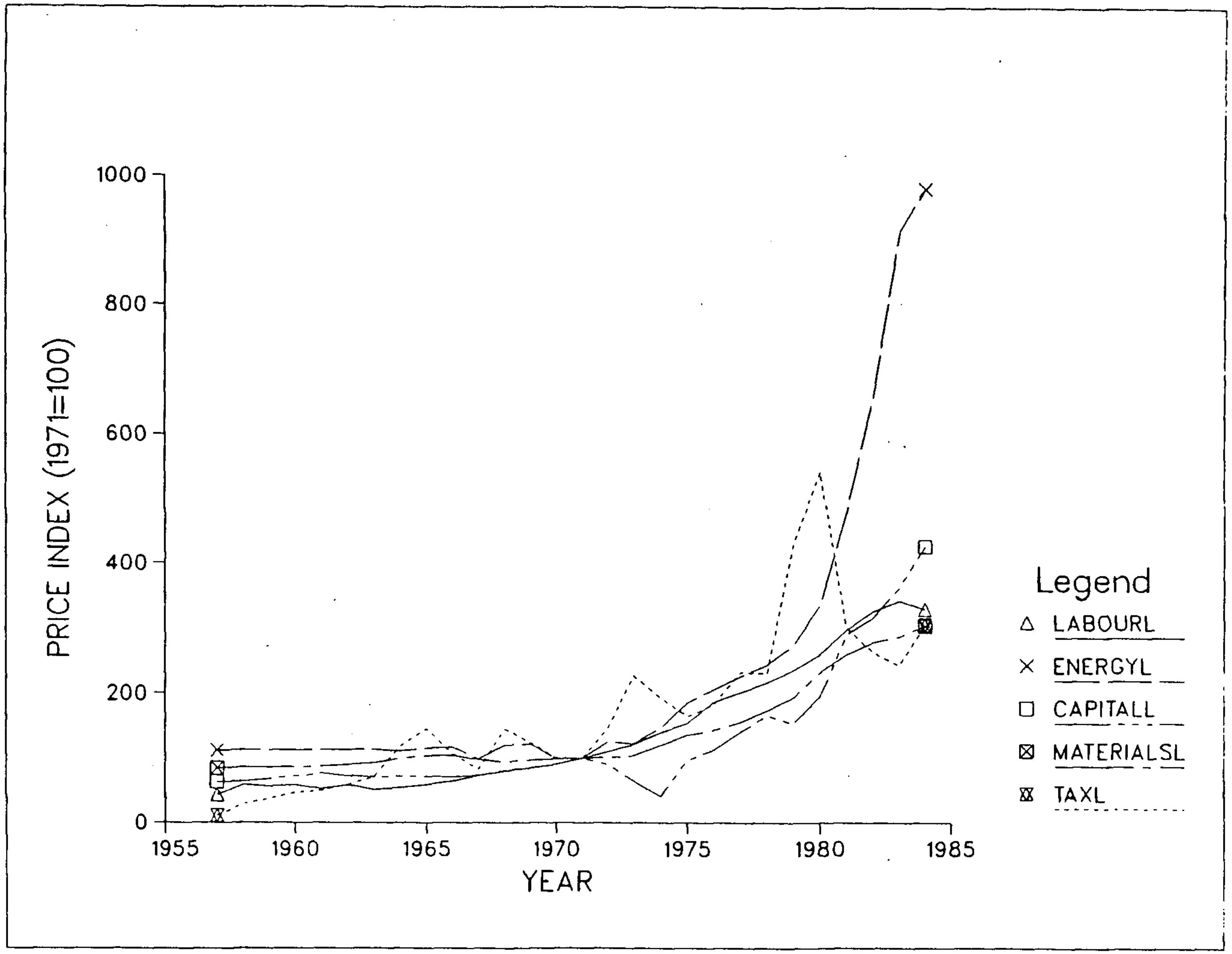

Figure 3.4: Indexes of Factor Prices for the Logging Industry, 1957–84

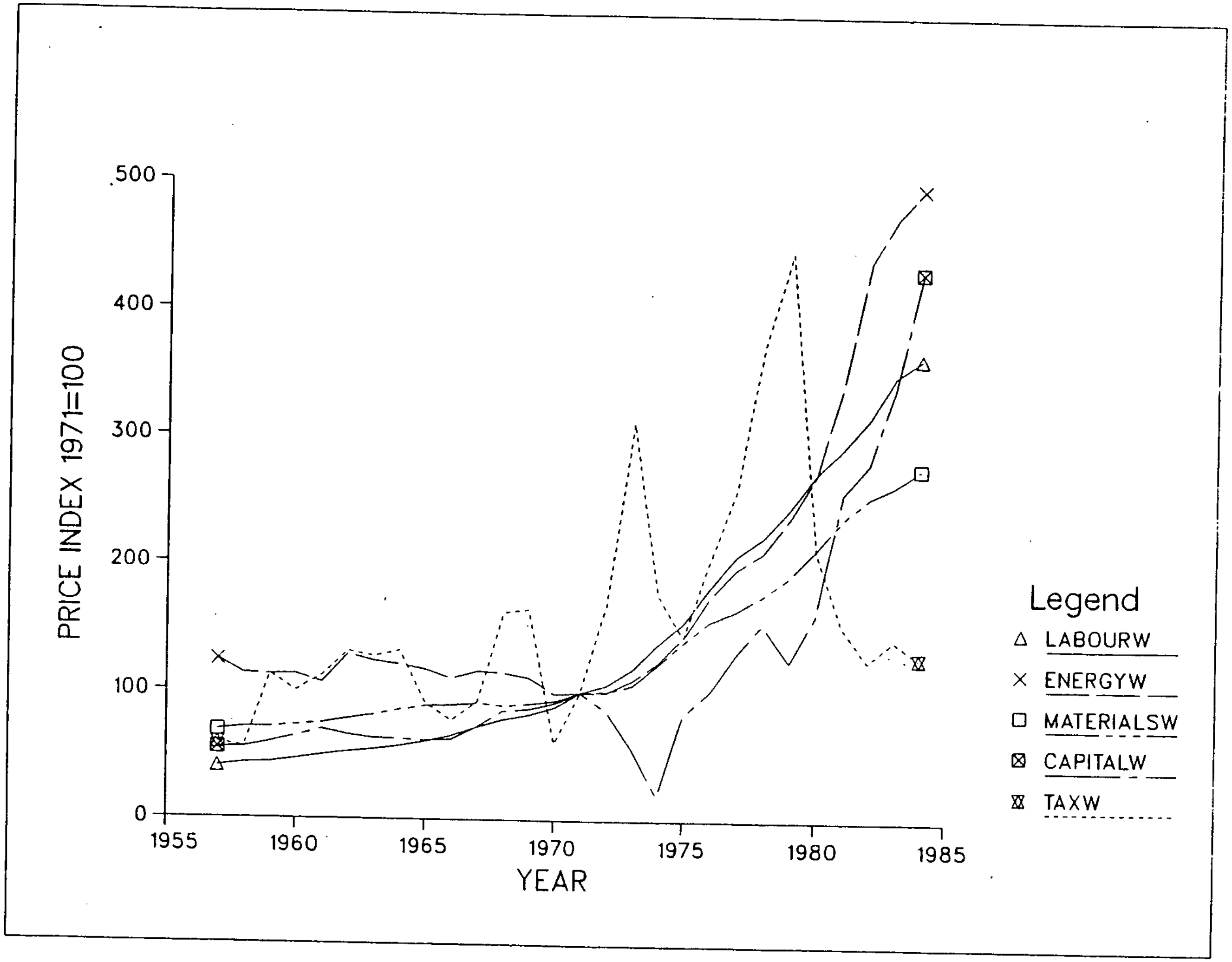

Figure 3.5: Indexes of Factor prices for the Wood Industries, 1957-84

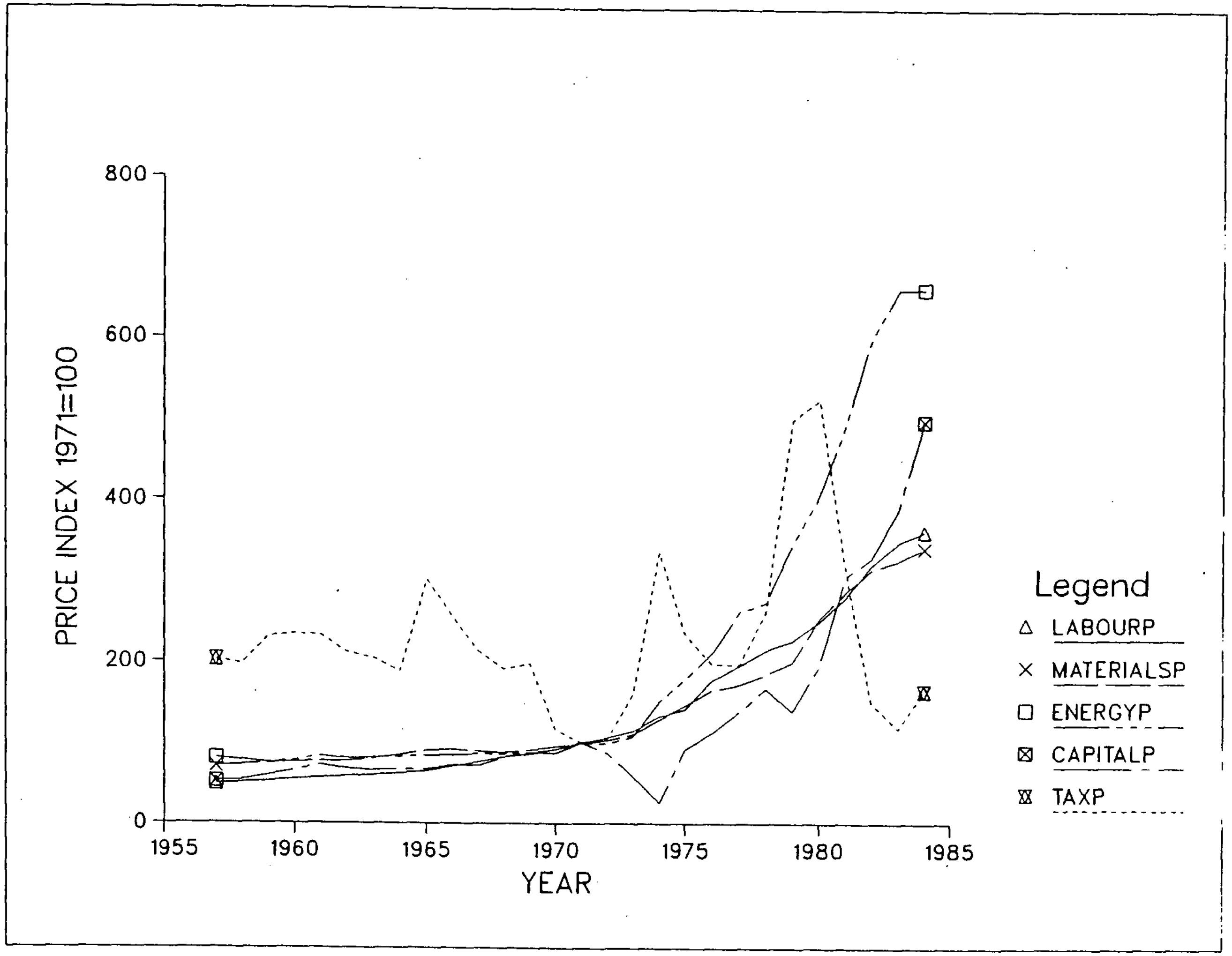

Figure 3.6: Indexes of Factor Prices for the Paper & Allied Industries

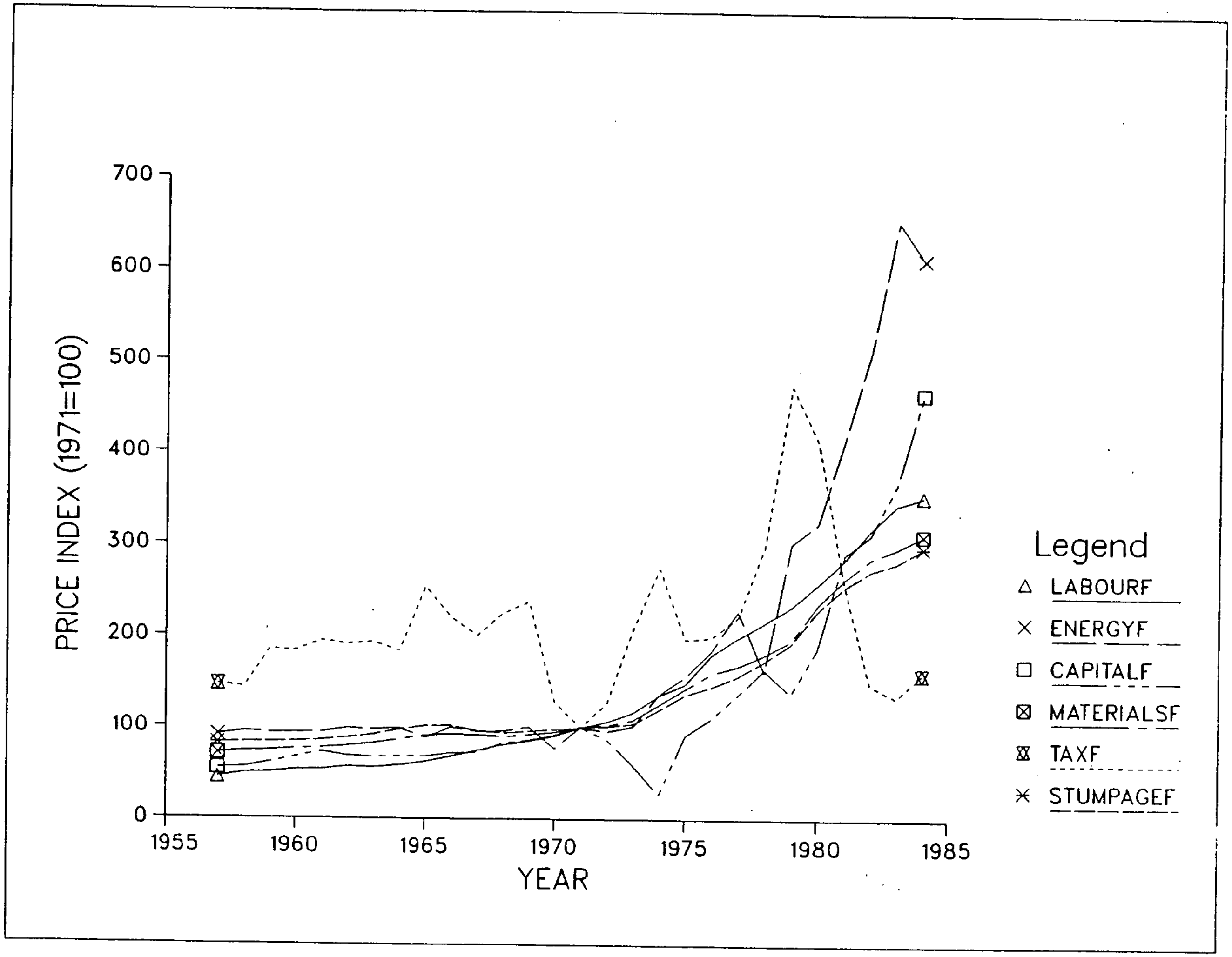

Figure 3.7: Indexes of Factor Prices for the Forest Industries, 1957-84

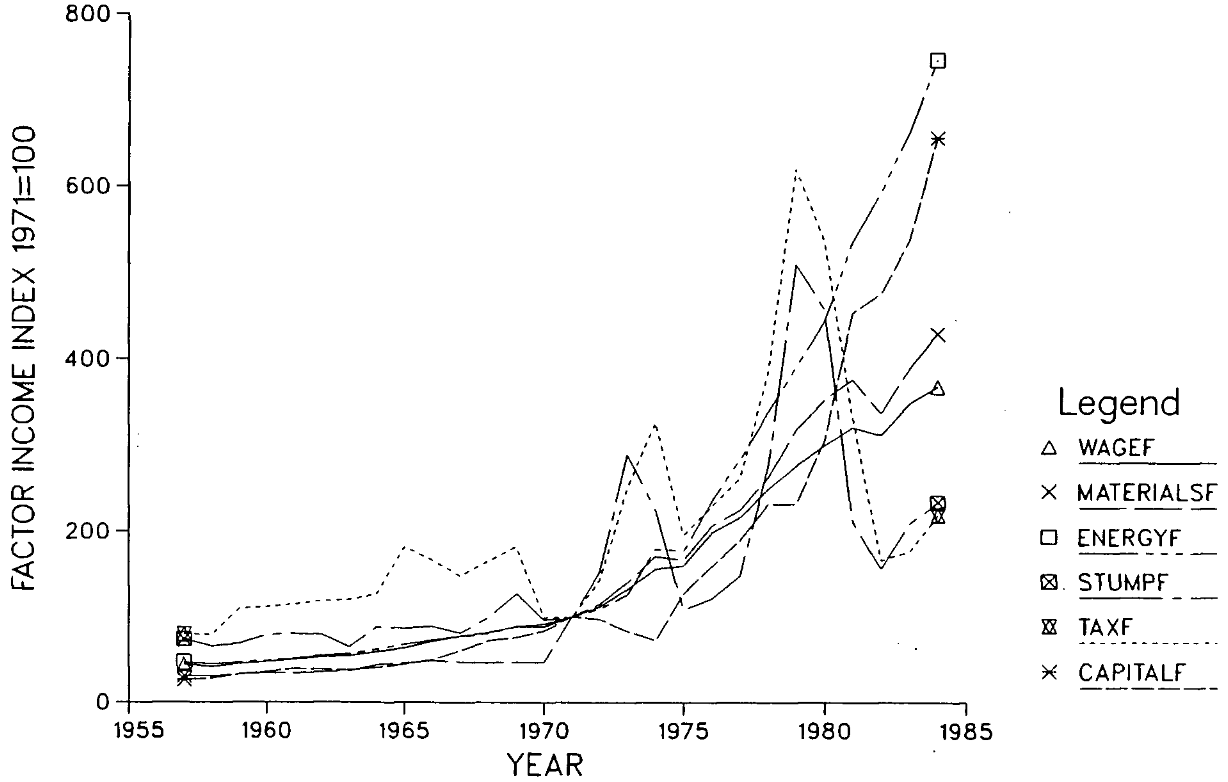

Figure 3.8: Indexes of Factor Incomes in the Forest Industries, 1957-84

This discontinuity in the reported data seriously affects the consistency and comparability of the data over the period of analysis. However, Statistics Canada reported the data in the old as well as the new format for the years 1963 and 1964. The data in the two formats were compared and the ratios of the data in the new format to that in the old format were ascertained. These ratios are reported in Table 3.1.

Table 3.1 : The computed ratios for standardizing data in the logging industry

Year	Employment	Wage	Material	Fuel	Value-added
			ratio		
1963	0.64	0.67	0.53	0.15	0.61
1964	0.65	0.67	0.54	0.15	0.61
average	0.645	0.67	0.535	0.15	0.61

Assuming that on average the same ratios were in force for the entire period 1957-1962, the data for this period are modified and made comparable to the rest of the period of analysis. Though the limitations of this assumption are recognised, it is accepted for the sake of simplicity[5]. The value of stumpage for this period was estimated by using regression against the modified values of shipment. The value of 'net value of production' has been also corrected accordingly.

2. In the case of the wood industries, the adaptation of the data to the requirements of this study posed two problems:

   a. The first problem is that some of the logging establishments which were included in the logging industry prior to 1960 revision of SIC code have

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[5] Another common approach to estimating missing data in a time-series is to regress the available observations on time and to use the estimated trend equation to interpolate or extrapolate the missing values. However, as one of the objectives of this study is to discern time-trends in the relative factor shares, this method has not been followed to avoid a possible bias in the share trends. Only one variable, that is the value of stumpage has been estimated using regression of this variable against the modified value of shipment, a reported variable that does not directly figure in this analysis. The regression of this variable against time has been deliberately avoided. This method has been preferred by many empirical researchers (Johnson Jr., Johnson & Buse, 1987).

since been transferred to the saw milling industry. This change necessitated the consideration of 'stumpage' as a 'factor input' separate from 'materials' as in the case of the logging industry. However, 'stumpage' is not separately reported prior to 1963. Therefore, 'stumpage' from 1957 to 1962 is estimated using a regression of this variable against the value of shipments (valship).

b. The second problem is that the quantities and values of various types of energy viz. electricity, gasoline, natural gas and other sources such as coal & wood are available only for the period 1963-84, not for the period 1957-62. The relevant information for the saw milling and shingle milling industry was, therefore, used to construct an energy price index for the period 1957-62. The energy quantity index was then constructed by dividing the value of fuel & energy by this price index for this period.

3. In the case of the paper and allied industries, the reported data for fuel & energy consumption include only the amount purchased. No cognizance has been taken of the amount of fuel and energy which is produced and used by an establishment. This industry group generates a considerable amount of energy for its own use. This self-generated energy is omitted from the study since data are not available. This unavoidable omission is likely to cause a downward bias in the share of energy. The empirical results relating to this factor must, therefore, be interpreted with caution.

4. Each of these industries employs different kinds of each factor and produces a variety of products. For example, each uses different types of energy such as electricity, petroleum and natural gas; and different types of capital goods such as equipment, machines and buildings. They produce different types of logs, lumber, shingles and shakes, paper and pulp. The major problem, therefore, is that of aggregating output and factor inputs in each of these industries. Aggregated data are generally found to suffer from the serious problem of autocorrelation. This study uses Divisia indexes for prices and

quantities of aggregated output and factor inputs.

3.2.1 AGGREGATION OF OUTPUT

The value of output (vship) for each of the constituent industries is the sum of the following: the value of fuel and energy; the value of stumpage[6]; the value of materials; and the total activity value-added of the respective industry groups. Care has been taken to avoid double counting in aggregating the value of output of the logging industry[7]. The problem, however, lies in aggregating the value of output of the forest industries.

Most of the output of the logging industry and part of the output of some of the wood industries are used as raw materials in other wood industries and the paper and allied industries and included in the value of 'materials' of these industries. A simple aggregation of outputs of, and factor inputs used by, these constituent industries will, therefore, result in double-counting which needs to be avoided. The procedure for avoiding this problem of double-counting is as follows.

To begin with, it is assumed that while aggregating the outputs of, and factor inputs used by, the wood industries and the paper & allied industries respectively, Statistics Canada have taken due care to avoid double-counting in these respective industries. In other words, no double-counting is assumed in the reported

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[6] Stumpage is not part of the value of output for the paper & allied industries. It is, however, part of the value of output of the wood industries, because some establishments in the sawmilling industry, which were part of the logging industry prior to 1960 revision of SIC code, are engaged in logging operations and pay stumpage for timber so harvested.

[7] Many establishments which Statistics Canada considers part of the logging industry are log 'merchandisers' who buy logs from loggers and sell them to sawmills or pulp and paper mills. If their output is included in the industry's output, the value of their logs is counted twice. Therefore, 'amount paid for purchased wood' and 'amount paid to others for contract work done' are excluded from the value of materials and supplies which form the part of the value of output of this industry. Double counting is, therefore, avoided in the value of output also. This method of avoiding double counting from the output of this industry has also been used by other researchers (Martinello, 1985).

data on the wood industries (SIC 25) and the paper & allied industries (SIC 27). The output of the logging industry is divided into three categories: exported output; pulpwood and chips; and the rest. Similarly, the value of chips is identified in the output of the saw-milling industry (SIC 251). Pulpwood and chips are used by the paper & allied industries as raw materials. The rest of the output of the logging industry is used by the wood industries as raw materials.

The value of pulpwood and chips in the output of the logging industry and the value of chips in the saw-milling industries are, therefore, subtracted from the value of output of, and the value of materials used by, the paper & allied industries (SIC 27). Thus, the modified values of output and materials for the paper & allied industries are obtained. Similarly, the value of the rest of the output (i.e. value of output - value of exported output - value of pulpwood and chips) of the logging industries is subtracted from both the value of output and from that of materials for the wood industries (SIC 25) and the modified values of the output of and materials used in these industries are thus obtained.

The value of output (vship) of the Canadian forest industries is the sum of the value of the output of the logging industry and the modified values of the outputs of the wood industries and the paper and allied industries. This, in turn, is the sum of the value of total purchased fuel & energy in all the constituent industries, the value of materials in the logging industry, the modified values of materials in the wood industries and the paper and allied industries, the value of stumpage in the logging industry and the wood industries, and the total activity value-added in all the constituent industries. The value of output of each of these industries is plotted against time in Figure 3.1.

The total value of logs, pulpwood, and bolts and poles accounts for more than 90% of the value of output of the logging industry. Therefore, the logging output price (pl) is an index of the prices of logs, pulpwood, and bolts and poles[8]. In the case of the wood industries, the output price (pw) is an index of the prices of lumber, chips, shingles and shakes, veneers and plywood products which account for more than 70% of the value of output of this group of industries. For the paper & allied industries, the output price (pp) is an index of the prices of pulp, newsprint, and paper & paperboard.

The output price (pf) for the forest industries is an index of the output prices of the constituent industries. The output price indexes for these industries are plotted against time in Figure 3.2. The quantity of aggregated output (Q) in each of these industries is obtained by dividing the value of output by the output price (p) of the given industry(ies). Indexes of quantity of output (qi) are constructed using the output price indexes (1971=100). The indexes for quantities of output for each of these industries are plotted against time in Figure 3.3. Output values, output indexes and output price indexes for each of these industries are reported in Table II.1 of Appendix II.

3.2.2 AGGREGATION OF FACTOR INPUTS

The procedure used for aggregating factor inputs is the same for each of the industries and has already been discussed in section 2.4 (Chapter 2). First, the values of different types of each factor input are aggregated. Second, a price index or quantity index is constructed or obtained from some other reliable source (e.g. Statistics Canada). These price indexes or quantity indexes are then used to construct desired quantity indexes or price indexes as the case may be.

For example, the total number of employees is available for each of the constituent industries. The price of labour (w) is the total compensation divided by the total number of employees. The energy price (pe) is an index of the prices of natural gas, petroleum, electricity and coal. An index for prices for 'materials' (pm),

[8]This output price index seems to be questionable since most of the firms in the forest industries are vertically integrated and so pricing mechanisms for roundwood are far from the perfect. However, in the absence of any other alternative, this output price index is accepted as the only reasonable choice.

constructed by Statistics Canada, is used as the price index (1971=100) for both 'timber' and 'materials' for each of the constituent industries. The price indexes for the constituent industries are further aggregated into the Divisia indexes to obtain the corresponding price indexes for the aggregated factor inputs for the forest industries.

The Tax share is the sum of logtax (i.e. total tax paid by the logging industry), woodtax (i.e. total tax paid by the wood industries), and paptax (i.e. total tax paid by the paper & allied industries). The tax rate (ptx) is an imputed price obtained by dividing the total tax share by the aggregated output quantity, that is tax per unit of output of the forest industries. This price is also converted into a price index (1971=100). Price indexes for factor inputs for each of the industries are: (1) plotted against time in the Figures 3.4, 3.5, 3.6, and 3.7; and (2) reported in Tables II.2 and II.3 of Appendix II.

Using the procedure for aggregating durable capital components as outlined in Appendix I, time-series data for capital quantity (k) and capital quantity indexes (ki) are obtained. A time-series for capital price (r) is obtained in the manner discussed in chapter 2. The durable capital income is then defined as a product of capital quantity and capital price (i.e. k.r). Interest on money capital is calculated assuming that entire money capital was spent at mid-year. Finally, the profit share is the residual after all the other factor inputs are paid out of the value of the output of the relevant industry. Factor incomes for each of the industries are: (1) plotted against time in Figures 3.8, 3.9, 3.10 and 3.11; and (2) reported in Tables II.4 and II.5 of Appendix II. Quantities of factor inputs (except labour) are obtained by dividing the amount spent on the relevant factor input by its corresponding price. Indexes of factor quantities in each of these industries are: (1) plotted against time in the Figures 3.12, 3.13, 3.14 and 3.15; and (2) reported in Tables II.6 and II.7 of Appendix II.

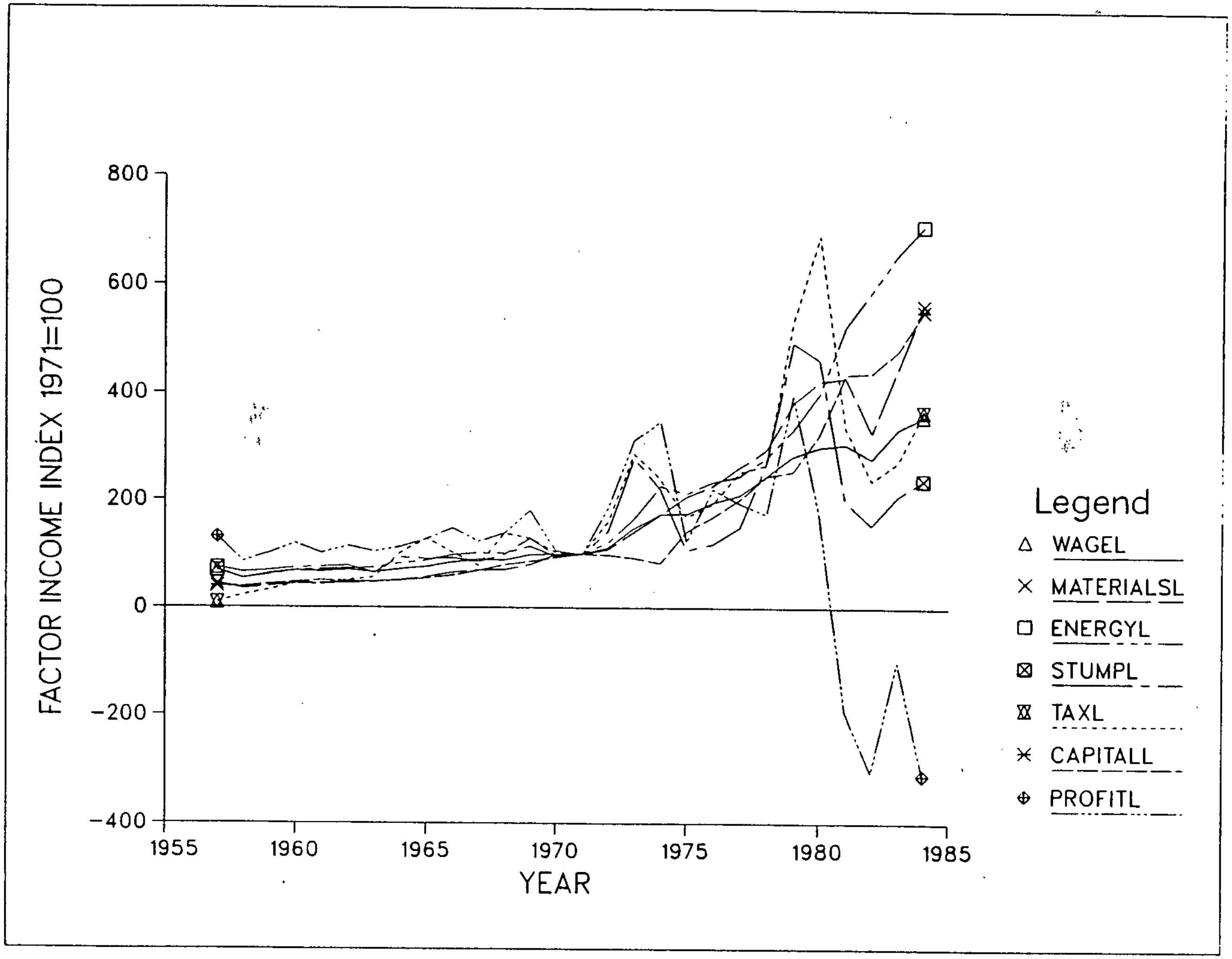

Figure 3.9: Indexes of Factor Incomes in the Logging Industry, 1957-84

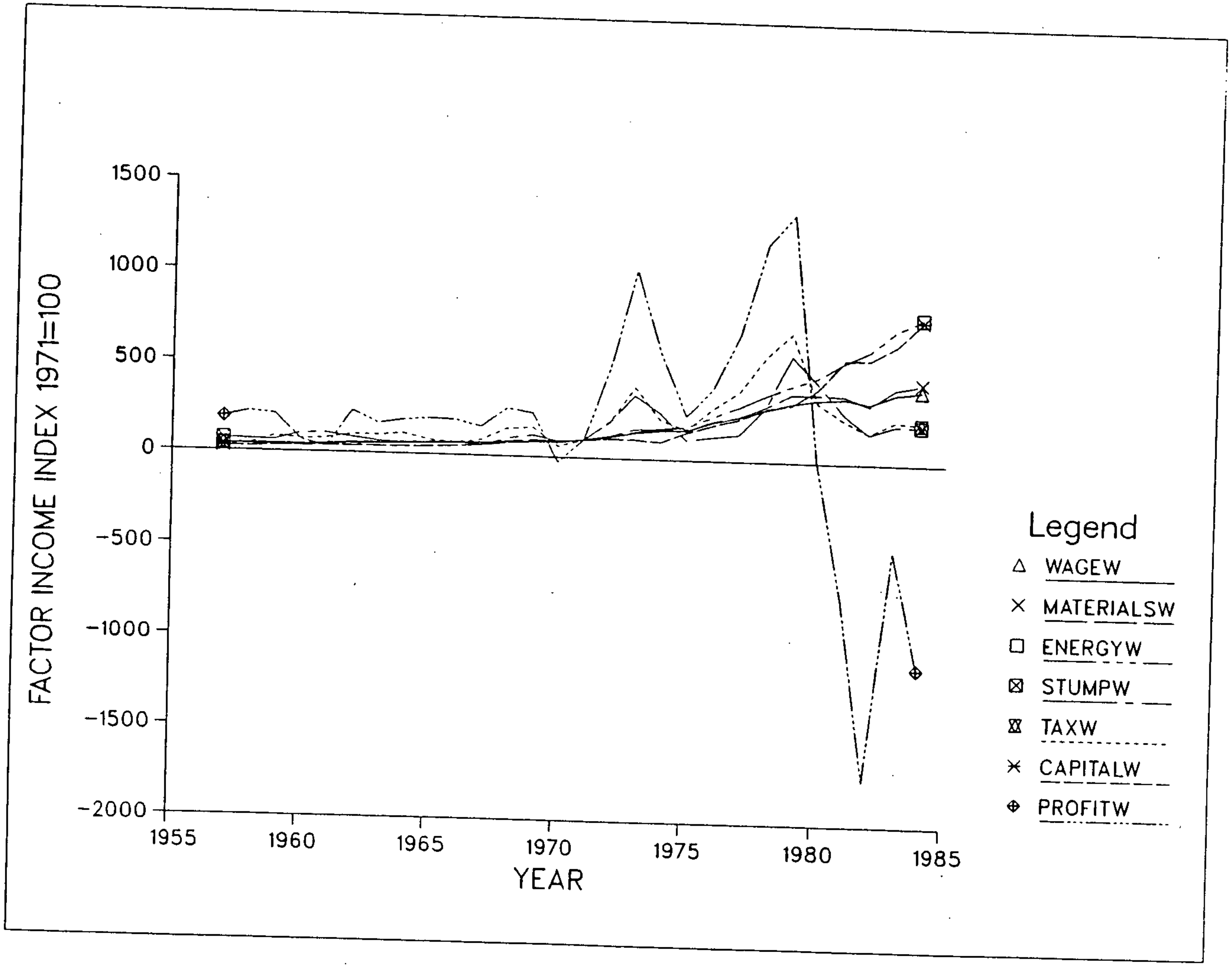

Figure 3.10: Indexes of Factor Incomes in the Wood Industries, 1957-84

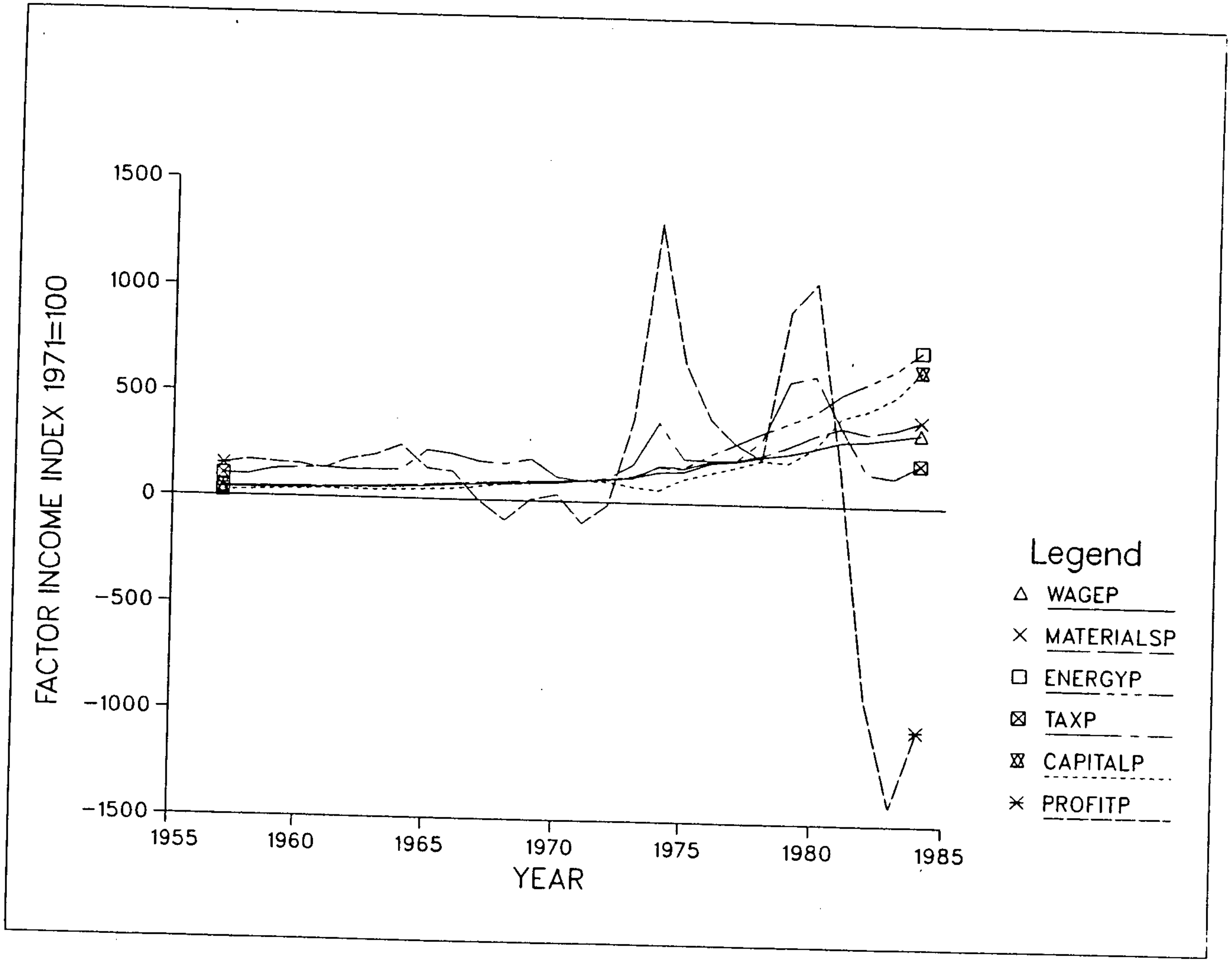

Figure 3.11: Indexes of Factor Incomes in the Paper & Allied Industries

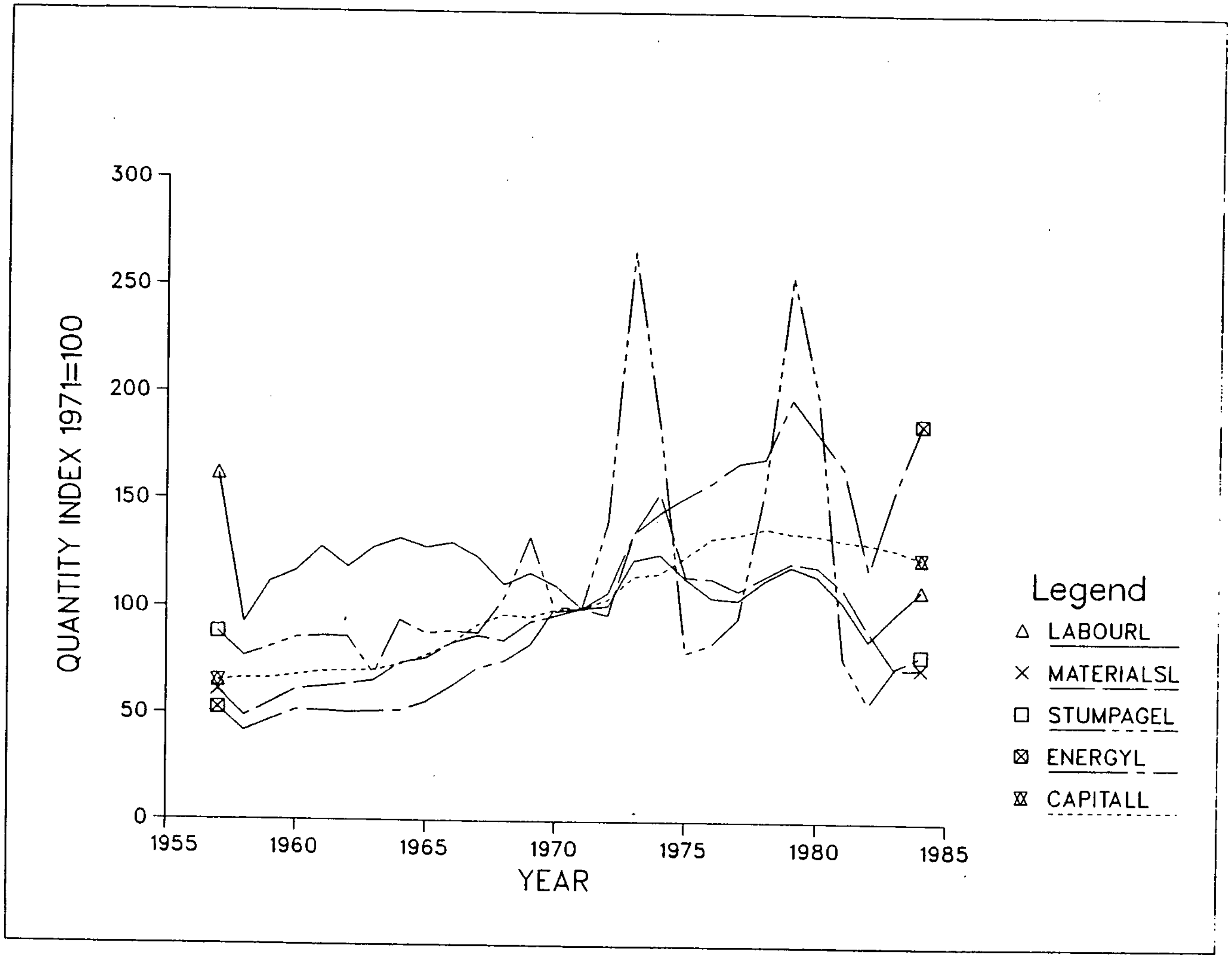

Figure 3.12: Indexes of Factor Quantities in the Logging Industry, 1957-84

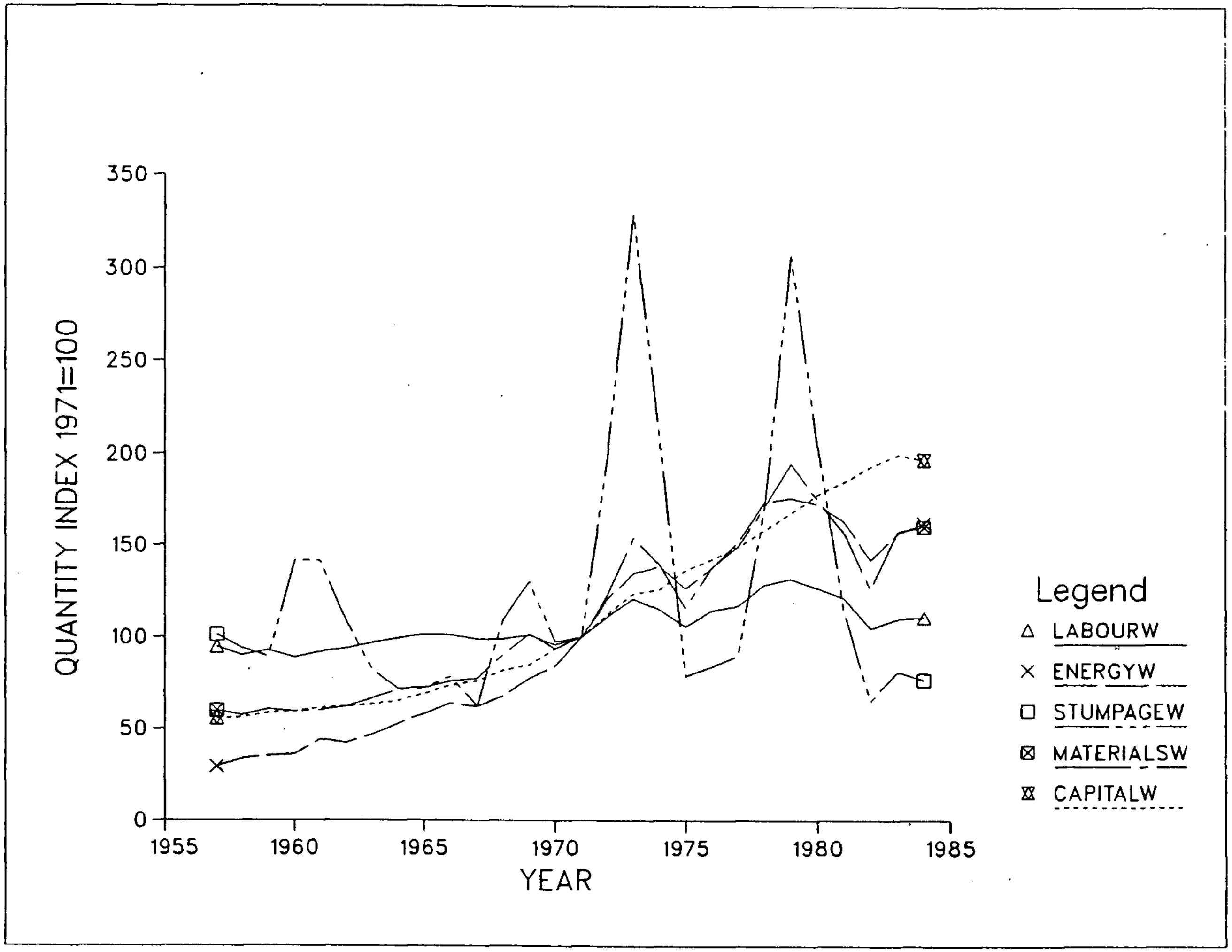

Figure 3.13: Indexes of Factor Quantities in the Wood Industries, 1957-84

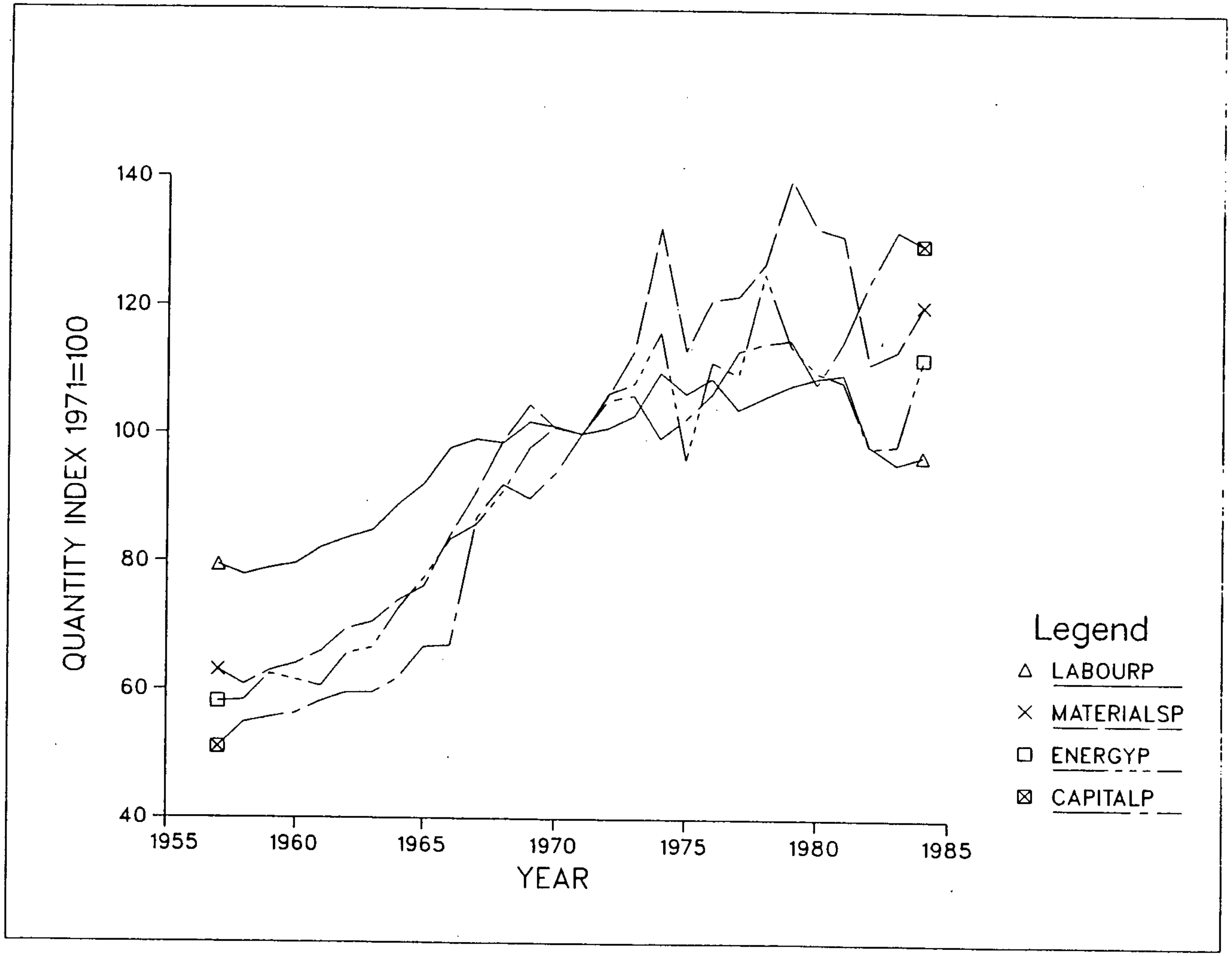

Figure 3.14: Indexes of Factor Quantitites in the Paper & Allied Industries

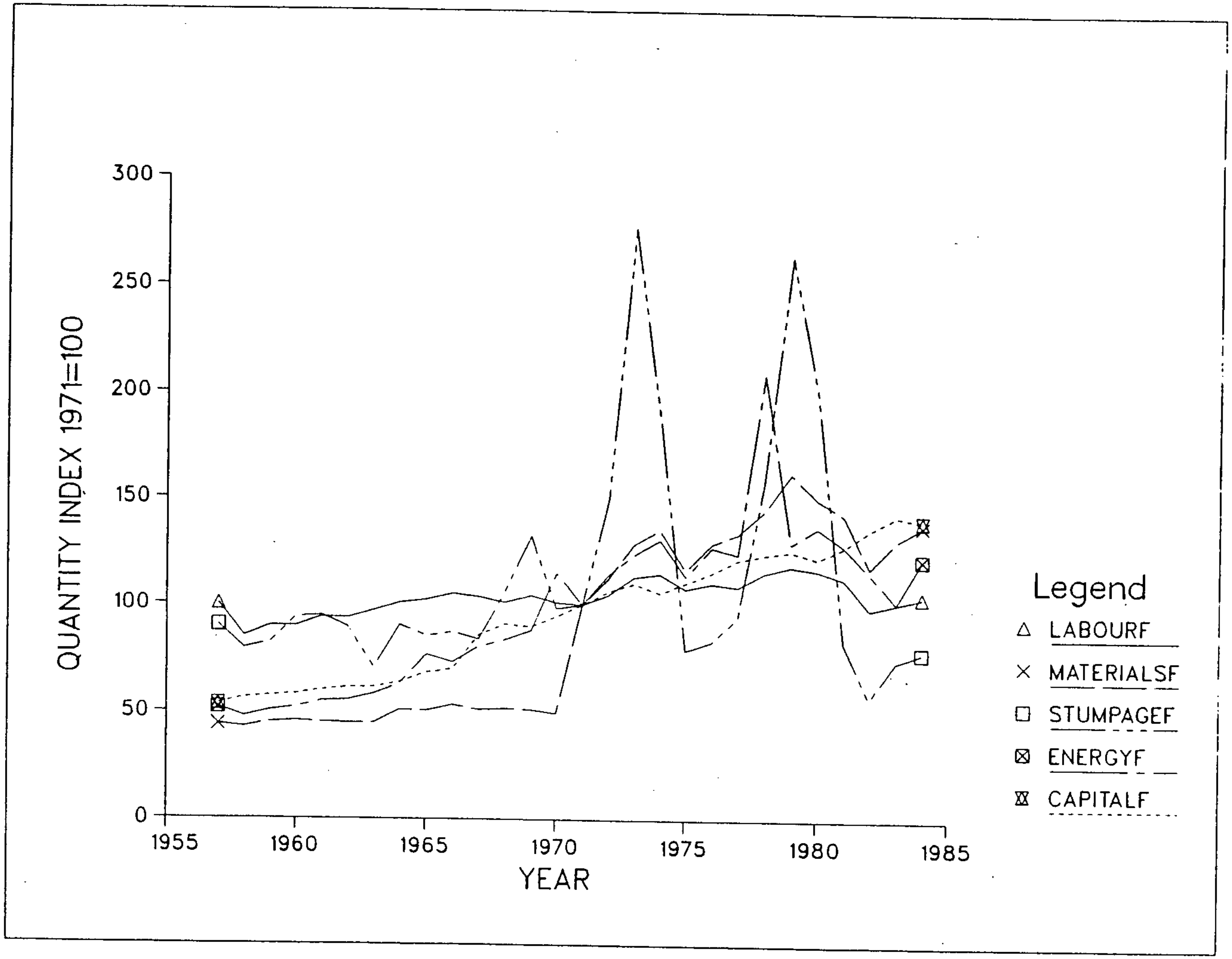

Figure 3.15: Indexes of Factor Quantities in the Forest Industries, 1957-84

3.3 GROWTH TRENDS IN OUTPUT VALUES, FACTOR INCOMES AND PRICES

Annual growth rates (expressed as percentages) in the nominal values of output, factor incomes, and output and factor prices for each of the industries are estimated using an exponential functional form, as explained in section 2.3.1 (Chapter 2). The annual growth rates in the nominal values of output and factor incomes may be used to infer expected trends of changes in relative factor shares[9]. Similarly, the annual growth rates in the nominal prices of output and factor inputs may be used to infer expected trends of changes in the real prices of factors[10]. The annual growth rates in the nominal values of output, factor incomes and relevant prices, and the expected trends of changes in the forest industries are reported in Table 3.2.

Table 3.2 : Annual growth rates in nominal values of output, factor incomes and nominal prices in the forest industries, 1957-84

VARIABLE	GNVALUE[1]	GNPRICE[2]	ETRS[3]	ETRP[4]
Output	9.40	5.30	-	-
Labour	8.40	8.20	dec[6]	inc[5]
Capital	11.10	7.10	inc	inc
Interest	15.10	4.80	inc	dec
Material	11.00	5.50	inc	no[7]
Energy	10.80	7.40	inc	inc
Stumpage	6.20	4.70	dec	dec
Tax	4.60	1.30	dec	dec
Profit	-48.00	-	dec	-

[1]GNVALUE refers to annual growth rate (%/a) in nominal values of relevant variable;
[2]GNPRICE refers to annual growth rate (%/a) in nominal price of relevant variable;
[3]ETRS refers to expected trends of changes in relevant relative shares;
[4]ETRP refers to expected trends of changes in real factor prices;
[5]inc refers to increasing trend;
[6]dec refers to decreasing trend;
[7]no refers to no change.

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[9]Recall that a relative factor shares is a ratio of factor income to the value of output. For example, if the nominal value of output of an industry grows at a rate of 8% per annum and the share of a factor, say labour, grows at an annual rate of 9%, the relative share of labour is expected to rise over time.

[10]Recall that real price of a factor is defined as the factor price divided by the output price. For example, if the nominal price of a factor, say labour, grows at an annual rate of 5% and the nominal output price grows at a rate of 7% per annum, the real labour price is expected to decrease over time.

The annual growth rates in the nominal values of output, factor incomes and relevant prices, and their expected trends of changes for each of the constituent industries are reported in Table II.14 of Appendix II.

3.4 SPECIFIC RESEARCH HYPOTHESES

On the basis of the expected trends of changes in relative factor shares and nominal factor prices reported in Table 3.2, the following subsidiary hypotheses are proposed:

1. the relative share of labour has consistently decreased.
2. the relative share of timber has consistently decreased.
3. the relative share of durable capital has consistently risen.
4. the relative share of materials has consistently risen.
5. the relative share of energy has consistently risen.
6. the real price of labour and labour productivity have risen.
7. the real rate of return to durable capital and capital productivity have risen.
8. the real price of materials has not changed, but materials productivity has declined.
9. the real price of energy and energy productivity have risen.
10. the real price of timber (that is stumpage) has decreased, but timber productivity has increased.
11. the rate of change in a relative factor share is consistent with the differential between the rate of change in the real factor price and that in factor productivity.
12. profitability of the forest industries has consistently declined.

No hypotheses have been specified for factor inputs: tax and money capital. However, actual trends in the relative shares of these factor inputs will be ascertained and the significance of their time variables will be tested.

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4. CANADIAN FOREST INDUSTRIES : EMPIRICAL ANALYSIS

4.1 RELATIVE FACTOR SHARES

Relative factor shares in the forest industries and each of the constituent industries are factor incomes expressed as percentages of the output value for the respective industries. The annual values of the relative factor shares for each of these industries are reported in Tables III.1, III.2, III.3, and III.4 of Appendix III. The mean values of these shares for each of the industries are summarized in Table 4.1.

Table 4.1 : Average relative factor shares in the forest industries, 1957-84

RELATIVE SHARE[1]	FOREST[2]		LOGGING[3]		WOOD[4]		PAPER[5]	
	MEAN[6]	VAR[7]	MEAN	VAR	MEAN	VAR	MEAN	VAR
Labour (SL)	30.75	12.99	45.85	5.99	28.31	3.14	23.79	3.37
Capital (SK)	9.35	10.44	10.43	12.08	4.84	4.88	10.36	14.30
Interest (SK1)	3.56	2.25	3.36	2.25	3.80	2.53	3.56	1.95
Material (SM)	39.95	41.98	16.39	21.21	53.04	4.34	47.57	2.80
Energy (SF)	5.12	1.06	3.82	1.09	2.10	0.35	6.51	2.63
Stumpage (ST)	1.65	0.35	8.00	5.56	0.87	0.14	-	-
Taxpart	3.34	1.89	0.99	0.15	2.35	0.76	3.89	3.01
Profit (SP)	6.30	39.58	10.36	65.82	4.69	36.61	4.32	43.81

[1]RELATIVE SHARE refers to relative factor shares which may not add upto 100.00 due to rounding error;
[2]FOREST refers to the forest industries;
[3]LOGGING refers to the logging industry;
[4]WOOD refers to the wood industries;
[5]PAPER refers to the paper & allied industries;
[6]MEAN is expressed as percentage (%); [7]VAR refers to variance.

Relative factor shares for each of these industries are plotted against time in Figures 4.1, 4.2, 4.3 and 4.4. Deviations of the relative factor shares from their mean values for each of these industries have been plotted against time in Figures III.1, III.2, III.3 and III.4 of Appendix III.

In the econometric results which follow, unless otherwise stated the statistical significance of the estimated parameters has been tested at the 5% level.

4.2 TRENDS AND GROWTH RATES IN RELATIVE FACTOR SHARES

The long-term linear trends in relative factor shares have been estimated using ordinary least squares (OLS) techniques. Autocorrelation was corrected using AR/MA models (Shazam: White et. al.; 1986). The estimates of the trend parameters for relative factor shares have been reported in Tables 4.2 and 4.3.

Table 4.2 : The forest industries: Trend parameter estimates and summary statistics[1]

SHARE	TIME	CONSTANT	R^2	RHO
Labour (SL)	0.25	-522.78	0.74	-0.04
	(-2.53)	(2.68)		
Capital (SK)	0.13	-255.04	0.76	0.05
	(1.75)	(-1.69)		
Interest (SK1)	0.17	-325.05	0.95	-0.01
	(3.87)	(-3.84)		
Material (SM)	0.61	-1161.5	0.79	0.17
	(4.14)	(-4.00)		
Energy (SF)	0.08	-159.23	0.83	-0.04
	(1.98)	(-1.92)		
Stumpage (ST)	-0.05	106.1	0.78	0.008
	(-7.86)	(7.99)		
Taxpart	15608	-30457000	0.78	-0.006
	(4.47)	(-4.42)		
Profit (SP)	-0.53	1053.1	0.77	0.01
	(-3.76)	(3.78)		

[1]t-ratios are in parentheses; for 26 degrees of freedom (df), critical values for one-tailed test are $t_{,.05}=1.706$ and $t_{,.1}=1.315$;
SHARE refers to relative factor share, dependent variable in a regression equation;
TIME is coefficient of time (%/a), the independent variable;
CONSTANT is coefficient of intercept term;
RHO is autocorrelation coefficient of the corrected residuals;
R^2 is coefficient of determination which is required to be interpreted with caution (see section 2.3.1).

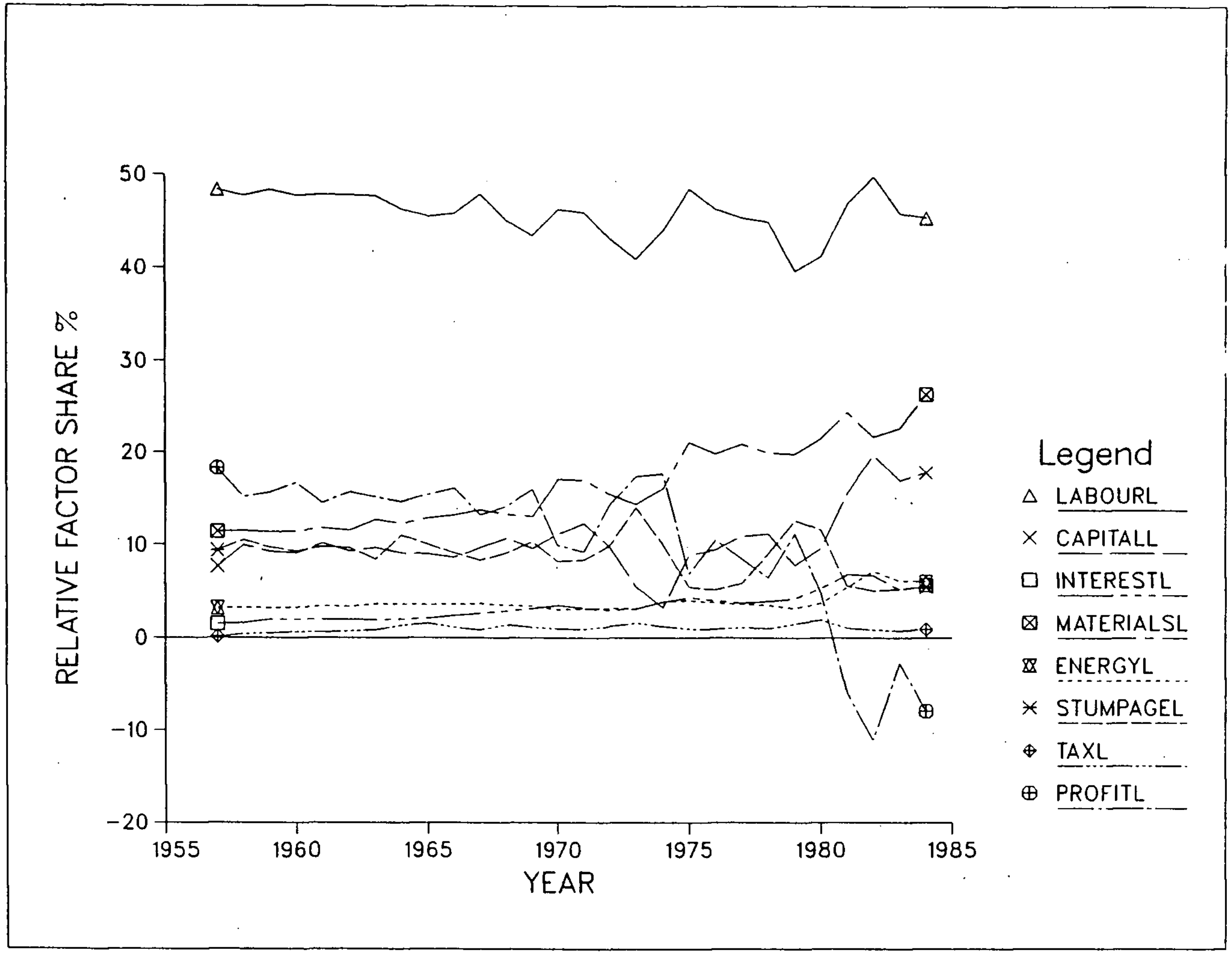

Figure 4.1: Relative Factor Shares in the Logging Industry, 1957-84

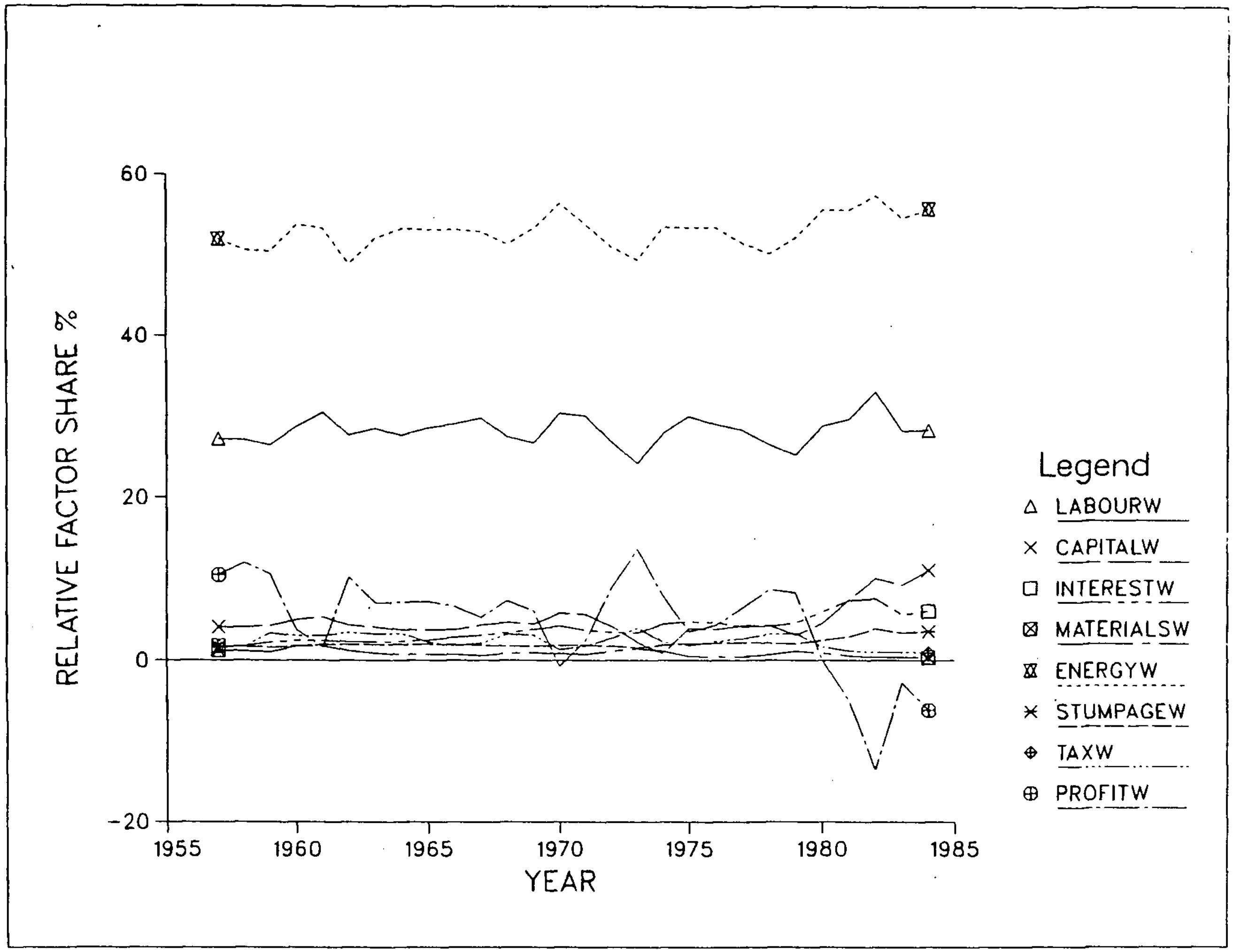

Figure 4.2: Relative Factor Shares in the Wood Industries, 1957-84

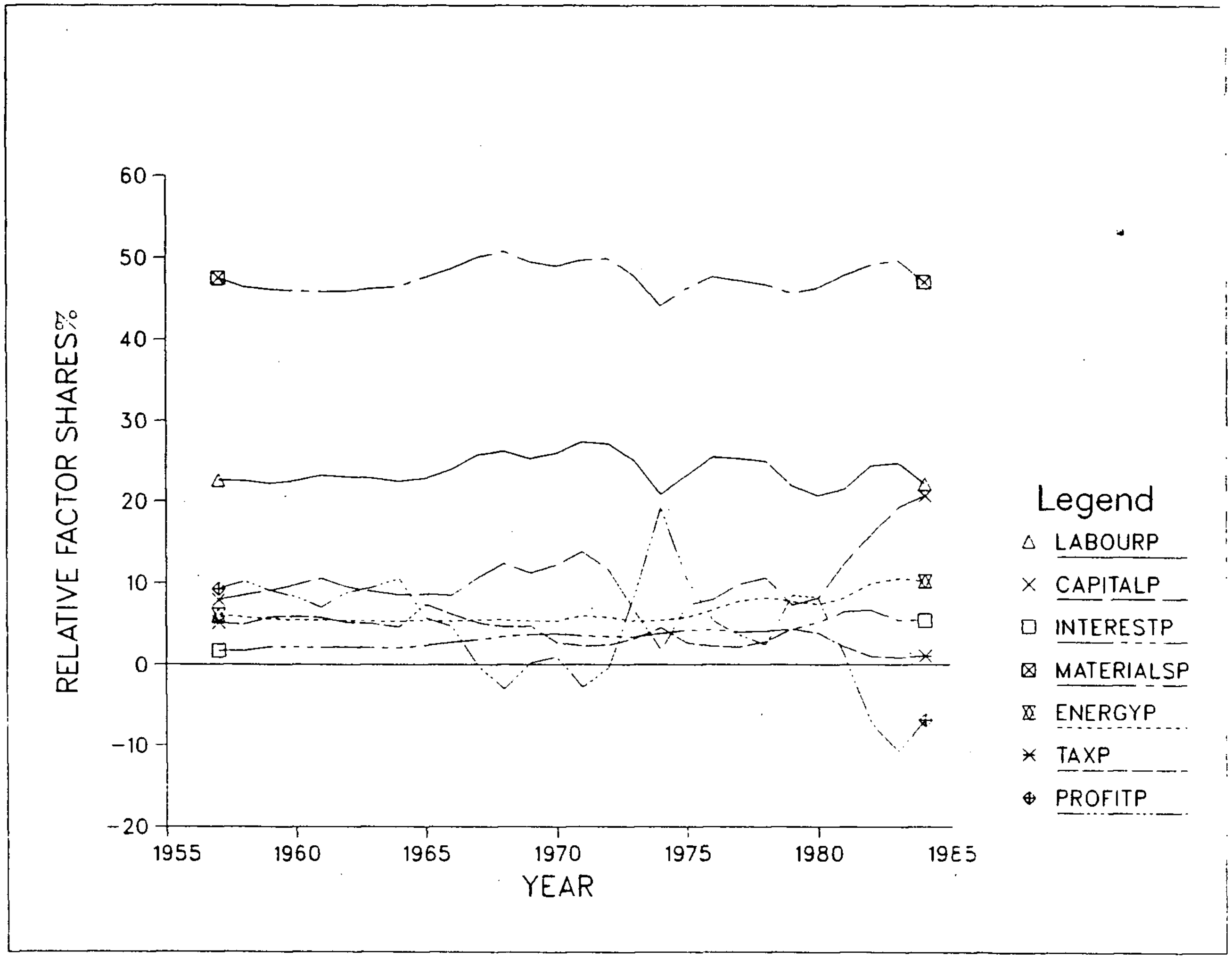

Figure 4.3: Relative Factor Shares in the Paper & Allied Industries, 1957-84

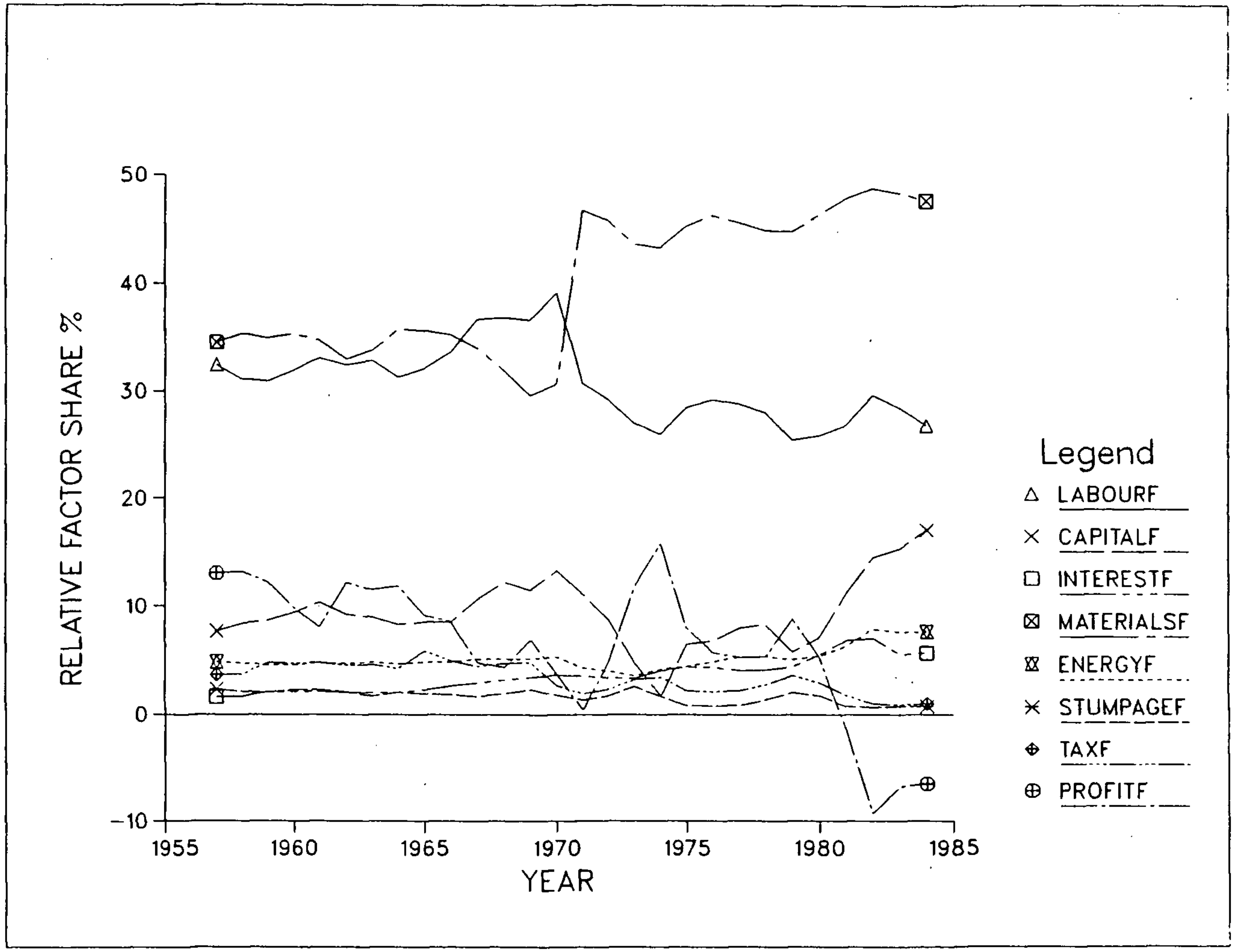

Figure 4.4: Relative Factor Shares in the Forest Industries, 1957-84

Table 4.3: The constituent industries: Trend parameter estimates and summary statistics[1]

SHARE	LOGGING INDUSTRY				WOOD INDUSTRIES				PAPER & ALLIED INDUSTRIES			
	TIME	CONSTANT	R^2	RHO	TIME	CONSTANT	R^2	RHO	TIME	CONSTANT	R^2	RHO
Labour (SL)	-0.13	293.97	0.49	0.05	0.038•	-46.83•	0.13	-0.03	0.03•	-33.96•	0.59	-0.09
	(-2.66)	(3.15)			(0.72)	(-0.45)			(0.48)	(-0.28)		
Capital (SK)	0.25	-473.29	0.64	0.06	0.21	-412.13	0.69	-0.20	0.23	-440.53	0.70	0.04
	(2.24)	(-2.19)			(1.74)	(-1.72)			(2.00)	(-1.95)		
Interest (SK1)	0.17	-322.91	0.90	0.26	0.17	-338.95	0.93	0.01	0.14	-268.73	0.96	-0.09
	(9.88)	(-9.78)			(12.1)	(-12.0)			(7.39)	(-7.31)		
Material (SM)	0.53	-1028.6	0.90	0.09	0.12	-179.22	0.40	-0.02	0.006•	-35.05•	0.56	-0.10
	(10.66)	(-10.50)			(2.83)	-2.18)			(0.11)	(-0.31)		
Energy (SF)	0.083	-158.68	0.79	0.002	0.06	-122.49	0.83	0.08	0.06	-115.77	0.95	0.13
	(2.25)	(-2.20)			(2.79)	(-2.74)			(2.31)	(-2.19)		
Stumpage (ST)	-0.11	223.04	0.60	-0.16	-0.028	55.80	0.69	0.03	-	-	-	-
	(-2.64)	(2.75)			(-4.01)	(4.07)						
Taxpart	0.023	-45.10	0.43	0.14	-0.045	91.24	0.45	0.08	-0.17	335.98	0.77	0.02
	(1.83)	(-1.80)			(-2.53)	(2.60)			(-6.07)	(6.14)		
Profit (SP)	-0.83	1643.70	0.75	0.04	-0.43	860.01	0.55	-0.07	-0.33	647.02	0.70	-0.05
	(-3.77)	(3.79)			(-2.45)	(2.47)			(-1.97)	(1.98)		

[1] t-ratios are in parentheses; for 26 degrees of freedom (df) critical values for one-tailed tests are $t_{.05} = 1.706$ and $t_{.1} = 1.315$;
SHARE refers to a relative factor share, dependent variable in a regression equation; TIME is coefficient of time (%/a), the independent variable; and CONSTANT refers to intercept term in a regression equation; R^2 is coefficient of determination which is required to be interpreted with caution (see section 2.3.1); RHO is coefficeint of autocorrelation in the corrected residuals;
Asterisk (•) indicates that the relevant result is not significant even at the 15% level.

Factor productivities were obtained by dividing output quantity indexes (qi) by the respective factor input quantity indexes. Factor price indexes were deflated by output price indexes to obtain indexes of real factor prices (i.e. marginal physical products). These indexes are reported in Tables III.5, III.6, III.7 and III.8 of Appendix III. Annual growth rates (as percentage per annum) in relative factor shares, real factor prices, and factor productivities have been estimated using exponential functional form and reported in Tables 4.4 and 4.5. The details of the respective regressions are reported in Tables III.6, III.7, III.8, and III.9 of Appendix III.

Table 4.4: Annual growth rates (%/a) of relative factor shares, real factor prices and factor productivities in the forest industries

FACTOR[1]	GSHARE[2]	GPRICE[3]	GPROD[4]	DIFF[5]
Labour (L)	-0.82	2.29	3.15	-0.86
Capital (K)	1.09**[7]	1.00**	-0.13**	1.13**
Money (K1)	5.10	-	-	-
Material (M)	1.51	0.07**	-1.38	1.38
Stumpage (T)	-3.98	-0.88	2.59	-3.47
Energy (F)	1.37	0.89*[6]	-0.45*	1.34
Taxpart	-4.89	-4.89	0.00	-4.89
Profit (P)	-7.74	-	-	-

[1]FACTOR refers to factor inputs used in the forest industries;
[2]GSHARE refers to the annual growth rates in the relative factor shares;
[3]GPRICE refers to the annual growth rates in the real factor prices;
[4]GPROD refers to the annual growth rates in factor productivities;
[5]DIFF = (GPRICE - GPROD);
[6]Asterisk (*) signifies that relevant result is significant only at the level 10% or 15%; and
[7]Double asterisk (**) suggests that relevant result is not significant even at the 15% level.

Table 4.5: Annual growth rates (%/a) of relative factor shares, real factor prices and factor productivies in the constituent industries

FACTOR	LOGGING INDUSTRY				WOOD INDUSTRIES				PAPER & ALLIED INDUSTRIES			
	Gshare[1]	Gprice[2]	Gprod[3]	Diff[4]	Gshare	Gprice	Gprod	Diff	Gshare	Gprice	Gprod	Diff
Labour (SL)	-0.28	1.97	2.24	-0.27	0.07**[7]	2.52	2.49	0.03	0.07**	2.19	2.26	-0.07
Capital (SK)	1.85	0.40**	-1.78	1.78	1.67*[6]	0.49**	-1.70	1.70	1.33*	1.00*	-0.34	1.34
Interest (SK1)	5.22	-	-	-	4.90	-	-	-	4.64	-	-	-
Material (SM)	3.23	-1.00	-4.20	3.20	0.22	-0.67	-0.90	0.23	0.02**	0.53*	0.49	0.04
Energy (SF)	1.80	1.09*	-0.84	1.93	2.68	-0.53**	-3.16	2.63	1.73*	2.47	0.66	1.81
Stumpage (ST)	-1.64	-1.00	0.11**	-1.00	-3.56	-0.67	2.64	-3.31	-	-	-	-
Taxpart	4.50	4.50	0.00	4.50	-2.50	-2.45	0.00	-2.45	-5.36	-5.36	0.00	-5.36
Profit (SP)	-10.30	-	-	-	-7.62	-	-	-	-6.64*	-	-	-

[1]FACTOR refers to factor inputs used in each of the industries;
[2]Gshare refers to the annual growth rates in a relative factor share;
[3]Gprice refers to the annual growth rates in a real factor price;
[4]Gprod refers to the annual growth rates in a factor productivity;
[5]Diff = (Gprice - Gprod);
[6]Asterisk (*) indicates that the relevant result is significant only at the 10% or 15%. level;
[7]Double asterisk (**) indicates that the relevant result is not significant even at the 15% level.

Table 4.6: Possible factor substitution & technical change in the forest industries and the logging industry, 1957-84

RATIOS[7]	FOREST INDUSTRIES						LOGGING INDUSTRY					
	GRFS[1]	ES[2]	GRF[3]	GRP[4]	CALES[5]	TECHONOLOGY[6]	GRFS	ES	GRF	GRP	CALES	TECHNOLOGY
RLK	-1.56*[8]	>1	3.28	1.89	1.74	L-saving, K-using	-2.1	>1	4.0	2.0	2.0	L-saving, K-using
RLM	-2.29	>1	4.75	2.56	1.86	L-saving, M-using	-3.5	>1	6.7	3.1	2.2	L-saving, M-using
RLT	2.99	<1	0.32**[9]	3.25	0.10	L-using, T-saving	1.4	<1	2.2	3.1	0.7	L-using, T-saving
RLF	-2.41	>1	3.22	1.57	2.05	L-saving, F-using	-2.2	>1	3.8	2.3	1.7	L-saving, F-using
RKM	-0.23**	≥1	1.41	1.02**	1.38	K-saving, M-using	-1.3*	>1	2.8	1.3	2.2	K-saving, M-using
RKT	4.29	<1	-2.72	1.79*	-1.52	K-using, T-saving	3.2	<1	-2.0	1.3	-1.5	K-using, T-saving
RFK	0.75**	≤1	-0.31**	0.81**	-0.38	neutral	0.02	≤1	1.0	1.0	1.0	neutral
RMT	5.73	<1	-4.83	0.77	-6.27	M-using, T-saving	-	-	-	-	-	-
RMF	0.34**	≤1	-1.49	-1.68*	0.89	M-using, F-saving	1.4	<1	-3.1	-2.8	1.1	M-using, F-saving
RFT	5.13	<1	-3.21	2.37	-1.35	T-saving, F-using	3.3	<1	-1.3	2.8	-0.5	T-saving, F-using

[7]RATIOS refers to ratio of one relative factor share to another. For example, RLK=SL/SK;
[1]GRFS refers to the annual growth rate in a ratio of relative factor shares;
[2]ES refers to elasticity of substitution deduced in accordance with proposition II (chapter 2); [5]CALES refers to calculated elasticity of substitution (GRF/GRP);
[3]GRF refers to the annual growth rate in a ratio of factor inputs. For example, the annual growth rate in the factor ratio K/L;
[4]GRP refers the annual growth rate in a ratio of factor prices. For example, the annual growth rate in ratio of the real labour price to the real rate of return to capital (w/r); [6]TECHNOLOGY refers to the bias of technical change as deduced in accordance with proposition III;
[8]Asterisk (*) indicates that the relevant result is significant at the 10% or 15% level.
[9]Double asterisk (**) refers indicates that the relevant result is not significant even at the 15% level.

Table 4.7: Possible factor substitution & technical change in the wood industries and the paper & allied industries, 1957-84

RATIOS[7]	WOOD INDUSTRIES						PAPER & ALLIED INDUSTRIES					
	GRFS[1]	ES[2]	GRF[3]	GRP[4]	CALES[5]	TECHONOLOGY[6]	GRFS	ES	GRF	GRP	CALES	TECHNOLOGY
RLK	-1.65*[8]	>1	4.25	2.81	1.51	L-saving, K-using	-1.70*	>1	2.50	1.30*	1.90	L-saving, K-using
RLM	-0.13	>1	3.53	3.21	1.10	L-saving, M-using	0.20**[9]	≤1	1.90	1.90	1.00	neutral
RLT	3.66	<1	0.16**	3.21	0.05	L-using, T-saving	-	-	-	-	-	-
RLF	-2.56	>1	5.98	3.37	1.77	L-saving, F-using	-2.10	>1	1.60	0.50**	2.50	L-saving, F-using
RKM	1.84*	<1	-0.76	0.94*	0.81	K-using, M-saving	1.60*	<1	-0.60	1.00*	0.60	K-using, M-saving
RKT	5.30	<1	-4.53	0.94*	-4.82	K-using, T-saving	-	-	-	-	-	-
RKF	-1.52	>1	1.68	1.09*	1.54	F-using, K-saving	0.80**	≤1	1.00	-1.60*	-0.60	neutral
RMT	3.78	<1	-3.78	0.00	<1	M-using, T-saving	-	-	-	-	-	-
RMF	-2.29	>1	-2.46	-0.30**	8.20	T-saving, F-using	-2.00	>1	-0.40	-2.00	0.20	M-using, F-saving
RFT	5.81	<1	6.34	-0.30**	-21.13	T-saving, F-using	-	-	-	-	-	-

[7]RATIOS refers to ratio of one relative factor share to another. For example, RLK=SL/SK;
[1]GRFS refers to the annual growth rate in a ratio of relative factor shares;
[2]ES refers to elasticity of substitution deduced in accordance with proposition II (chapter 2); [5]CALES refers to calculated elasticity of substitution (GRF/GRP);
[3]GRF refers to the annual growth rate in a ratio of factor inputs. For example, the annual growth rate in the factor ratio K/L;
[4]GRP refers the annual growth rate in a ratio of factor prices. For example, the annual growth rate in ratio of the real labour price to the real rate of return to capital (w/r); [6]TECHNOLOGY refers to the bias of technical change as deduced in accordance with proposition III;
[8]Asterisk (*) indicates that the relevant result is significant at the 10% or 15% level.
[9]Double asterisk (**) refers indicates that the relevant result is not significant even at the 15% level.

4.3 POSSIBLE FACTOR SUBSTITUTION AND TECHNICAL CHANGE

By dividing one relative factor shares by another, ratios of relative factor shares have been obtained. Ratios of factor quantities and those of factor prices have been similarly obtained. Exponential temporal trends in these ratios have been estimated and annual growth rates (percentage per annum) have been determined. The details of regressions are reported in Tables III.10, III.11, III.12, and III.13 of Appendix III. The values of annual growth rates for the above mentioned ratios are reported in Tables 4.6 and 4.7.

The values of annual growth rates in the ratios of relative factor shares have been used to deduce: (1) the possibilities for substitution between two corresponding factors in accordance with proposition II (chapter 2); and (2) the bias of technological change in accordance with proposition III (chapter 2), in each of the industries. The values of the annual growth rates in the ratios of factor quantities and those of factor prices have been used to calculate the elasticities of substitution (CALES) between various factors so as to verify the elasticities of substitution (ES) deduced in accordance with proposition II. These results are also summarized in Tables 4.6 and 4.7.

The empirical results, reported in this chapter, will now be interpreted in the light of the specific research hypotheses and compared with the results of Ovaskainen (1986) and with those for the Canadian manufacturing sector.

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5. EMPIRICAL RESULTS : DISCUSSED

5.1 INTERPRETATION OF RESULTS

The mean values of the relative factor shares in the forest industries and each of the constituent industries, summarized in Table 4.1, are indicators of the relative importance of the factor inputs in each of these sectors. For example, labour is the dominant factor input in the logging industry, whereas materials dominate in the other industries studied.

The estimates of trend parameters for the relative factor shares in each of these industries, reported in Tables 4.2 and 4.3, are significantly different from zero except for labour in the wood industries, and labour and materials in the paper & allied industries. The trend parameters of these factor inputs are not significantly different from zero even at the 15% level. The annual growth rates (as percentage per annum) in relative factor shares, real factor prices and factor productivities in each of the industries have been reported in Tables 4.4 and 4.5. Except in the case of stumpage, the rates of change in relative factor shares in each of these industries seem to be consistent with the difference between the annual growth rate in the corresponding real factor price and that in the corresponding factor productivity[1]. That is, these results support the principal hypothesis. The changes in individual relative factor shares in each of these industries are interpreted in the light of the specific research hypotheses as follows.

5.1.1 FOREST INDUSTRIES

The results, reported in Table 4.4, suggest that the relative share of labour (SL) has decreased by 0.82% per annum, which is significantly different from zero. Therefore, Hypothesis 1 that the relative share of labour has consistently decreased is accepted. Real labour price and labour productivity have increased by 2.29% and

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[1] In the case of stumpage the rate of change in the relative share is significantly different from the difference between the rate of change in stumpage rate and that in timber productivity.

3.15% per annum respectively. Both these results are statistically significant. Therefore, Hypothesis 6 that real labour price and labour productivity have risen is accepted.

The net productivity gain (i.e. difference between the rate of increase in labour productivity and that in real labour price, which is 3.15% - 2.29% = 0.86%) is positive suggesting that these industries have maintained a comfortable competitive edge in the use of labour input. This difference also accounts for the decline in relative share of labour by almost the same rate, that is 0.82%. Hence, Hypothesis 11 that the rate of change in a relative factor share is consistent with the difference between the rate of change in the real factor price and that in factor productivity is accepted for the relative share of labour.

The relative share of stumpage (ST) has declined at a statistically significant rate of 3.56% per annum. Hence, Hypothesis 2 that the relative share of timber has consistently decreased is accepted. Real stumpage rate has decreased at an annual rate of 0.88%, which is significantly different from zero. Timber productivity has risen at a statistically significant rate of 2.59%. Hence, Hypothesis 10 that real stumpage rate has declined, but timber productivity has increased is accepted.

The difference between the rate of increase in timber productivity and that of decrease in real timber price (i.e. 2.59 - (-0.88) = 3.47) is positive implying that the industries maintained their competitiveness in the use of this factor input. However, this difference accounts only for 3.47% out of a 3.98% decline in the share of this input. Hence, the Hypothesis 11 is not accepted for the relative share of stumpage. This raises the question: how can the difference between the observed and the theoretical rate of decline in the relative share of this input (i.e. 3.98 - 3.47 = 0.41) be explained?

This is a very complex question which needs to be analyzed in more detail than can be undertaken in this thesis. However, two possible explanations can be offered:

- It is likely that: (i) the forest industries concerned have not paid stumpage at the rate they would have paid if market forces had been allowed to determine stumpage levels, and/or (ii) the actual stumpage rate paid by these industries has declined more than the rate used in this thesis[2].
- It is also likely that governments have encouraged investments, through various policy instruments, in order to stabilize communities in economically depressed regions. That is, various incentives have been provided to the forest industries in these regions so that they be there to meet some deliberate social obligations. If this is the case, the Crown has probably voluntarily relinquished part of the 'true' economic rent in order to subsidize distributional policies.

In either of these cases, the 'reported' share of stumpage is likely to be less than the 'true' share of stumpage, that is 'true' economic rent.

The relative share of durable capital (SK) has risen at an annual rate of 1.09%, which is not statistically significant even at the 15% level. Similarly, the changes in the real rate of return to capital and capital productivity are both not significantly different from zero at the 15% level, the former having increased by 1.00% and the latter having decreased by 0.13% per annum. However, in view of the facts that: (i) these results (except the one for capital productivity) are in accordance with the expectations reported in Table 3.2; and (ii) the estimates of the trend parameters for this relative factor share are statistically significant; these results have been accepted in spite of their low level of significance[3]. Hence,

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[2] Recall that an index for prices for 'materials (pm), constructed by Statistics Canada, is used as the price index (1971=100) for 'timber'. This has been accepted under the assumption that the forest industries face perfectly competitive factor markets, that is, prevailing factor prices are the competitive market prices. This assumption is highly questionable in the case of timber input.

[3] The scatter diagrams for the relative capital share and rate of return to capital respectively suggest wide variations. It was, therefore, theorized that these two variables had widely varied during the period 1973-84 due to the two oil-shocks of 1973 and 1979. Consequently, there seem to be two time-series: one for the period 1957-72, and the other for the period 1973-84. To test this premise, a dummy variable was introduced into the regression analysis for the variables: relative capital share, real rate of return to capital (i.e. real capital price), and capital productivity. This rendered the coefficient of the variable 'time' and that of the 'dummy' variable statistically significant at the 5% level. Hence, the premise was

Hypothesis 3, that the relative share of durable capital has consistently risen, is accepted. The first part of Hypothesis 7, that the real rate of return to capital has risen, is also accepted. But the second part of this Hypothesis, that capital productivity has risen, is rejected and the alternative Hypothesis, that capital productivity has declined, is accepted.

The difference between the rate of change in capital productivity and that in the real rate of return to capital (i.e. -0.13 - 1.00 = - 1.13) is negative suggesting cost pressure on the industries. This pressure pushed the relative share of capital to rise by almost the same rate, that is 1.09% per annum. Therefore, Hypothesis 11 is accepted for the relative share of capital.

The relative share of materials (SM) has risen at a rate of 1.51% per annum, which is statistically significant. Hence, Hypothesis 4, that the relative share of materials has consistently risen, is accepted. Real price of materials declined at an annual rate of 0.07%, which is not significantly different from zero even at the 15% level. Materials productivity has declined at a statistically significant rate of 1.38% per annum. Hence, Hypothesis 8, that the real price of materials has not changed, but materials productivity has declined, is accepted. The net productivity gain (i.e. -1.38 - 0.00 = -1.38) is negative implying cost pressure on these industries in the use of materials input. This pressure has caused the materials' relative share to rise by almost the same rate, that is 1.51% per annum. Hence, Hypothesis 11 is accepted for this factor input.

The increase in the relative share of energy (SF) by 1.37% per annum is statistically significant. Therefore, Hypothesis 5 that the relative share of energy has consistently risen is accepted. The real price of energy has increased at a rate of 0.89% per annum and energy productivity has declined at an annual rate of 0.45%. Both these results are statistically significant only at the 15% level. However,

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[3](cont'd) accepted and the simultaneous occurrence of the problems of autocorrelation and heteroscedasticity was suspected. As there is no satisfactory way to deal with both these problems simultaneously in the type of analysis undertaken in this thesis, the results are corrected only for the problem of autocorrelation.

introduction of a dummy variable into the regression analyses rendered the coefficients of both the variables: 'time' and 'dummy', in both the regressions, significant at the 5% level. Hence, these results have been accepted in spite of their low level of significance. Therefore, the first part of Hypothesis 9, that the real energy price has risen, is accepted. But the second of part of this Hypothesis, that energy productivity has risen, is rejected and the alternative hypothesis that energy productivity has declined is accepted.

The difference between the rate of decline in energy productivity and that in the real energy price (i.e. -0.45 - 0.89 = -1.34) is negative. This implies cost pressure on these industries in the use of this input. This pressure has caused the relative share of this input to rise by almost the same amount, that is 1.37% per annum. Hence, Hypothesis 11 is accepted for this factor input.

Profitability[4] has declined at a rate of 7.74% per annum, which is statistically significant. Hence, Hypothesis 12, that profitability in the forest industries has consistently declined, is accepted. The relative. share of money capital has increased at a statistically significant rate of 5.10% per annum.

The relative share of taxes and the real tax rate[5] both declined by 4.89% per annum. These results are statistically significant. The decline in the real tax rate fully explains the decline in the relative share of this factor input. That is, the rate of change in the relative tax share is consistent with the rate of change in the real tax rate and in tax productivity, which is zero by definition. The consistent decline in the real tax rate and in the relative share of taxes also suggest that governments have provided a tax structure which, in effect, has been progressively favourable to these industries.

Compared to the rate of increase in the real labour price (2.29%), there are less increases in real rate of return to capital (1.00%) and that of the real energy

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[4]The term 'profitability' is here defined as the relative share of profit.

[5]As defined for the purpose of this study

price (0.89%). The real materials price has not significantly changed. Also, productivities for the factors: materials, energy, and capital have consistently declined. On the other hand, labour productivity has significantly increased. However, despite a decrease in the real stumpage rate, timber productivity has increased. In view of these observations, it seems reasonable to infer that:

- the factor inputs: materials, energy, and capital have been increasingly used, and labour input has been reduced;
- comparatively costly labour has been progressively substituted by other factor inputs such as capital, energy, and materials in order to maintain industrial competitiveness;
- decrease in real stumpage rate would be expected to cause the use of the timber input to increase. This, in turn, should cause timber productivity to decline. In fact, contrary to these expectations, timber productivity has risen. It is difficult to explain this rise in timber productivity. However, the observed rise in timber productivity may be attributed to a mix of factors such as government policies on close utilization standards; and use of pulp chips.

In fact, the results reported in Table 4.6 support these inferences. The changes in relative factor shares suggest possibilities for substitution between factor input pairs: labour-capital, labour-energy, labour-materials, and capital-materials. Factor pairs: labour-timber, capital-timber, materials-timber, capital-energy, materials-energy, and timber-materials have been found not to be easily substitutable. The elasticities of substitution, deduced in accordance with proposition II (i.e. ES), are in agreement with the calculated elasticities of substitution (CALES). The inter-temporal changes in relative factor shares also indicate that technical change in these industries is labour and timber saving, and capital, materials and energy using.

5.1.2 LOGGING INDUSTRY

The results, reported in Table 4.5, suggest that the relative share of labour (SL) has decreased by 0.28% per annum, which is statistically significant. Hence, Hypothesis 1, that the relative labour share has decreased, is accepted. Real labour price and labour productivity have risen at statistically significant rates of 1.97% and 2.24% per annum respectively. Therefore, Hypothesis 6, that real labour price and labour productivity have risen is, accepted.

The difference between the rate of increase in labour productivity and that in real labour price (i.e. 2.24 - 1.97 = 0.27) is positive and implies that the industry has maintained competitiveness in the use of this input. This difference also explains the decline in the relative labour share by almost the same rate, that is 0.28% per annum. Hence, Hypothesis 11, that the rate of change in a relative factor share is consistent with the difference between the rate of change in the real factor price and that in factor productivity, is accepted for the relative share of labour.

The relative share of stumpage (ST) has decreased at an annual rate of 1.64%, which is statistically significant. Hence, Hypothesis 2 that the relative share of timber has consistently declined is accepted. Real rate of stumpage has declined at a statistically significant rate of 1.00% per annum. However, timber productivity has risen by 0.11% per annum, which is not significantly different from zero even at the 15% level. Therefore, the first part of Hypothesis 10 that the real rate of stumpage has decreased is accepted. But the second part of this Hypothesis that timber productivity has risen is rejected and the alternative hypothesis that timber productivity has not changed is accepted.

The difference between the rate of change in real timber price and that in timber productivity (i.e. -1.00 - 0.00 = -1.00) does not fully explain the decline in the relative share of timber. Hence, Hypothesis 11 is not accepted for this factor input. The question, however, is: how can the difference between the observed and the theoretical rate of decline in the relative share of this input (i.e. 1.64 - 1.00 =0.64) be explained? Some possible explanations to this question have already been suggested in section 5.1.1.

The relative share of capital (SK) has risen at a rate of 1.89% per annum, which is statistically significant. Therefore, Hypothesis 3, that the relative share of durable capital has increased, is accepted. Real rate of return to capital has increased by 0.40% per annum, which is not significantlly different from zero even at the 15% level. Capital productivity has declined at an annual rate of 1.78%, which is statistically significant. Hence, the first part of Hypothesis 7, that the real rate of return to capital has risen, is rejected and the alternative hypothesis that there is no significant change in real rate of return to capital is accepted. Also, the second part of this Hypothesis, that capital productivity has risen, is rejected and the alternative hypothesis that capital productivity has declined is accepted.

The net productivity gain (i.e. -1.78 -0.00 = -1.78) is negative. This suggests that the industry experienced cost pressure in the use of capital input. This, in turn, pushed the capital's relative share up by almost the same rate, that is 1.85% per annum. Therefore, Hypothesis 11 is accepted for the relative share of capital.

Materials' relative share (SM) has increased at an annual rate of 3.23%, which is statistically significant. Hence, Hypothesis 4 that materials' relative share has consistently risen is accepted. Real materials price and its productivity have declined by 1.00% and 4.20% per annum, respectively. Both these results are statistically significant. Hence, the first part of Hypothesis 8, that the real price of materials has not changed is rejected and the alternative hypothesis that the real materials price has declined is accepted. The second part of this Hypothesis, that materials productivity has declined, is accepted.

The difference between the rate of change in materials productivity and that in real materials price (i.e. -4.20 - (-1.00) = -3.20) is negative implying cost pressure on the industry in the use of materials. This has caused the materials' relative share to rise by almost the same rate, that is 3.23% per annum. Hence, Hypothesis 11 is accepted for this factor input.

The relative share of energy (SF) has increased at an annual rate of 1.80%, which is statistically significant. The increase in real energy price by 1.09% per annum is statistically significant only at the 10% level. Energy productivity has declined at a statistically significant rate of 0.84%. Hence, Hypothesis 5, that the relative share of energy has consistently risen, is accepted. The first part of Hypothesis 9, that the real energy price has increased, is accepted at the 10% level. However, the second part of this Hypothesis, that energy productivity has risen, is rejected and alternative hypothesis that energy productivity has declined is accepted. Negative productivity gain (i.e. -0.84-1.09 = -1.93) for this input implies cost pressure on the industry and has pushed the relative share of this input up by almost the same rate, that is 1.80%. Hence, Hypothesis 11 is accepted for energy's relative share.

Profitability (SP) in this industry has declined at a statistically significant rate of 10.30% per annum. Hence, Hypothesis 12, that profitability in the logging industry has consistently declined, is accepted. The relative share of money capital (SK1) has increased by 5.22% per annum.

The relative share of taxes (taxpart) has increased at an annual rate of 4.50%, which is statistically significant. Real tax rate has also increased at a statistically significant rate of 4.50% per annum, which fully explains the increase in the relative share of taxes. That is, the rate of change in the relative tax share is consistent with the difference between the rate of change in real tax rate and that in tax productivity, which is zero under the definition of tax rate. Interestingly, the relative share of taxes has increased only in the logging industry, while the same has declined in the rest of the industries. This seems anomalous and is explained as follows.

For the purpose of this study, taxes include only corporate income tax and taxes other than sales tax and excise tax. Taxes do not include personal income tax. Over time, more and more logging firms, which were earlier operated as unincorporated firms, were brought into the corporate sector by way of vertical and/or horizontal integration. In this way, these firms became subject to corporate income tax as and when they were integrated into the corporate sector. Hence, the share of taxes in the logging industries has grown over time, while this share has declined in the other industries in which most of the firms were already the part of the corporate world.

Results regarding possible inter-factor substitutions and the bias of technical change in the logging industry are reported in Table 4.7. The changes in relative factor shares suggest possibilities for substitution between labour and capital; labour and materials; labour and energy; and capital and materials. Factor pairs: labour and timber; capital and timber; materials and energy; capital and energy; and energy and timber have not been found easily substitutable. The calculated elasticities of substitution (CALES) are in general agreement with the elastitities of substitution deduced according to proposition II (i.e. ES). The inter-temporal changes in relative factor shares also indicate that the bias of technical change in this industry is labour and timber saving; and capital, materials and energy using.

Martinello (1985) reported that for the logging industry: (i) energy and wood were complements and all other inputs were substitutes; (ii) technical change was labour-saving, and capital, energy and wood using; and (iii) timber productivity declined. This study, however, suggests that: (i) capital and energy are complements and all other factors are substitutes, the degree of substitution being higher amongst the input pairs: labour and capital; labour and materials; labour and energy; and capital and materials, and the degree of substitution being less between the rest of the factor pairs; (ii) the bias of technical change is labour and timber-saving; and capital, energy and materials using; (iii) the estimated changes in factor productivities (except that in timber productivity) are in the same direction as reported by Martinello (1985); and (iv) the decline in timber productivity, as reported by Martinello (1985), could not be established in this study.

5.1.3 WOOD INDUSTRIES

The results, reported in Table 4.5, suggest that the relative share of labour (SL) has increased by 0.07% per annum, which is not significantly different from zero even at the 15% level. In Table 4.3, the coefficient of the time variable for labour share is also not statistically significant at the 15% level. This implies that the relative share of labour has not significantly changed. Hence, Hypothesis 1, that the relative share of labour has consistently decreased, is rejected and the alternative hypothesis that labour's relative share has not changed is accepted. Real labour price and labour productivity have risen at statistically significant rates of 2.52% and 2.49% per annum. Hence, hypothesis 6 that the real labour price and labour productivity have risen is accepted.

However, the increase in real labour price at an annual rate of 2.52% is almost offset by an increase in labour productivity of 2.49% per annum. The net productivity gain (i.e. 2.49 - 2.52 = -0.03) is negligible. In other words, entrepreneurs have adjusted their use of labour so that any increase in real labour price is balanced by the same increase in labour productivity. That is, the profit-maximizing firms in the wood industries have used the optimum amount of labour input at the level where the marginal physical product of this factor input (i.e. real labour price) was equal to its average physical product. This explains the constant relative share of labour. Hypothesis 11 that the rate of change in the relative labour share is consistent with the difference between the rate of change in real labour price and labour productivity is accepted.

The relative share of stumpage (ST) has declined by 3.56% per annum, which is statistically significant. Hence, Hypothesis 2, that the relative share of stumpage has consistently declined, is accepted. Real stumpage rate has declined at an annual rate of 0.67%, while timber productivity has increased by 2.64% per annum. Both these results are statistically significant. Hence, Hypothesis 10, that the real stumpage rate has decreased, but timber productivity has increased, is accepted.

The net productivity gain (i.e. 2.64 - (-0.67) = 3.31) is positive implying that the industries have maintained their competitiveness in the use of this factor input. But this difference does not fully explain the decline in the relative share of stumpage. Some possible explanations for the difference between the observed and the theoretical rate of change in the relative share of stumpage have been given in section 5.1.1. Therefore, Hypothesis 11 is not accepted for this factor input.

The relative share of durable capital (SK) has risen at a rate of 1.67% per annum, which is statistically significant only at the 15% level. However, in view of the facts that: (i) this result is in accordance with the expectations reported in Table II.8 of Appendix II; and (ii) the estimates of trend parameters for the relative share of capital, reported in Table 4.3, are statistically significant at the 5% level; this result has been accepted in spite of its low significance level[6]. Hence, Hypothesis 3, that the relative share of durable capital has consistently risen, is accepted at the 15% level.

The real rate of return to durable capital increased by 0.49% per annum, which was not found to be statistically significant even at the 15% level. Even the introduction of a dummy variable in the regression analysis did not change the outcome. Capital productivity declined at a statistically significant rate of 1.70% per annum. Hence, the first part of Hypothesis 7, that the real rate of return to capital has risen, is rejected and the alternative hypothesis that there is no significant change in real rate of return to capital has been accepted. Similarly, the second part of this Hypothesis, that capital productivity has risen, is rejected and the alternative hypothesis that capital productivity has declined, is accepted.

The difference between the rate of change in capital productivity and that in the real rate of return to capital (i.e. -1.70 - 0.00 = -1.70) is negative suggesting

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[6] For further explanation, see footnote 3 of this section

cost pressure on the wood industries. This has caused the relative share of this factor input to rise by almost the same rate, that is, 1.67% per annum. Hence, Hypothesis 11 is accepted for this factor input.

The relative share of materials (SM) has risen by 0.22% per annum, which is statistically significant. Therefore, Hypothesis 4, that the share of materials has consistently risen, is accepted. Real price of materials and its productivity have declined by 0.67% and 0.90% per annum respectively. Both these results are statistically significant. Hence, the first part of Hypothesis 8, that the real materials price has not changed, is rejected and the alternative hypothesis, that real materials price has declined, is accepted. But the second part of the Hypothesis, that materials productivity has declined, is accepted.

The net productivity gain (i.e. -0.90 - (-0.67)= -0.23) is negative indicating cost pressure on the industries in use of materials input. This has caused the relative share of materials to rise by almost the same rate, that is, 0.22% per annum. Hence, Hypothesis 11 is accepted for this factor input.

The rate of increase in relative share of energy (SF) by 2.68% per annum is statistically significant. Hence, Hypothesis 5, that the relative share of energy has consistently risen, is accepted. The real price of this factor input has decreased at an annual rate of 0.53%, which is not statistically significant even at the 15% level. This seemed anomalous, particularly in view of the expectations reported in Table II.8 of Appendix II. Therefore, a dummy variable was introduced into the regression analysis for the relevant exponential trend equation and it was observed that the coefficient of the time variable became statistically significant at the 5% level[7].

Therefore, the rate of change in real energy price at an annual rate of -0.53% is accepted, in spite of its low level of significance. Energy productivity has appreciably declined by 3.10% per annum, which is statistically significant. Hence, Hypothesis 9, that the real energy price and energy productivity have risen, is

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[7] For further explanation, see footnote 3 of this section.

rejected and the alternative hypothesis, that real energy price and energy productivity have declined is accepted.

The difference between the rate of change in energy productivity and that in real energy price (i.e. -3.10 - (-0.53)= -2.63) is negative. This implies that the industries have experienced increasing cost pressure in the use of energy. This has caused the share of this input to rise by almost the same rate, that is, 2.68% per annum. Hence, Hypothesis 11 is accepted for this factor input.

The relative share of taxes and real tax rate have declined by 2.50% and 2.45% per annum, respectively. Both these results are statistically significant. Hence, the rate of change in the relative share of tax is almost fully accounted by the rate of change in real tax rate. That is, the rate of change in relative share of taxes is consistent with the difference between the rate of change in real tax rate and that in tax productivity, which is zero under the definition of tax rate. The consistent decline in real tax rate and in the relative tax share also suggest that governments provided a tax structure which, in effect, was progressively favourable to these industries.

The relative share of profit (SP) or profitablity has consistently declined by 7.62% per annum, which is statistically significant. Hence, Hypothesis 12, that profitability in the wood industries has consistently declined, is accepted. The relative share of money capital (SK1) has also risen at a statistically significant rate of 4.90% per annum.

The results regarding possible inter-factor substitution and the bias of technical change in the wood industries are reported in Table 4.7. The changes in relative factor shares suggest possibilities for substitution between labour and capital; labour and materials; labour and energy; materials and energy; and timber and energy. Factor pairs: labour and timber; materials and timber; energy and timber; capital and materials; and capital and timber have been found to be not easily susbstitutable. Elasticities of substitution, deduced in accordance with proposition II, are in accordance with the calculated elasticities of substitution. The inter-temporal change in relative factor shares also indicates that the technical change in these industries is labour and timber saving and capital, materials and fuel & energy using.

This study supports the results of: (i) Martinello (1985) in that the technical change is labour saving and capital & energy using; (ii) Martinello (1985) and Singh & Nautiyal (1986) in that labour productivity has increased and productivities of capital, energy and wood (materials in this case) have decreased. The results, however, differ from those of Martinello (1985) in that the technical change in the wood industries is materials using, not materials (wood in the case of Martinello (1985)'s studies) saving. The results of this study, however, substantially differ from those of Rao & Preston (1983).

5.1.4 PAPER & ALLIED INDUSTRIES

The results, reported in Table 4.5, suggest that the relative share of labour (SL) has only marginally increased at an annual rate of 0.07%, which is not significantly different from zero even at the 15% level. The estimates for the trend parameters for the relative labour share, reported in Table 4.3, are also not statistically significant at the 15% level. Hence, Hypothesis 1, that the relative share of labour has consistently decreased, is rejected and the alternative hypothesis that labour's relative share has not changed is accepted. Real labour price and labour productivity have risen by 2.19% and 2.26% per annum, both being statistically significant. Hence, Hypothesis 6 that real labour price and labour productivity have risen is accepted.

The increase in the real labour price at an annual rate of 2.19% is almost fully offset by an increase in labour productivity at a rate of 2.26% per annum. The difference between the rate of change in labour productivity and that in real labour price (i.e. 2.26 - 2.19 = 0.07) is not significant. This explains the constant relative share of this factor input. Hence, Hypothesis 11, that the rate of change in the relative labour share is consistent with the difference between the rate of change in real labour price and that in labour productivity, is accepted. Profit-maximizing firms in the paper & allied industries have optimally used this factor input and have maintained their competitiveness.

The relative share of durable capital (SK) has risen at a rate of 1.33% per year, which is significant only at the 15% level. However, in view of the facts that: (i) this result is as expected in table II.8 of Appendix II, and (ii) the estimates of trend parameters for this factor input, reported in Table 4.3, are significant; this result is accepted in spite of its low level of significance[8]. Hence, Hypothesis 3, that the relative share of durable capital has consistently risen, is accepted. Real rate of return to durable capital has risen by 1.00% per annum, which is also significant only at the 15% level. However, for reasons stated above, this result has been accepted in spite of its low level of significance. Capital productivity, on the other hand, has declined by 0.34% per annum, which is statistically significant. Hence, the first part of Hypothesis 7, that the real rate of return to durable capital has risen, is accepted. But the second part of this Hypothesis, that capital productivity has risen, is rejected and the alternative hypothesis, that capital productivity has declined, is accepted.

The net productivity gain (i.e. -0.34-1.00= -1.34) is negative, which implies cost pressure on these industries in the use of capital. This has caused the relative share of durable capital to rise by almost the same rate, that is, 1.33% per annum. Therefore, Hypothesis 11 is accepted for this factor.

The relative share of materials (SM) has risen by 0.02% per annum, which is not significant even at the 15% level. Therefore, Hypothesis 4, that the share of materials has risen, is rejected and the alternative hypothesis, that the relative share of materials has not changed, is accepted. Real price of materials has increased at an annual rate of 0.53%, which is significant at the 10% level of significance. Materials productivity has risen at a significant rate of 0.49% per annum. Therefore,

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[8] For further explanation, see footnote 3 of this section.

the first part of Hypothesis 8, that the real materials price has not changed, is rejected and alternative hypothesis about rise in the real materials price is accepted. Similarly, the second part of the Hypothesis 8, that materials productivity has declined, is rejected and alternative hypothesis, that materials productivity has risen, is accepted. The net productivity gain (i.e. 0.53 - 0.49 = 0.04) is negligible. This explains the constant relative share of materials. Hence, Hypothesis 11 is accepted for this factor share. Materials which are a dominant factor input in these industries, have been optimally used by profit-maximizing firms at the level where their marginal physical product matches with their average physical product.

The relative share of energy (SF) has increased by 1.73% per annum, which is siginficant only at the 15% level. However, in view of the facts that: (i) the change in this share is in accordance with the expectations reported in Table II.8 of Appendix II, (ii) the estimates of trend parameters for this factor input, reported in Table 4.3, are significant at the 5% level, and (iii) the coefficients of the time and dummy variables were found to be significant at the 5% level, when a dummy variable was introduced into the regression analysis; this result is accepted despites its low level of significance. Hence, Hypothesis 5, that the relative share of energy has consistently risen, is accepted at the 15% level. Real energy price has increased at a statistically significant rate of 2.47% per year and energy productuctivity also increased at a statistically significant rate of 0.66% per annum. Hence, hypothesis 9, that the real energy price and energy productivity have risen, is accepted.

The difference between the rate of change in energy productivity and that in real energy price (i.e. 0.66 - 2.47 = -1.81) is negative. This suggests cost pressure on the industries and explains the rise in the relative share of this input by almost the same rate, that is, 1.73% per annum. Therefore, Hypothesis 11 is accepted for this factor input.

Both, the relative share of taxes and real tax rate, have declined at a statistically significant rate of 5.36% per year. The decline in the real tax rate fully accounts for the decline in the relative share of taxes. Hence, the rate of change in the relative tax share is consistent with the difference between the rate of change in real tax rate and that in tax productivity, which is zero under the definition of tax rate. Moreover, the difference between the rate of change in productivity of this input and that in real tax rate (i.e. 0.00 - (-5.36) = 5.36) is positive. This suggests that effective tax rates have been progressively beneficial to these industries causing the share of this input to decline.

Profitability, or the relative profit share (SP), declined by 6.10% per annum, which is significant at the 10% level. Hence, Hypothesis 12, that profitability in these industries has consistently declined is accepted. The relative share of money capital (SK1) has risen at a statistically significant rate of 4.64% per annum.

The results regarding possible inter-factor substitution and the bias of technical change are reported in Table 4.7. The changes in relative factor shares suggest possibilities for substitution between labour and capital; labour and energy; and materials and energy. Factor pairs: labour and materials; capital and materials; and capital and energy have been found not to be easily susbstitutable. Elasticities of substitution, deduced in accordance with proposition II (i.e. ES), are in agreement with the calculated elasticities of substitution (CALES) except in the case of the factor input pair: materials and energy. In this case the calculated elasticity of substituttion is much less than that deduced in accordance with proposition II. This anomaly appears probably due to two reasons: (1) the energy generated by the establishments in this industry for their own use has contributed to production, but has not been taken into account for the purpose of this analysis. This deliberate omission distorts the growth rates in the relative energy share, real energy prices, and relevant factor ratios and ratios of factor prices; and (2) the prices of energy have greatly varied over the period of analysis. This variation has caused the simultaneous econometric problems of autocorrelation and heteroscedasticity. As there is no satisfactory method available to deal with these econometric problems simultaneosly in the type of analysis undertaken in this thesis, the empirical results have been corrected only for the problem of autocorrelation. The empirical results reported in Table 4.7 also indicate that the bias of technical change in these industries is labour and materials saving; and capital and energy using.

The results of this study: (i) only partly agree with those of Rao & Preston (1983) in that technological change is labour-saving and energy-using, and (ii) differ in that technological change is capital-using and materials-saving. These results are in general agreement with the results of Sherif (1983) in that capital and energy are complements; and technological change is capital and energy using and labour and wood (in this study, wood is included in materials) saving. Martinello (1985) reported: (i) wood-energy and wood-capital to be complements and other pairs to be substitutes, and (ii) labour-saving, and capital, materials and energy using technological change, while this study considers only capital and energy to be complements and other pairs to be substitutes in varying degrees. The technological change is estimated to be labour and material saving and capital and energy using. Nautiyal & Singh (1986) reported decline in materials productivity and an increase in labour productivity, while this study estimates increase in both labour and materials productivities.

The question now arises: how do these changes in relative factor shares in the Canadian forest industries compare with those in the manufacturing sector of the Canadian economy and with the results of Ovaskainen (1986), who has studied 'functional income distribution' in the Finnish forest industries? These comparisons are undertaken in the next section.

5.2 COMPARISON OF THE EMPIRICAL RESULTS WITH OTHER STUDIES

This section is organised as follows. First, the scope of the comparisons made is clarified. Second, functional income distribution in the Canadian forest industries and that in the Canadian manufacturing industries are compared in sub-section 5.2.1. Finally, the comparison of the functional income distribution in the

Canadian forest industries with that in the Finnish forest industries follows in sub-section 5.2.2.

It seems that no study of functional income distributioin in the manufacturing sector of Canadian economy, covering the same period of analysis, has yet been undertaken. Therefore, Canadian manufacturing industries are analyzed employing the same approach that has been used to determine functional income distribution in the forest industries. Two differences, however, deserve mention. First, the factor input, stumpage, which is an input particular to the forest industries is not taken into consideration when analyzing the manufacturing sector. Second, taxes include only the corporate income tax, and thus differ somewhat from taxes entering into the analysis of the forest industries.

Table 5.1 : Average relative factor shares in the Canadian forest industries, Canadian manufacturing industries, and the Finnish forest industries

FACTOR[4]	CANFORESTIND[1]		CANMANUFIND[2]		FINFORESTIND[3]	
	MEAN[5]	VAR.[6]	MEAN	VAR.	MEAN	VAR.
Labour (SL)	30.75	12.87	22.83	2.14	24.00	-
Capital (SK)	9.35	10.44	5.07	2.77	16.70	-
Interest (SK1)	3.56	2.25	3.59	2.13	-	-
Tax (Taxpart)	3.34	1.89	2.50	0.27	-	-
Profit (SP)	6.30	39.58	9.58	17.99	-	-
Material (SM)	39.95	29.56	54.24	5.55	44.80	-
Energy (SF)	5.12	1.06	2.19	0.18	-	-
Stumpage (ST)	1.65	0.35	-	-	14.4	-

[1]CANFORESTIND refers to the Canadian forest industries;
[2]CANMANUFIND refers to the Canadian manufacturing sector;
[3]FINFORESTIND refers to the Finnish forest industries;
[4]FACTOR refers to relative factor shares;
[5]MEAN is expressed as percentage; and
[6]Var. refers to variance.

In his study of functional income distribution in the Finnish forest industries, Ovaskainen (1986) considered only four factor inputs: labour, capital, materials, and stumpage, while the present study has considered eight factor inputs: labour, durable capital, money capital, material, energy, stumpage, taxes and entrepreneurship.

Capital share in Ovaskainen's study is equivalent to the total of the shares of factors: durable capital, money capital, entrepreneurship and taxes in this study; and materials in the Finnish study is comparable to the sum of the shares of materials and energy in this study. Also, Ovaskainen divided the Finnish forest industries into only two sub-groups: (i) the wood industries, and (ii) paper industries. He considered the logging industry only for the purpose of labour employed in logging operations.

5.2.1 COMPARISON WITH CANADIAN MANUFACTURING SECTOR

Average relative factor shares in the forest industries and those in the manufacturing sector are reported in Table 5.1 for ease of comparison. The relative share of labour in the forest industries (30.75%) is substantially higher than that in the manufacturing industries (22.83%) implying that the forest industries are comparatively labour-intensive. However, it may be relevant to mention here that labour share in the paper & allied industries is of the same order as in the manufacturing sector, but that in the wood industries and the logging industries is substantially higher. Similarly, the shares of durable capital and fuel & energy in the forest industries (9.35% and 5.12% respectively) are also substantially higher than those in the manufacturing sector (5.07% and 2.50% respectively).

On the other hand, the share of material in the manufacturing sector (54.24%) is higher than that in the forest industries (41.60% including the share of stumpage). Similarly, the share of profit in the manufacturing sector (9.58%) is higher than that in the forest industries. The factor shares of money capital and taxes are of the same order in both groups of industries. Annual growth rates (as percentages per annum) in relative factor shares (GRS), real factor prices (GPR) and factor productivities (GRP) have been estimated for both, the forest industries and the manufacturing industries, using exponential trends and are reported in Table 5.2 for ease of comparison. The differences between annual growth rates of real factor prices and factor productivities (i.e. DIFF = GPR - GRP) are also reported in the same table.

Table 5.2 : Annual growth rates (%/a) of relative factor shares and other relevant variables in the forest and manufacturing industries, 1957-84

FACTOR[1]	CANFORESTIND[2]				CANMANFIND[3]			
	GRS[4]	GPR[5]	GRP[6]	DIFF[7]	GRS	GPR	GRP	DIFF
Labour (SL)	-0.82	2.29	3.15	-0.86	-0.34	2.76	3.23	-0.47
Capital (SK)	1.09**	1.00**	-0.13**	1.13**	1.13**	1.00**	-0.09**	1.09**
Interest (SK1)	5.10	-	-	-	5.09	-	-	-
Material (SM)	1.51	0.07**	-1.38	1.38	0.48	0.60	0.35	0.25
Stumpage (ST)	-3.98	-0.88	2.59	-3.47	-	-	-	-
Energy (SF)	1.37	0.89*	-0.45*	1.34	1.34	2.91	1.53	1.38
Tax (Taxpart)	-4.89	-4.89	0.00	-4.89	-2.50	-	-	-
Profit	-7.74	-	-	-	-6.56	-	-	-

[1]FACTOR refers to relative factor shares;
[2]CANFORESTIND refers to the Canadian forest industries;
[3]CANMANUFIND refers to the Canadian manufacturing industries;
[4]GRS refers to annual growth rates (%/a) in relative factor shares;
[5]GPR refers to annual growth rates (%/a) in real factor prices; [6]GRP refers to annual growth rates (%/a) in factor productivities;
[7]DIFF = GPR - GRP.

Table 5.2 suggests that relative factor shares in the forest industries and manufacturing industries have changed in the same direction, albeit to varying degrees. Labour's relative share in the forest industries declined more, at an annual rate of 0.82%, than that in the manufacturing sector (0.34%). This suggests that the forest industries, which have been traditionally labour-intensive, are increasingly substituting this factor by other factor inputs, particularly capital. This change is more pronounced in the logging industries than that in the other constituents of the forest industries.

The rate of increase in labour productivity is of the same order in both the forest industries (3.15% per annum) and the manufacturing industries (3.23%).

However, the rate of increase in real labour price is slightly higher in the manufacturing industries (2.76% per annum) than that in the forest industries (2.29% per annum). These empirical results do not support the general impression that the forest industry unions have caused wages to rise more than those in the manufacturing sector.

The changes in relative shares of durable capital, money capital, fuel & energy, taxes and profit are also in the same direction and of the same order in both the forest industries and total manufacturing. However, the real price of energy has risen significantly higher in the manufacturing sector (2.91% per annum) than that in the forest industries (0.89%). The use of this input has probably declined in the manufacturing sector causing its productivity to rise by 1.53% per annum, whereas the use of this input in the forest industries probably continues to rise causing its productivity to decline by 0.45% per annum. An explanation for this apparent anomaly is as follows.

The forest industries are increasingly substituting comparatively costly labour input by other inputs, particularly capital, materials, and energy. Also, capital and energy have been found to be complements. That is, the use of the use of the use of energy input has risen with the rise in the use of capital. Therefore, energy has also been increasingly used despite an appreciable rise in its real price.

The relative share of materials has also risen in both the forest industries and total manufacturing, but the rate of increase is more in the forest industries (1.51% per annum) than that in the manufacturing industries (0.48% per annum). Real materials price has not significantly changed in the forest industries, while it has increased slightly in the manufacturing sector (0.60% per annum). As a result, the use of material has probably increased in the forest industries and decreased in the manufacturing industries. This has caused material productivity to decline in the forest industries (i.e. -1.38% per annum) and to increase in the manufacturing sector (0.35% per annum).

5.2.2 COMPARISON WITH FINNISH FOREST INDUSTRIES

Average relative shares in the Canadian forest industries and those in the Finnish forest industries are reported in table 5.1. Annual growth rates in relative factor shares, real factor prices and factor productivities in the Finnish forest industries are reported in table 5.3.

Table 5.3 : Annual growth rates (%/a) of relative factor shares and other relevant variables in the Finnish forest industries, 1955-83

FACTOR SHARE[1]	GRS[4]	GPR[5]	GRP[6]	DIFF[7]
Labour (SL)	slight increase	3.7	4.0	-0.3
Profit (SK+SK1+Tax+SP)	no trend	-1.3	-ve	-
Raw material (SM+SF)	-	-	-	-
Stumpage (ST)	decreasing	0.6	0.0	0.6
Labour (logging)	decreasing	6.5	7.2	-0.7

[1]FACTOR SHARES refers to relative factor shares;
[2]CANFORESTIND refers to the Canadian forest industries;
[3]CANMANUFIND refers to the Canadian manufacturing industries;
[4]GRS refers to annual growth rates (%/a) in relative factor shares;
[5]GPR refers to annual growth rates (%/a) in real factor prices; [6]GRP refers to annual growth rates (%/a) in factor productivities;
[7]DIFF =GPR - GRP.

It may be observed from Tables 5.1 and 5.3 that the relative share of labour in the Canadian forest industries (30.75% per annum) is significantly higher than that in the Finnish forest industries (24.00% per annum)[9]. That is, the Canadian forest industries are comparatively more labour intensive than those in Finland. The real labour price in Finland has risen by 3.7% per annum as opposed to 2.29% in the Canadian forest industries. Labour productivity in the Finnish forest industries has risen by about 4% per annum, while that in the Canadian forest

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[9]The shares of labour in the Finnish wood and paper industries are respectively 22.1% and 17.4% as against 28.31% and 23.79% respectively in the corresponding Canadian industries.

industries has risen by 3.15% per annum. Ovaskainen (1986) has reported a slight increase in the share of labour, whereas this change is negative in the Canadian forest industries.

The share of stumpage is significantly higher in Finland (14.4%) than that in Canada (1.65%). The changes in this share are, however, in the same direction in that this share is declining in both the countries. However, the rate of decline is higher in Canada (3.98% per annum) than that in Finland (about 0.6% per annum). Ovaskainen (1986) reported no perceptible change in profit, which includes returns to durable capital, money capital, taxes and entrepreneurship. On the other hand, relative shares of durable capital and money capital have increased and those of taxes and profit have decreased in Canada.

The average shares of material (including fuel & energy in Canada) are of the order of 45% per annum in both the countries. However, the rate of change in this share is not available for the Finnish forest industries. Therefore, the directions of change can not be compared. While it may be observed that the structures of the industries in Canada and Finland are significantly different, the scope of this comparison is rather limited.

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6. EMPIRICAL RESULTS IN PERSPECTIVE

6.1 THE PROBLEM ADDRESSED

This study, for the first time, has empirically investigated time-series data in order to describe the existing functional income distribution and trends in the Canadian forest industries and its constituent sectors. In particular, the study has addressed the following major questions:

1. How have relative factor shares changed over time?
2. How have real factor prices changed over time?
3. How have factor productivities changed over time?
4. What have been the trends in inter-factor substitution and technological change?

In this study, it was assumed that each factor was paid the value of its marginal product. This implies that each factor has been paid as much as its opportunity cost. The study has, however, only superficially dealt with the controversial issue of stumpage: is stumpage charged by the Crown equal to its 'true' economic rent?

The principal hypothesis of this thesis is that relative factor shares in the forest industries have changed and that the rate of change in a relative factor share is consistent with the difference between the rate of change in real factor price and factor productivity. A methodology has been followed based on an incoming accounting approach.

6.2 SUMMARY OF RESULTS

The results of this study can be summarized as follows:

1. The results support the principal hypothesis. There is only one exception. The observed change in the relative share of stumpage is not consistent with the hypothesized change in this share.
2. The relative share of labour has declined in the logging industry and the forest industries. Real labour price and labour productivity have significantly

increased in these industries, but the increase in labour productivity is more than the increase in real labour price. This difference has led to a decline in labour's relative share in both the industries.

3. The relative share of labour in the wood industries and the paper & allied industries has not significantly changed. In these industries, the rise in real labour price is almost fully offset by the rise in labour productivity. This explains the constant relative share of labour.

4. The relative share of capital has increased in the forest industries and its constituent industries. Capital productivity has declined in all industries. This implies that capital has been intensively used in these industries.

5. The relative share of interest income has significantly increased in the forest industries and its constitutent industries.

6. Materials' relative share has increased in the forest industries. There is no significant change in the real price of materials, but its productivity has declined. The increase in materials' relative share is mainly due to the decline in its productivity. However, the sources of change in materials' relative share in each of the constituent industries vary.

   a. the relative share of materials in the logging industry significantly increased. Materials' real price slightly decreased, but materials productivity substantially declined.

   b. materials' relative share in the wood industries only slightly increased. The real price of materials and its productivity both slightly declined; the decline in productivity being more than that in real materials price.

   c. materials' relative share in the paper & allied industries has not significantly changed. The decline in materials' productivity is offset by the decline in its real price.

7. The relative share of stumpage substantially declined in all the industries, except the paper & allied industries. The hypothesized rate of change in this share, that is the difference between the rate of change in real stumpage rate and that in timber productivity only partially explains the observed decline in

this share. The reported share of stumpage is likely to be less than the 'true' economic rent.

8. The relative share of energy increased in the forest industries. Real energy price increased, but energy productivity decreased, causing a positive change in this share. The sources of change in this share, however, differ from industry to industry.
   a. energy's relative share increased in the logging industry. Real energy price increased and energy productivity decreased, causing an enhanced increase in this share.
   b. the relative share of energy in the wood industries significantly increased. Real energy price only slightly decreased, but energy productivity substantially declined causing a substantial increase in this share.
   c. the relative share of purchased energy in the paper & allied industries also increased. Real energy price substantially increased, but energy productivity only slightly increased.
9. The relative share of taxes substantially declined in the forest industries, the wood industries and the paper & allied industries, the decline being the most in the paper & allied industries and least in the wood industries.
10. The relative share of taxes, however, increased in the logging industries. A probable explanation for this apparent anomaly is that over time more and more unincorporated firms became integrated with other firms in the corporate sector and thus became subject to corporate income tax.
11. Profitability has declined in all the forest industries.
12. The changes in relative factor shares in all the forest industries suggest possibilities for substitution between pairs of factor inputs in varying degrees. The factor input pairs: labour & capital, labour and energy, and labour and materials have, in general, been found more susbtitutable than other factor input pairs. Capital and energy have been found to be complements.
13. The inter-temporal changes in relative factor shares in the forest industries indicate that the bias of technological change in these industries is labour and

timber saving; and material, energy, and capital using. The directions of technical change in the constituent industries are as follows:

a. technological changes in the logging industries and the wood industries are estimated to be labour and timber saving; and material, energy, and capital using.

b. technological change in the paper & allied industries is estimated to be labour and material saving; and capital and energy using.

14. The directions of change in the relative factor shares, real factor prices and factor productivities in the forest industries are in general agreement with those in the Canadian manufacturing industries.

15. A comparison of the Canadian forest industries with the Finnish forest industries reveals:

a. that the industries have substantially different structures. The Canadian forest industries are more labour intensive than the Finnish ones.

b. the directions of change in the relative factor shares widely differ in both industries.

c. the relative share of stumpage is substantially higher in the Finnish forest industries than that in the Canadian ones.

6.3 SOME POLICY IMPLICATIONS OF THE FINDINGS

Some policy implications of the findings of this study are suggested as follows:

- This study has described the existing distribution of income amongst various factor inputs employed in the forest industries. It has also described trends in relative factor shares, real factor prices, factor productivities, inter-factor substitution and bias of technical change. The findings of this study may be used in devising policies aimed at bringing desired changes in any of the above mentioned variables.
- For example, real labour price has substantially risen compared to the real

prices of other factors. This has encouraged the use of labour-saving technologies and labour employment has declined over time. Thus, policies aimed at increasing real labour wage and labour employment would be incompatible and ineffective unless they are otherwise subsidized.

- It may be inferred from above that labour unions may not achieve both their objectives: (i) rise in real wages for their members; and (ii) increase in employment of their members in the forest industries.
- Any attempt to raise the relative share of stumpage is likely to have adverse effects on relative shares of labour and profit.
- The microeconomic model used in this study explains very well the behaviour of firms in the forest industries. This implies that the firms respond to microeconomic policies which may be used to bring desired changes in the behaviour of these firms.

6.4 SOME REFLECTIONS ON AREAS FOR FURTHER RESEARCH

No study which embarks upon unraveling the intricate relationships between the changes in relative factor shares and those in factor productivities, factor prices, inter-factor substitution and technological change could be exhaustive. In spite of considerable care, the short-comings in this study are apparent and several have been identified in the text. This study was a first attempt at an investigation of this kind and may be considered, at the most, preliminary. However, it does form a good base for further enquiries into these complex issues and some of the areas for further research are identified as follows:

- This study is based on some heroic assumptions such as: (i) the forest industries face competitive product and factor markets; and (ii) the underlying production function exhibits constant returns to scale. Some readers may take strong exception to these and other assumptions. This is particularly true for the factor input timber, which is specific to these industries and in Canada is supplied through imperfect markets. There is, therefore, a need to re-investigate the subject of functional income distribution under less constraining assumptions.

- This study has used: (i) only published time-series data, and (ii) implicit price indexes, as reported in most of the cases by Statistics Canada. It could be improved by supplementing the time-series data with cross-sectional analysis. More important is the construction of more reliable price indexes for various factor inputs and outputs.
- Though the shifts in relative factor shares in all the industries included in this study are statistically significant in most cases, yet these shifts would be viewed with skepticism by some. Some empirical researchers including Porter (1973), accept significant shifts in factor shares in individual industries, but consider them to be exceptions rather than the rule. These empirical researchers attribute such shifts in factor shares to cyclical fluctuations and maintain that there is stability beneath such cyclical fluctuations. Therefore, there is a need to examine functional distribution in individual industries over a considerably longer period, as well as for shorter periods, so that cyclical variations can be separated from the secular trends.
- This study concentrated only on linear trends, which, in a number of cases, may be a very restrictive form. Future studies should consider other functional forms for time-trends, which fit the data more closely.
- There is also a need to investigate the problem of functional income distribution in individual industries following alternative approaches. One possibility is to use a macro-model, that involves specification and estimation of underlying production functions. This approach will help address some of the questions which this thesis only raised superficially such as (i) are all factors of production in the forest industries earning returns equivalent to their opportunity costs?, (ii) are factors earning some 'economic rent'?, and (iii) is stumpage charged by the Crown equal to its true economic rent?
- This study has used a very extensive aggregation (in geographical sense) of industries, which are operating in different geographical zones under widely

varying circumstances. Some of zonal differences in the industrial structure would only be revealed by disaggregating the data, at least at the provincial level. Such studies would also reveal the impacts of local policies on functional income distribution in these industries.

- This study has also used a very extensive aggregation of a number of widely diverse industries. Such an aggregation conceals those features which are particular to some specific industries. These special charateristics could be revealed if individual industries were studied, at least, at the three-digit level of the Standard Industrial Classification (SIC), 1980.

- An important aspect of the problem of functional income distribution in an individual industry is to explain the income distribution. This involves conceptual and empirical research and is, indeed, more difficult than the question of explaining income distribution at economy level. This study recognises the importance of this question, but considers this beyond the scope of this thesis.

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APPENDIX I

CAPITAL MEASUREMENT METHOD

The measurement of aggregate durable capital stock is still one of the major problems in applied economics and has attracted attention of a number of scholars including Coen (1976), Diewert (1976), Hulten & Wykoff (1976) and Wright (1964). Three aspects of this problem can be highlighted: (1) first, all the required data on investment, type of capital items, their prices etc. are not generally available; (ii) second, even if all the relevant data were available, assumptions which are generally used in the analytical framework are only a partial representation of the reality; and (iii) third, aggregation of widely diverse capital items adds to the complexities of the problem. For these reasons, any measure of durable capital is only an approximation.

Statistics Canada uses revised perpetual inventory methods in constructing time-series data on durable capital stocks and flows. The theory underlying this method is elaborated in Stat. Canada Cat.No. 13-522 and salient steps involved in the procedure are summarized in Stat. Canada Cat. No.13-211 (1986). Important steps involved in this procedure are outlined as follows:

- Step 1: obtain data on annual investment series, broken down by the type of expenditure for each industry, back into the period of 'average economic life' of the relevant capital good. This is a series of current dollar gross fixed capital formation.
- Step 2: obtain or, if necessary, construct an appropriate price index of the relevant capital goods.
- Step 3: estimate 'average economic lives' of the assets used in the industry concerned. If average economic life of a machinery is L years, this machinery will be discarded (i.e. withdrawn from the production) in the (L+1)th year.
- Step 4: the current dollar gross fixed capital formation series is then deflated by the given price index (cf. step 2) to derive capital formation expressed in

terms of the average prices of capital goods in the year which is the base year for the price index. This is called constant dollar gross fixed capital formation series.

- Step 5: constant dollar gross fixed capital data are accumulated for L years (cf. step 3). At the end of this period, a gross stock of capital good is derived. For subsequent years, the new additions in each year are added to the stock while additions which were made L years ago are deducted.
- Step 6: as a given capital good declines in its worth over time, some method of depreciation is used to ascertain annual depreciation. As Statistics Canada uses straight line depreciation method, the same is used in this study.
- Step 7: the estimates of annual depreciation are substracted from the estimates of constant dollar gross fixed capital formation year by year. The resultant series measures the addition to the capital stock. This is also called net fixed capital formation. The stock may be expressed as the mid-year gross (net) stock and/or end-year gross (net) capital stock. The constant dollar gross (net) stock may be also be expressed as current dollar gross (net) stock.

The following hypothetical examples illustrates the procedure. Let L be the average economic lives of capital goods in a particular category, say, machinery and equipment. Let w_i be the weights of capital expenditure in year i, and I_{it} be the investment expenditures (in constant dollars) during each period. Then:

1. Gross fixed capital formation at the end of period L is:

$$K_n = \Sigma w_i . I_{it}$$

where summation is over entire average economic life, that is, i= 1, 2,..., L.

2. Net fixed capital formation at the end of period L is:

$$K1_n = \Sigma w_i . I_{it} . d_i$$

where d_i is depreciation factor in the year i.

3. If K_n and K_{n1} are the gross (net) fixed capital formation at the end of two consecutive years n and n1, then mid-year gross (net) fixed capital formation is given by:

$$K = (K_n + K_{n1})/2$$

Following the same procedure for each category of capital goods, gross (net) fixed capital data series are obtained. For a given industry, the relevant data on each category are added together for the period of empirical study. Thus a combined time-series on capital stock and depreciation is obtained.

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APPENDIX II

TABLE II.1: Output Values, Output Indexes, & Price Indexes for the Forest Industries, 1957-1984.

YEAR	FOREST INDUSTRIES			LOGGING INDUSTRY			WOOD INDUSTRIES			PAPINDUSTRIES[1]		
	VSHIP[2]	QIND[3]	PIND[4]	VSHIP	QIND	PIND	VSHIP	QIND	PIND	VSHIP	QIND	PIND
1957	3108.3	54.3	77.5	646.2	85.0	77.9	995.5	69.5	61.2	1877.6	51.3	89.8
1958	3047.4	55.0	74.9	510.7	77.8	67.2	1008.4	73.2	58.9	1909.4	51.6	90.9
1959	3289.3	59.3	75.1	582.6	89.0	67.1	1071.9	76.1	60.2	2033.5	55.3	90.3
1960	3382.7	60.7	75.5	646.1	96.0	69.0	1012.1	72.4	59.8	2129.0	57.8	90.5
1961	3446.0	58.8	79.3	629.9	85.7	75.3	1053.3	69.9	65.2	2225.1	59.5	91.8
1962	3704.6	61.7	81.2	653.4	87.3	76.7	1242.5	77.2	68.8	2355.3	62.4	92.7
1963	3756.3	62.0	82.0	619.8	79.8	79.6	1304.0	79.6	70.0	2465.9	65.7	92.2
1964	4261.2	68.7	84.0	693.7	85.8	82.9	1443.2	85.0	72.6	2723.5	71.8	93.1
1965	4469.0	71.5	84.6	743.5	88.1	86.5	1516.6	88.9	72.9	2908.5	76.8	93.0
1966	4809.6	75.6	86.2	825.8	96.1	88.0	1607.6	90.9	75.6	3208.0	84.2	93.6
1967	4777.7	73.6	87.8	842.8	94.9	91.0	1685.2	92.5	77.9	3281.7	85.5	94.2
1968	5022.7	73.2	92.9	884.4	95.5	94.9	1979.2	93.9	90.1	3450.5	90.6	93.6
1969	5485.7	76.7	96.8	1019.2	104.5	100.0	2190.9	98.4	95.2	3877.0	99.3	95.9
1970	5312.5	77.5	92.8	967.5	102.7	996.5	1961.2	99.7	84.1	3983.7	100.3	97.5
1971	7385.6	100.0	100.0	975.7	100.0	100.0	2339.2	100.0	100.0	4070.7	100.0	100.0
1972	8679.0	111.9	105.0	1161.4	108.2	110.0	3088.0	118.4	111.4	4429.7	108.8	100.0
1973	11077.2	119.2	125.8	1618.1	126.2	131.4	4162.9	126.8	140.3	5296.2	112.7	115.4
1974	13627.3	119.0	155.1	1778.6	123.9	147.1	4021.1	123.4	139.3	7827.6	114.7	167.7
1975	12705.1	99.6	172.7	1621.3	102.4	162.2	3848.4	118.3	139.1	7235.3	89.7	198.1
1976	15435.3	115.0	181.7	1892.2	106.5	182.0	5088.8	138.4	157.2	8454.3	105.3	197.2
1977	17064.0	118.0	195.8	2069.0	108.1	196.1	6028.0	146.9	175.5	8967.0	105.9	208.0
1978	20159.0	128.2	212.8	2440.1	115.7	216.1	7573.7	155.8	207.8	10145.2	117.6	212.0
1979	24592.4	130.7	254.7	3191.9	124.2	263.4	9030.6	160.1	241.1	12369.9	117.6	258.3
1980	26351.2	129.8	274.9	3249.1	127.8	260.6	8461.1	155.1	233.1	14641.0	117.6	305.8
1981	27224.0	129.0	285.8	2917.7	112.2	266.4	8446.9	155.9	231.7	15859.4	119.1	327.0
1982	23945.8	112.3	288.7	2498.4	90.1	284.3	7078.9	134.9	224.2	14368.5	105.5	334.4

1983	27878.3	131.4	287.2	3271.2	112.2	298.8	9613.1	167.3	245.7	14993.9	118.1	311.8
1984	31186.0	137.7	306.6	3536.9	120.7	300.4	10059.4	175.6	244.9	17589.7	123.0	351.3

[1]PAPINDUSTRIES refers to the Paper & Allied Industries;
[2]VSHIP refers to the value of output (in million dollars) of the given industry;
[3]QIND refers to output quantity index (1971=100);
[4]PIND refers to output price index (1971=100).

Table II.2: Factor Price Indexes in the Forest Industries, 1957-84[1]

YEAR	WIND[3]	PMIND[4]	PTIND[5]	PEIND[6]	RIND[7]	PXIND[8]
1957	44.39	70.67	81.72	90.79	54.39	146.63
1958	49.17	72.82	82.88	94.81	55.26	143.50
1959	49.94	73.78	83.17	93.30	60.58	184.80
1960	53.00	75.52	83.88	93.45	66.67	18.33
1961	53.40	76.84	85.33	93.96	72.75	194.83
1962	56.45	78.73	88.15	98.49	68.36	191.07
1963	55.94	81.94	91.25	97.24	67.17	193.02
1964	58.41	86.51	97.20	98.90	67.86	183.88
1965	62.01	90.77	101.34	88.21	67.99	253.96
1966	67.80	91.87	101.77	99.65	71.64	220.13
1967	74.61	91.53	96.50	95.15	72.49	200.90
1968	80.73	89.54	93.47	95.88	82.73	225.43
1969	84.86	91.65	95.79	100.21	85.90	237.71
1970	90.71	94.87	97.88	76.75	91.26	128.36
1971	100.00	100.00	100.00	100.00	100.00	100.00
1972	106.62	102.33	101.20	95.50	86.89	127.33
1973	116.92	108.60	104.59	101.53	58.86	209.71
1974	136.23	125.97	120.29	137.10	26.86	275.41
1975	148.22	143.21	137.00	156.22	90.85	196.94
1976	180.37	160.26	145.46	184.98	110.86	199.51
1977	199.50	168.41	157.48	228.67	137.38	222.14
1978	215.71	180.98	173.80	162.12	164.59	300.74
1979	233.19	196.36	193.28	302.67	138.25	474.91
1980	258.08	235.39	229.12	324.73	187.89	414.56
1981	285.77	264.29	255.28	418.27	291.44	258.39
1982	18.11	286.88	273.31	514.47	312.29	148.35
1983	345.28	297.92	282.69	654.46	368.20	134.55
1984	353.88	312.07	298.33	613.88	466.04	159.44

[1]Prices are indexed to the base year 1971=100;
[3]WIND refers to labour price index;
[4]PMIND refers to materials' price index;
[5]PTIND refers to stumpage rate index;
[5]PEIND refers to energy price index;
[6]RIND refers to the index of rate of return to durable capital;
[7]PXIND refers to the index of tax rate.

Table II.3: Factor Price Indexes for the Logging Industry, 1957-84[1]

YEAR	WIND[3]	PEIND[6]	RIND[7]	PMIND[4]	PXIND[8]
1957	43.10	111.62	63.42	84.50	10.57
1958	58.66	111.95	63.86	85.40	28.87
1959	56.40	112.05	67.82	85.70	36.60
1960	58.91	112.15	72.09	86.10	46.81
1961	52.61	112.46	76.46	87.40	49.81
1962	58.78	112.89	72.30	90.00	59.22
1963	51.64	113.09	70.97	93.00	70.41
1964	54.25	111.05	71.66	99.30	117.90
1965	58.95	114.74	72.04	103.60	145.40
1966	64.93	116.98	71.37	104.00	106.37
1967	73.01	98.60	73.84	97.50	82.83
1968	80.11	120.09	81.62	94.30	144.67
1969	84.92	121.49	85.27	96.80	123.67
1970	90.30	99.56	90.35	98.80	100.62
1971	100.00	100.00	100.00	100.00	100.00
1972	110.36	125.46	90.65	101.20	147.42
1973	120.74	122.75	65.19	104.20	227.03
1974	139.50	147.07	41.15	119.70	193.17
1975	153.96	185.46	96.90	136.20	164.50
1976	186.13	205.76	112.92	143.00	182.46
1977	201.50	226.31	140.35	155.70	232.74
1978	216.24	243.24	165.84	173.00	230.15
1979	235.90	273.71	153.09	193.50	430.69
1980	259.53	334.55	195.24	232.60	542.56
1981	296.97	480.30	289.59	259.20	300.31
1982	324.99	657.03	315.02	277.50	263.18
1983	341.60	914.83	362.18	286.80	242.36
1984	328.89	980.29	426.01	303.00	304.44

[1]Prices are indexed to the base year 1971=100;
[3]WIND refers to labour price index;
[4]PMIND refers to materials' price index;
[5]PEIND refers to energy price index;
[6]RIND refers to the index of rate of return to durable capital;
[7]PXIND refers to the index of tax rate.

Table II.4: Factor Price Indexes for the Wood Industries, 1957-84[1]

YEAR	WIND[3]	PEIND[6]	PMIND[6]	RIND[4]	PXIND[8]
1957	40.75	123.79	68.70	55.13	58.93
1958	43.21	112.91	70.90	55.27	55.66
1959	43.60	112.39	71.10	59.41	112.70
1960	46.63	112.83	72.90	64.36	99.84
1961	49.84	106.29	74.70	69.50	111.75
1962	52.32	128.28	78.10	65.58	131.01
1963	54.63	123.65	81.50	63.35	127.10
1964	57.16	121.06	85.70	62.66	131.84
1965	60.83	117.19	88.90	61.82	91.09
1966	65.76	110.77	89.50	62.75	77.65
1967	72.37	116.41	91.60	72.81	92.75
1968	78.38	115.01	89.50	85.27	161.86
1969	82.34	111.41	91.00	86.93	164.61
1970	88.45	98.77	93.50	91.82	60.43
1971	100.00	100.00	100.00	100.00	100.00
1972	105.75	100.36	101.20	86.46	169.25
1973	118.58	109.89	106.00	56.60	312.15
1974	138.46	124.16	122.50	20.16	176.71
1975	154.91	143.94	140.10	83.15	143.83
1976	183.23	175.57	156.40	101.65	205.44
1977	207.47	197.10	165.00	130.83	261.04
1978	222.58	210.18	176.60	154.60	374.33
1979	246.21	238.82	191.80	125.21	446.50
1980	273.45	272.69	213.60	161.97	212.14
1981	293.10	343.91	237.80	257.64	153.36
1982	317.10	440.39	254.60	281.39	126.060
1983	350.52	474.01	264.30	341.34	142.60
1984	364.07	496.16	277.40	431.65	128.71

[1]Prices are indexed to the base year 1971=100;
[3]WIND refers to labour price index;
[4]PMIND refers to materials' price index;
[5]PEIND refers to energy price index;
[6]RIND refers to the index of rate of return to durable capital;
[7]PXIND refers to the index of tax rate.

Table II.5: Factor Price Indexes for the Paper & Allied Industries, 1957-84[1]

YEAR	WIND[3]	PMIND[6]	PEIND[7]	RIND[4]	PXIND[8]
1957	47.81	69.90	80.06	51.34	202.15
1958	49.44	72.10	77.77	52.49	197.04
1959	51.24	73.80	74.87	58.74	230.59
1960	53.95	75.60	77.53	65.35	233.90
1961	56.24	76.50	82.96	71.81	232.50
1962	58.07	76.90	80.08	67.10	211.24
1963	59.51	79.90	81.48	65.86	204.11
1964	61.71	84.60	82.08	66.59	188.12
1965	64.51	89.90	83.84	66.88	301.70
1966	70.35	91.60	84.26	72.41	255.87
1967	76.33	89.30	86.41	71.26	213.34
1968	82.25	87.70	85.62	82.34	191.44
1969	86.05	90.80	87.39	85.98	198.05
1970	91.57	95.60	86.84	91.76	116.28
1971	100.00	100.00	100.00	100.00	100.00
1972	106.79	103.20	99.16	86.80	105.49
1973	115.28	110.90	108.09	58.62	160.77
1974	133.44	129.10	150.94	25.30	336.01
1975	141.24	146.20	178.95	91.68	234.66
1976	177.34	164.90	210.73	112.66	197.82
1977	195.47	172.20	261.70	138.78	196.99
1978	214.25	185.00	273.01	167.43	262.41
1979	226.26	199.90	345.61	139.40	499.00
1980	249.85	253.40	405.97	195.89	524.45
1981	279.88	286.30	492.49	305.29	314.97
1982	319.53	313.70	600.33	328.04	149.93
1983	347.86	326.00	661.93	389.02	118.50
1984	361.77	340.70	662.53	497.61	164.62

[1]Prices are indexed to the base year 1971=100;
[2]YEAR refers to time variable;
[3]WIND refers to labour price index;
[4]PMIND refers to materials' price index;
[5]PEIND refers to energy price index;
[6]RIND refers to the index of rate of return to durable capital;
[7]PXIND refers to the index of tax rate.

Table II.6: Factor Incomes in the Forest Industries, 1957-84

YEAR	WAGE[1]	MATE[2]	FUEL[3]	STUMP[4]	TAX[5]	KAPT[6]	PROFIT[7]
	(in million dollars)						
1957	1007.5	1072.2	149.6	72.6	113.8	287.6	404.8
1958	946.5	1074.9	143.5	64.9	112.9	304.1	400.3
1959	1016.4	1147.6	149.4	67.4	156.5	351.7	400.2
1960	1078.7	1192.8	154.6	77.7	159.0	388.1	331.7
1961	1138.0	1195.5	164.1	79.7	163.8	428.9	276.0
1962	1198.5	1218.7	173.4	77.8	168.6	417.4	450.3
1963	1231.0	1266.4	179.8	63.7	171.0	412.2	432.1
1964	1331.9	1520.7	197.6	86.7	180.5	439.9	503.9
1965	1434.0	1588.8	214.4	85.3	259.4	480.5	406.5
1966	1612.9	1692.7	231.8	87.6	237.7	534.4	412.5
1967	1750.9	1619.9	242.9	79.8	211.4	645.0	227.7
1968	1847.6	1598.6	254.5	97.5	235.8	772.5	216.2
1969	2006.0	1621.3	280.0	125.3	260.7	816.5	375.8
1970	2077.2	1625.5	279.4	94.9	142.1	896.8	196.7
1971	2267.6	3450.8	317.5	98.7	142.9	1077.0	31.2
1972	2532.4	3969.3	346.5	150.3	203.6	1046.0	431.0
1973	2995.5	4830.2	398.5	286.4	357.4	898.3	1310.9
1974	3539.5	5897.9	569.9	223.0	468.2	778.0	2150.7
1975	3616.7	5750.1	562.6	106.9	280.3	1373.2	1015.2
1976	4508.3	7140.0	747.7	119.5	328.0	1714.4	877.3
1977	4918.2	7782.1	901.4	146.9	374.5	2045.3	895.6
1978	5641.9	9048.9	1076.6	271.9	551.2	2495.9	1072.5
1979	6270.0	11014.3	1243.3	504.4	887.2	2500.9	2172.2
1980	6818.3	12202.6	1411.5	452.4	768.9	3309.1	1388.4
1981	7299.6	13016.0	1702.7	209.6	476.3	4893.2	-373.3
1982	7094.4	11671.6	1885.7	154.9	238.1	5134.9	-2233.8
1983	7928.6	13470.9	2108.9	207.4	252.7	5804.8	-1895.0
1984	8365.5	14845.5	2375.7	230.9	313.8	7087.9	-2033.3

[1]WAGE refers total labour compensation;
[2]MATE refers to total value of materials;
[3]FUEL refers to total value of energy purchased and used;
[4]STUMP refers to total stumpage paid by the industries;
[5]TAX refers total tax share;
[6]KAPT refers to total share of durable capital and money capital;
[7]PROFIT refers to total profit share.

Table II.7 Factor Incomes in the Logging Industry, 1957-84

YEAR	WAGE[1]	MATE[2]	FUEL[3]	STUMP[4]	TAX[5]	KAPT[6]	PROFIT[7]
	(in million dollars)						
1957	312.7	73.7	20.6	60.8	0.8	59.3	118.2
1958	243.7	58.7	16.4	53.6	2.0	58.8	77.4
1959	281.8	66.2	18.5	56.6	2.9	65.4	91.2
1960	308.3	73.7	20.8	60.1	4.0	71.4	107.7
1961	301.3	74.3	21.3	61.6	3.8	76.2	91.4
1962	312.2	75.4	21.8	63.3	4.6	73.6	102.6
1963	295.6	78.8	22.5	52.2	5.0	71.8	93.8
1964	320.7	84.9	24.8	76.2	9.0	76.5	101.4
1965	338.3	95.6	26.5	74.4	11.4	82.5	114.8
1966	378.4	109.1	29.6	75.6	9.1	90.9	133.2
1967	403.8	116.1	30.8	70.1	7.0	103.8	111.2
1968	398.3	117.4	30.8	80.7	12.3	119.9	124.9
1969	442.6	132.8	34.4	105.0	11.5	129.7	163.3
1970	447.5	165.0	29.1	79.3	9.2	141.3	96.0
1971	448.3	165.8	30.3	81.6	8.9	150.5	90.3
1972	500.2	179.9	36.8	115.7	14.2	147.6	166.9
1973	662.4	232.5	49.9	226.7	25.5	139.7	281.4
1974	782.2	286.8	68.4	179.4	21.3	125.7	314.8
1975	785.8	342.9	64.4	88.1	15.0	213.8	111.4
1976	876.7	376.2	70.9	97.0	17.3	254.9	199.1
1977	938.5	433.3	74.2	121.5	22.4	303.1	175.9
1978	1097.0	487.9	84.6	220.6	23.7	369.0	157.3
1979	1265.5	634.8	100.6	403.6	47.6	381.5	358.4
1980	1342.5	701.3	121.0	377.7	61.7	487.5	157.3
1981	1370.3	712.9	158.9	163.0	30.0	656.7	-174.0
1982	1244.9	543.0	178.9	126.5	21.1	660.9	-276.8
1983	1501.2	742.8	199.7	170.7	24.2	724.0	-91.4
1984	1606.5	935.9	215.2	194.4	32.7	833.7	-281.4

[1]WAGE refers total labour compensation;
[2]MATE refers to total value of materials;
[3]FUEL refers to total value of energy purchased and used;
[4]STUMP refers to total stumpage paid by the industries;
[5]TAX refers total tax share;
[6]KAPT refers to total share of durable capital and money capital;
[7]PROFIT refers to total profit share.

Table II.8 Factor Incomes in the Wood Industries, 1957-84

YEAR	WAGE[1]	MATE[2]	FUEL[3]	STUMP[4]	TAX[5]	KAPT[6]	PROFIT[7]
	(in million dollars)						
1957	270.9	517.9	15.7	11.9	17.0	57.6	104.5
1958	273.0	511.4	16.6	11.4	16.9	58.2	120.8
1959	283.4	541.9	17.2	10.8	35.6	69.4	113.7
1960	291.0	544.8	17.7	17.6	30.0	74.2	36.8
1961	321.1	563.2	20.4	18.0	32.0	81.1	17.3
1962	344.1	609.6	23.6	14.5	42.0	81.2	127.4
1963	371.7	680.8	25.2	11.4	42.0	81.8	91.2
1964	399.0	770.3	27.8	10.5	46.5	86.5	102.7
1965	432.9	807.2	29.6	10.9	33.6	93.1	109.3
1966	468.0	856.0	30.7	12.0	29.3	105.9	105.8
1967	502.7	893.3	31.3	9.7	35.6	124.7	88.0
1968	544.4	1018.8	33.8	16.8	63.1	157.7	144.6
1969	585.5	1169.2	37.4	20.3	67.2	179.0	132.2
1970	595.8	1107.5	36.2	15.6	25.0	194.8	-13.8
1971	702.9	1261.6	43.5	17.1	41.5	217.5	55.0
1972	829.5	1578.0	53.0	34.6	83.2	233.0	276.7
1973	1009.3	2062.0	64.5	59.7	164.3	232.5	570.6
1974	1123.6	2155.2	74.9	43.6	90.5	211.7	321.6
1975	1153.7	2060.6	79.4	18.9	70.6	331.0	134.4
1976	1478.4	2725.4	105.0	22.4	118.0	423.1	216.4
1977	1711.2	3110.4	130.4	25.4	159.1	505.5	386.0
1978	2012.4	3814.0	158.7	51.2	242.1	635.6	659.6
1979	2284.7	4725.6	183.0	100.8	296.7	688.6	751.1
1980	2440.0	4715.9	205.0	74.7	136.6	881.0	7.8
1981	2510.0	4708.5	244.6	46.6	99.2	1246.6	-408.6
1982	2343.5	4069.5	272.8	28.4	70.6	1253.1	-959.0
1983	2719.6	5260.7	323.1	36.7	99.0	1432.6	-258.5
1984	2852.8	5620.9	351.2	36.4	93.8	1722.3	-618.2

[1]WAGE refers to total labour compensation;
[2]MATE refers to total value of materials;
[3]FUEL refers to total value of energy purchased and used;
[4]STUMP refers to total stumpage paid by the industries;
[5]TAX refers total tax share;
[6]KAPT refers to total share of durable capital and money capital;
[7]PROFIT refers to total profit share.

Table II.9: Factor Incomes in the Paper & Allied Industries, 1957-84

YEAR	WAGE[1]	MATE[2]	FUEL[3]	TAX[5]	KAPT[6]	PROFIT[7]
			(in million dollars)			
1957	423.8	891.6	113.3	96.0	179.4	173.5
1958	429.8	885.9	110.5	94.0	194.7	194.5
1959	451.2	938.2	113.8	118.0	227.9	184.3
1960	479.3	978.9	116.0	125.0	253.2	176.5
1961	515.6	1020.3	122.2	128.0	282.8	156.0
1962	542.1	1080.4	128.0	122.0	275.5	207.4
1963	563.8	1140.4	132.2	124.0	272.0	233.6
1964	612.0	1264.8	145.0	125.0	288.6	288.1
1965	662.9	1385.5	158.3	214.4	320.2	167.0
1966	766.6	1559.4	171.5	199.3	360.9	150.3
1967	844.4	1642.6	180.9	168.8	449.8	-4.8
1968	904.9	1753.8	189.9	160.4	546.3	-104.7
1969	978.1	1920.6	208.2	182.0	579.7	8.3
1970	1033.9	1952.7	214.0	107.9	637.3	37.8
1971	1116.3	2023.4	243.7	92.5	709.0	-114.1
1972	1202.6	2211.3	256.8	106.2	668.7	-15.9
1973	1323.8	2535.7	284.0	167.6	530.7	454.3
1974	1633.6	3455.9	426.6	356.4	441.8	1513.1
1975	1677.2	3346.7	418.8	194.7	832.8	765.1
1976	2153.2	4038.5	571.7	192.7	1039.7	458.5
1977	2268.4	4238.4	696.8	193.0	1243.9	326.5
1978	2532.6	4747.0	833.3	285.4	1499.3	247.5
1979	2719.8	5654.0	959.7	542.9	1440.1	1053.3
1980	3035.8	6785.5	1085.4	570.6	1953.8	1210.0
1981	3419.2	7594.7	1299.3	347.1	3007.7	191.4
1982	3506.0	7059.0	1434.0	146.4	3260.7	-1037.5
1983	3707.7	7467.5	1586.0	129.5	3715.6	-1612.5
1984	3906.3	8288.7	1809.3	187.3	4602.3	-1204.2

[1]WAGE refers total labour compensation;
[2]MATE refers to total value of materials;
[3]FUEL refers to total value of energy purchased and used;
[5]TAX refers total tax share;
[6]KAPT refers to total share of durable capital and money capital;
[7]PROFIT refers to total profit share.

Table II.10: Indexes of Factor Quantities in the Forest Industries, 1957-84

YEAR	LI[1]	MI[2]	TI[3]	FI[4]	KI[5]
1957	100.09	43.97	90.05	51.90	53.60
1958	84.89	42.78	79.37	47.70	56.46
1959	89.76	45.08	82.11	50.47	57.44
1960	89.74	45.77	93.90	52.12	58.27
1961	93.98	45.08	94.62	55.00	60.09
1962	93.62	44.86	89.43	55.46	61.22
1963	97.04	44.78	70.69	58.26	61.47
1964	100.55	50.94	90.38	62.93	63.77
1965	101.98	50.72	85.30	76.57	68.36
1966	104.90	53.39	87.16	73.27	70.02
1967	103.48	51.28	83.79	80.43	85.74
1968	100.92	51.73	105.62	83.61	90.89
1969	104.25	51.25	132.56	88.00	89.80
1970	100.99	49.65	98.25	114.65	94.54
1971	100.00	100.00	100.00	100.00	100.00
1972	104.74	112.39	150.46	114.27	106.37
1973	112.97	128.88	277.38	123.64	109.97
1974	114.57	135.66	187.81	130.93	105.70
1975	107.60	116.35	79.09	113.44	110.50
1976	110.22	129.09	83.25	127.32	115.26
1977	108.71	133.90	94.49	124.17	121.43
1978	115.34	144.88	158.47	209.19	124.17
1979	118.57	162.54	264.37	129.39	125.79
1980	116.50	150.21	200.03	136.91	122.21
1981	112.65	142.71	83.17	128.22	128.01
1982	98.34	117.89	57.42	115.45	136.19
1983	101.26	131.02	74.32	101.50	142.57
1984	104.25	137.85	78.40	121.90	140.18

[1]LI refers to index of labour employed (1971=100);
[2]MI refers to materials' quantity index (1971=100);
[3]TI refers to timber quantity index (1971=100);
[4]FI refers to fuel quantity index (1971=100);
[5]KI refers durable capital quantity index (1971=100).

Table II.11: Indexes of Factor Quantities in the Logging Industry, 1957-84

YEAR	LI[1]	MI[2]	TI[3]	FI[4]	KI[5]
1957	161.84	61.04	88.09	52.57	65.34
1958	92.65	48.53	76.87	41.48	66.36
1959	111.47	54.65	80.89	46.58	66.42
1960	116.76	61.24	85.53	51.63	68.10
1961	127.74	62.62	86.42	51.26	69.76
1962	118.48	63.89	86.14	50.51	70.08
1963	127.68	65.70	68.81	51.10	70.60
1964	131.90	73.89	94.05	51.54	73.30
1965	127.99	76.31	87.96	55.67	77.61
1966	129.99	83.46	89.04	63.28	83.39
1967	123.37	86.91	88.12	71.81	92.15
1968	110.91	84.73	104.80	75.09	96.75
1969	116.24	93.49	132.94	82.75	95.82
1970	110.54	96.54	98.38	100.73	99.57
1971	100.00	100.00	100.00	100.00	100.00
1972	101.11	96.80	140.14	107.19	104.17
1973	122.38	134.53	266.59	134.54	114.75
1974	125.07	153.71	183.62	144.48	116.27
1975	113.86	114.70	79.27	151.81	124.09
1976	105.07	113.85	83.20	158.64	132.66
1977	103.90	108.37	95.59	167.84	134.34
1978	113.16	114.92	156.27	170.08	137.50
1979	119.67	121.45	255.56	197.83	135.26
1980	115.38	119.55	198.99	181.83	134.46
1981	102.93	109.29	77.04	165.85	131.98
1982	85.44	89.94	55.87	118.01	130.65
1983	98.03	72.13	72.94	156.19	128.08
1984	108.96	72.46	78.63	186.26	123.85

[1]LI refers to index of labour employed (1971=100);
[2]MI refers to materials' quantity index (1971=100);
[3]TI refers to timber quantity index;
[4]FI refers to fuel quantity index (1971=100);
[5]KI refers durable capital quantity index (1971=100).

Table II.12: Indexes of Factor Quantities in the Wood Industries, 1957-84

YEAR	LI[1]	MI[2]	TI[3]	FI[4]	KI[5]
1957	94.58	29.09	101.21	59.75	55.68
1958	89.89	33.75	93.69	57.17	55.93
1959	92.46	35.12	89.09	60.40	58.34
1960	88.76	36.14	141.53	59.23	59.24
1961	91.65	44.25	141.38	59.75	61.22
1962	93.55	42.33	108.87	61.86	62.04
1963	96.77	46.80	82.09	66.20	63.05
1964	99.31	52.69	71.64	71.24	65.05
1965	101.20	57.99	72.09	71.97	68.78
1966	101.23	63.79	78.34	75.80	73.44
1967	98.80	61.82	61.92	77.29	75.83
1968	98.80	67.63	109.74	90.22	81.54
1969	101.14	77.20	130.65	101.84	84.84
1970	95.82	84.42	97.57	93.88	93.86
1971	100.00	100.00	100.00	100.00	100.00
1972	111.58	121.29	199.73	123.59	112.98
1973	121.08	134.91	329.19	154.19	123.90
1974	115.43	138.62	208.31	139.45	126.36
1975	105.94	126.81	78.68	116.58	136.51
1976	114.77	137.59	83.91	138.12	142.43
1977	117.33	152.04	90.10	149.41	149.18
1978	128.62	173.60	169.69	171.18	158.42
1979	132.00	176.11	307.43	195.29	167.78
1980	126.93	172.84	204.48	174.99	177.96
1981	121.82	163.48	114.56	156.94	185.07
1982	105.13	142.41	65.16	126.69	193.64
1983	110.37	156.70	81.11	157.76	199.80
1984	111.46	162.73	76.84	160.61	197.34

[1]LI refers to index of labour employed (1971=100);
[2]MI refers to materials' quantity index (1971=100);
[3]TI refers to timber quantity index (1971=100);
[4]FI refers to fuel quantity index (1971=100);
[5]KI refers durable capital quantity index (1971=100).

Table II.13: Indexes of Factor Quantities in the Paper & Allied Industries, 1957-84

YEAR	LI[1]	MI[2]	FI[4]	KI[5]
1957	79.39	63.04	58.08	51.06
1958	77.85	60.72	58.31	54.84
1959	78.86	62.83	62.35	55.67
1960	79.57	63.99	61.44	56.32
1961	82.12	65.91	60.47	58.15
1962	83.62	69.43	65.56	59.50
1963	84.85	70.53	66.55	59.52
1964	88.83	73.88	72.48	61.81
1965	92.05	76.16	77.49	66.66
1966	97.61	84.13	83.51	66.92
1967	99.08	90.90	85.89	86.90
1968	98.53	98.83	90.98	92.00
1969	101.81	104.54	97.75	89.89
1970	101.14	100.94	101.11	93.81
1971	100.00	100.00	100.00	100.00
1972	100.87	105.90	106.25	105.24
1973	102.86	113.00	107.83	106.02
1974	109.65	132.30	115.98	99.30
1975	106.36	113.13	96.04	102.41
1976	108.76	121.03	111.33	106.29
1977	103.95	121.64	109.26	113.06
1978	105.88	126.81	125.25	114.28
1979	107.67	139.78	113.95	114.85
1980	108.84	132.34	109.71	107.88
1981	109.43	131.10	108.25	114.70
1982	98.28	111.21	98.02	124.21
1983	95.47	113.20	98.32	131.94
1984	96.72	120.23	112.06	129.87

[1]LI refers to index of labour employed (1971=100);
[2]MI refers to materials' quantity index;
[4]FI refers to fuel quantity index (1971=100);
[5]KI refers durable capital quantity index (1971=100).

Table II.14: Annual Growth Rates in Nominal Values of Output, Factor Incomes and Nominal Prices in the Constituent Industries, 1957-84

VARIABLE[9]	LOGGING INDUSTRY				WOOD INDUSTRIES				PAPINDUSTRIES[1]			
	GNVAL[2]	GNPR[3]	ETRS[4]	ETRP[5]	GNVAL	GNPR	ETRS	ETRP	GNVAL	GNPR	ETRS	ETRP
Output	7.50	5.00	–	–	9.80	5.90	–	–	9.00	5.10	–	–
Labour	7.00	8.00	dec[6]	inc[7]	9.40	8.50	dec	inc	9.00	7.80	no[8]	inc
Capital	9.70	6.80	inc	inc	12.30	6.60	inc	inc	11.20	7.50	inc	inc
Interest	13.00	4.80	inc	dec	15.00	4.80	inc	dec	14.50	4.80	inc	dec
Materials	10.80	4.60	inc	dec	10.00	5.30	inc	dec	9.00	5.90	no	inc
Energy	9.30	7.90	inc	inc	11.40	4.60	inc	dec	10.90	7.60	inc	inc
Stumpage	6.10	4.60	dec	dec	6.50	5.30	dec	dec	–	–	–	–
Tax	12.10	10.60	inc	inc	7.60	3.80	dec	dec	3.90	0.60	dec	dec
Profit	-44.37	–	–	–	-36.90	–	–	–	-30.70	–	–	–

[1]PAPINDUSTRIES refers to the Paper & Allied Industries;
[2]GNVAL refers to annual growth rate (%/a) in the nominal value of relevant variable;
[3]GNPR refers to annual growth rate (%/a) in the nominal price of the relevant variable;
[4]ETRS refers to expected trend in relative factor shares;
[5]ETRP refers to expected trend in real factor price;
[6]dec refers to decreasing trend;
[7]inc refers to increasing trend;
[8]no refers to no change;
[9]VARIABLE refers to either output or any factor input used in these industries.

APPENDIX III

Table III.1: Relative Factor Shares in the Forest Industries, 1957-84

YEAR	SL[1]	SK[2]	SK1[3]	SM[4]	SF[5]	ST[6]	TAXPT[7]	SP[8]
1957	32.4	7.6	1.6	34.5	4.8	2.3	3.7	13.0
1958	31.1	8.3	1.6	35.3	4.7	2.1	3.7	13.4
1959	30.9	8.6	2.1	34.9	4.5	2.0	4.7	12.2
1960	31.9	9.3	2.1	35.3	4.6	2.3	4.7	9.8
1961	33.0	10.3	2.1	34.7	4.8	2.3	4.7	8.0
1962	32.3	9.2	2.1	32.9	4.7	2.1	4.5	12.1
1963	32.8	8.9	2.0	33.7	4.8	1.7	4.5	11.5
1964	31.2	8.3	2.0	35.7	4.6	2.0	4.2	11.8
1965	32.1	8.5	2.3	35.5	4.8	1.9	5.8	9.1
1966	33.5	8.5	2.6	35.2	4.8	1.8	4.9	8.6
1967	36.6	10.6	2.9	33.9	5.1	1.7	4.4	4.8
1968	36.8	12.2	3.2	31.8	5.1	1.9	4.7	4.3
1969	36.6	11.5	3.4	29.5	5.1	2.3	4.7	6.8
1970	39.1	13.2	3.6	30.6	5.2	1.8	2.7	3.7
1971	30.7	11.0	3.5	46.7	4.3	1.3	1.9	4.3
1972	29.2	8.7	3.4	45.7	4.0	1.7	2.3	5.0
1973	27.0	4.8	3.3	43.6	3.6	2.6	3.2	11.8
1974	26.0	1.7	4.0	43.3	4.2	1.6	3.4	15.8
1975	28.5	6.4	4.4	45.2	4.4	0.8	2.2	8.0
1976	29.2	6.7	4.4	46.2	4.8	0.8	2.1	5.7
1977	28.8	8.0	4.0	45.6	5.3	0.9	2.2	5.2
1978	28.0	8.3	4.1	44.9	5.3	1.3	2.7	5.3
1979	25.5	5.8	4.4	44.8	5.0	2.0	3.6	8.8
1980	25.9	7.1	5.4	46.3	5.3	1.7	2.9	5.3
1981	26.8	11.2	6.8	47.8	6.2	0.8	1.7	-1.4
1982	29.6	14.5	7.0	48.7	7.9	0.6	1.0	-9.3
1983	28.4	15.3	5.5	48.3	7.6	0.7	0.9	-6.8
1984	26.8	17.1	5.6	47.6	7.6	0.7	1.0	-6.5

[1]SL refers to relative labour share (%/a);
[2]SK refers to relative capital share (%/a);
[3]SK1 refers to relative share of interest income (%/a);
[4]SM refers materials' relative share (%/a);
[5]SF refers to relative share of stumpage (%/a);
[6]ST refers relative share of energy (%/a);
[7]TAXPT refers to relative share of taxes (%/a);
[8]SP refers to relative profit share (%/a).

Table III.2: Relative Factor Shares in the Logging Industry, 1957-84

YEAR	SL[1]	SK[2]	SK1[3]	SM[4]	SF[5]	ST[6]	TAXPT[7]	SP[8]
1957	48.4	7.7	1.5	11.4	3.2	9.4	0.1	18.3
1958	47.7	9.9	1.6	11.5	3.2	10.5	0.4	15.2
1959	48.4	9.3	2.0	11.4	3.2	9.7	0.5	15.6
1960	47.7	9.1	1.9	11.4	3.2	9.3	0.6	16.7
1961	47.8	10.1	1.9	11.8	3.4	9.8	0.6	14.5
1962	47.8	9.3	2.0	11.5	3.3	9.7	0.7	15.7
1963	47.7	9.7	1.9	12.7	3.6	8.4	0.8	15.1
1964	46.2	9.1	1.9	12.2	3.6	11.0	1.3	14.6
1965	45.5	9.0	2.1	12.9	3.6	10.0	1.5	15.4
1966	45.8	8.6	2.4	13.2	3.6	9.1	1.1	16.1
1967	47.9	9.7	2.6	13.8	3.6	8.3	0.8	13.2
1968	45.0	10.7	2.9	13.3	3.5	9.1	1.4	14.1
1969	43.4	9.6	3.1	13.0	3.4	10.3	1.1	16.0
1970	46.2	11.1	3.5	17.0	3.0	8.2	0.9	9.9
1971	45.9	12.3	3.1	17.0	3.1	8.4	0.9	9.2
1972	47.1	9.7	3.0	15.5	3.2	10.0	1.2	14.4
1973	40.9	5.5	3.1	14.4	3.1	14.0	1.6	17.4
1974	44.0	3.2	3.8	16.1	3.8	10.1	1.2	17.7
1975	48.5	8.9	4.3	21.1	4.0	5.4	0.9	6.9
1976	46.3	9.5	4.0	19.9	3.7	5.1	0.9	10.5
1977	45.4	10.9	3.7	20.9	3.6	5.9	1.1	8.5
1978	44.9	11.2	3.9	20.0	3.5	9.0	1.0	6.4
1979	39.6	7.8	4.2	19.9	3.1	12.6	1.5	11.2
1980	41.3	9.7	5.3	21.6	3.7	11.6	1.9	4.8
1981	47.0	15.7	6.8	24.4	5.4	5.6	1.0	-6.0
1982	49.8	19.7	6.7	21.7	7.1	5.1	0.8	-11.1
1983	45.9	17.0	5.1	22.7	6.1	5.2	0.7	-2.8
1984	45.4	17.9	5.7	26.4	6.1	5.5	0.9	-7.9

[1]SL refers to relative labour share (%/a);
[2]SK refers to relative capital share (%/a);
[3]SK1 refers to relative share of Interest income (%/a);
[4]SM refers materials' relative share (%/a);
[5]SF refers to relative share of stumpage (%/a);
[6]ST refers relative share of energy (%/a);
[7]TAXPT refers to relative share of taxes (%/a);
[8]SP refers to relative profit share (%/a).

Table III.3: Relative Factor Shares in the Wood Industries, 1957-84

YEAR	SL[1]	SK[2]	SK1[3]	SF[4]	SM[5]	ST[6]	TAXPT[7]	SP[8]
1957	27.2	4.0	1.7	1.2	52.0	1.6	1.7	10.5
1958	27.1	4.0	1.7	1.1	50.7	1.6	1.7	12.0
1959	26.4	4.2	2.2	1.0	50.5	1.6	3.3	10.6
1960	28.7	4.9	2.4	1.7	53.8	1.7	3.0	3.6
1961	30.5	5.3	2.4	1.7	53.5	1.9	3.0	1.6
1962	27.7	4.3	2.2	1.2	49.0	1.9	3.4	10.2
1963	28.5	4.0	2.2	0.9	52.2	1.9	3.2	7.0
1964	27.6	3.7	2.3	0.7	53.4	1.9	3.2	7.1
1965	28.5	3.7	2.5	0.7	53.2	1.9	2.2	7.2
1966	29.1	3.8	2.8	0.7	53.2	1.9	1.8	6.6
1967	29.8	4.3	3.1	0.6	53.0	1.8	2.1	5.2
1968	27.5	4.6	3.3	0.8	51.5	1.7	3.2	7.3
1969	26.7	4.4	3.7	0.9	53.4	1.7	3.1	6.0
1970	30.4	5.8	4.2	0.8	56.5	1.8	1.3	-0.7
1971	30.0	5.6	3.7	0.7	53.9	1.8	1.8	2.3
1972	26.9	4.1	3.4	1.1	51.1	1.7	2.7	8.9
1973	24.2	2.2	3.4	1.4	49.5	1.5	3.9	13.7
1974	27.9	0.8	4.4	1.1	53.6	1.9	2.2	8.0
1975	30.0	3.9	4.7	0.5	53.5	2.1	1.8	3.5
1976	29.0	3.7	4.6	0.4	53.5	2.1	2.3	4.2
977	28.4	4.2	4.1	0.4	51.6	2.2	2.6	6.4
1978	26.6	4.2	4.1	0.7	50.3	2.1	3.2	8.7
1979	25.3	3.0	4.6	1.1	52.3	2.0	3.3	8.3
1980	28.8	4.5	5.9	0.9	55.7	2.4	1.6	0.1
1981	29.7	7.4	7.3	0.5	55.7	2.9	1.2	-4.8
1982	33.1	10.1	7.6	0.4	57.5	3.8	1.0	-13.5
1983	28.3	9.3	5.6	0.4	54.7	3.4	1.0	-2.7
1984	28.3	11.1	6.0	0.4	55.9	3.5	0.9	-6.1

[1]SL refers to relative labour share (%/a);
[2]SK refers to relative capital share (%/a);
[3]SK1 refers to relative share of Interest income (%/a);
[4]SM refers materials' relative share (%/a);
[5]SF refers to relative share of stumpage (%/a);
[6]ST refers relative share of energy (%/a);
[7]TAXPT refers to relative share of taxes (%/a);
[8]SP refers to relative profit share (%/a).

Table III.4: Relative Factor Shares in the Paper & Allied Industries, 1957-84

YEAR	SL[1]	SK[2]	SK1[3]	SM[4]	SF[6]	TAXPT[7]	SP[8]
1957	22.6	7.9	1.7	47.5	6.0	5.1	9.2
1958	22.5	8.5	1.7	46.4	5.8	4.9	10.2
1959	22.2	9.1	2.1	46.1	5.6	5.8	9.1
1960	22.5	9.7	2.1	46.0	5.4	5.9	8.3
1961	23.2	10.6	2.1	45.8	5.5	5.7	7.0
1962	23.0	9.5	2.1	45.9	5.4	5.2	8.8
1963	22.9	9.0	2.1	46.2	5.3	5.0	9.5
1964	22.5	8.5	2.1	46.4	5.3	4.6	10.6
1965	22.8	8.6	2.4	47.6	5.4	7.4	5.7
1966	23.9	8.5	2.7	48.6	5.3	6.2	4.7
1967	25.7	10.6	3.1	50.0	5.5	5.1	-0.1
1968	26.2	12.4	3.4	50.8	5.5	4.6	-3.0
1969	25.2	11.2	3.7	49.5	5.4	4.7	0.2
1970	25.9	12.2	3.8	49.0	5.4	2.7	0.9
1971	27.4	13.8	3.6	49.7	6.0	2.3	-2.8
1972	27.1	11.6	3.5	49.9	5.8	2.4	-0.4
1973	25.0	6.6	3.4	47.9	5.4	3.2	8.6
1974	20.9	1.8	3.8	44.1	5.4	4.5	19.3
1975	23.2	7.3	4.2	46.2	5.8	2.7	10.6
1976	25.5	8.0	4.3	47.8	6.8	2.3	5.4
1977	25.3	9.9	4.0	47.3	7.8	2.1	3.6
1978	25.0	10.6	4.1	46.8	8.2	2.8	2.4
1979	22.0	7.3	4.3	45.7	7.7	4.4	8.5
1980	20.7	8.1	5.2	46.3	7.4	3.9	8.3
1981	21.5	12.4	6.5	47.9	8.2	2.2	1.2
1982	24.4	16.0	6.7	49.1	10.0	1.0	-7.2
1983	24.7	19.3	5.5	49.8	10.6	0.9	-10.7
1984	22.2	20.7	5.4	47.1	10.3	1.1	-6.8

[1]SL refers to relative labour share (%/a);
[2]SK refers to relative capital share (%/a);
[3]SK1 refers to relative share of Interest income (%/a);
[4]SM refers materials' relative share (%/a);
[6]SF refers relative share of energy (%/a);
[7]TAXPT refers to relative share of taxes (%/a);
[8]SP refers to relative profit share (%/a).

Table III.5: The Forest Industries: Regression Parameter Estimates and Summary Statistics for Annual Growth Rates in Relative Factor Shares, Real Factor Prices and Factor Productivities[1]

DEPENDENT	TIME	DUM1	DUM2	CONST	R^2	RHO
RELATIVE FACTOR SHARES						
Labour (SL)	-0.008			19.50	0.76	0.02
	(-2.66)			(3.23)		
Capital (SK)	0.011**	-	-	-19.25**	0.36	0.08
	(0.58)			(-0.53)		
Capital (SK)	0.022	-250.47	0.12	-41.27	0.70	-0.002
	(1.94)	(-6.07)	(6.05)	(-1.84)		
Interest (SK1)	0.05			-96.82	0.98	-0.05
	(23.90)			(-23.61)		
Materials (SM)	0.015			-25.90	0.79	0.007
	(4.60)			(-4.03)		
Energy (SF)	0.014			-25.13	0.82	-0.06
	(1.86)			(-1.74)		
Stumpage (ST)	-0.04			77.37	0.83	0.09
	(-7.73)			(7.77)		
Taxpart	-0.048			-95.12	0.87	0.08
	(-6.12)			(6.19)		
Profit (SP)	-0.077			154.1	0.52	0.11
	(-2.84)			(2.87)		
REAL FACTOR PRICES						
Labour (rw)	0.023			-44.79	0.93	-0.15
	(8.06)			(-8.09)		
Capital (rr)	0.01**			-19.73**	0.36	0.09
	(0.58)			(-0.59)		
Capital (rr)	0.01	-237.24	0.11	-21.36	0.83	0.2
	(3.85)	(-19.19)	(19.15)	(-3.88)		
Materials (rpm)	0.0007**			-1.37**	0.79	0.005
	(0.31)			(-0.33)		
Materials (rpm)	0.001**	-26.60**	0.013**	-2.86**	0.75	0.11
	(0.31)	(-1.52)	(1.51)	-0.32)		
Timber (rpt)	-0.009			17.20	0.89	-0.05
	(-1.77)			(1.77)		
Energy (rpe)	0.009*			-17.23*	0.60	0.05
	(1.09)			(-1.08)		
Energy (rpe)	0.02	-219.07	0.11	42.47	0.79	0.05
	(-3.29)	(9.20)	(9.19)	(3.29)		
Tax (rpx)	-0.048			94.47	0.87	0.09
	(-6.12)			(6.14)		
FACTOR PRODUCTIVITIES						
Labour	0.031			-61.35	0.94	0.11
	(10.46)			(-10.49)		
Capital	-0.0013**			2.58**	0.21	0.06
	(-0.41)			(0.40)		
Capital	-0.009	-3.68	0.002	17.6	0.43	-0.21
	(-2.32)	(-0.25)	(0.26)	(2.32)		
Materials	-0.014			27.13	0.83	0.03
	(-1.84)			(1.85)		

Timber	0.0255			-50.51	0.75	0.13
	(4.20)			(-4.21)		
Energy	-0.0044*			8.73*	0.11	0.05
	(-1.08)			(1.08)		
Energy	-0.02	-87.17	0.04	40.9	0.37	-0.04
	(-2.92)	-(3.37)	3.37)	2.93)		

[1]t-ratios are in parentheses; for 26 degrees of freedom (df), critical values for one-tailed test are t,.05=1.706 and t,.1=1.315;
DEPENDENT refers to dependent variable in a regression equation;
TIME refers to the coefficient of time (%/a), the independent variable;
DUM1 refers to dummy variable;
DUM2 refers to (DUM1*YEAR) variable;
CONST refers to coefficient of intercept term;
R^2 is coefficient of determination which is required to be interpreted with caution (see section 2.3.1);
RHO refers to autocorrelation coefficient of residuals;
Asterisk (*) signifies that relevant result is significant only at the 10% or 15% level; and Double asterisk (**) signifies that relevant result is not significant even at the 15% level.

Table III.6: The Logging Industry: Regression Parameter Estimates and Summary Statistics for Annual Growth Rates in Relative Factor Shares, Real Factor Prices and Factor Productivities[1]

DEPENDENT	TIME	CONST	R^2	RHO
RELATIVE FACTOR SHARES				
Labour (SL)	-0.0028	9.40	0.50	0.05
	(-2.71)	(4.56)		
Capital (SK)	0.018	-33.36	0.43	0.08
	(1.90)	(-1.77)		
Interest (SK1)	0.05	-99.06	0.95	0.29
	(12.78)	(-12.63)		
Materials (SM)	0.032	-59.82	0.92	0.09
	(13.8)	(-13.2)		
Energy (SF)	0.018	-33.81	0.81	0.01
	(2.75)	(-2.64)		
Stumpage (ST)	-0.016	34.19	0.69	-0.19
	(-3.42)	(3.65)		
Taxpart	-0.044	-86.53	0.55	-0.001
	(-2.54)	(-2.54)		
Profit (SP)	-0.097	195.1	0.82	0.10
	(-3.06)	(3.09)		
REAL FACTOR PRICES				
Labour (rw)	0.019	-38.53	0.72	-0.0005
	(5.59)	(-5.60)		
Capital (rr)	0.004**	-8.12**	0.51	0.09
	(0.34)	(-0.35)		
Materials (rpm)	-0.009	19.47**	0.80	0.07
	(-2.74)	(2.75)		
Timber (rpt)	-0.009	17.20	0.89	-0.05
	(-1.77)	(1.77)		
Energy (rpe)	0.01*	-20.97*	0.80	0.05
	(1.62)	(-1.60)		
Tax (rpx)	-0.044	-86.43	0.55	-0.001
	(2.53)	(-2.54)		
FACTOR PRODUCTIVITIES				
Labour	0.02	-43.72	0.77	-0.04
	(6.30)	(-6.32)		
Capital	-0.018	34.70	0.75	0.14
	(-6.30)	(6.31)		
Materials	-0.04	81.10	0.96	-0.06
	(-6.66)	(6.67)		
Timber	0.001**	2.40	0.57	0.04
	(0.16)	(0.18)		
Energy	-0.008	16.12	0.60	0.3
	(-1.72)	(1.74)		

[1]t-ratios are in parentheses; for 26 degrees of freedom (df), critical values for one-tailed test are t,.05=1.706 and t,.1=1.315;
DEPENDENT refers to dependent variable in a regression equation;
TIME refers to the coefficient of time (%/a), the independent variable;
DUM1 refers to dummy variable;

DUM2 refers to (DUM1*YEAR) variable;
CONST refers to coefficient of intercept term;
R^2 is coefficient of determination which is required to be interpreted with caution (see section 2.3.1);
RHO refers to autocorrelation coefficient of residuals;
Asterisk (*) signifies that the relevant result is significant at the 10% or 15% level;
Double asterisk (**) signifies that the relevant result is not significant even at the 15% level.

Table III.7: The Wood Industries: Regression Parameter Estimates and Summary Statistics for Annual Growth Rates in Relative Factor Shares, Real Factor Prices and Factor Productivities[1]

DEPENDENT	TIME	DUM1	DUM2	CONST	R^2	RHO
RELATIVE FACTOR SHARES						
Labour (SL)	-0.0007**			2.01*	0.36	0.01
	(0.79)			(1.20)		
Labour (SL)	0.002**	-13.15	0.007	-1.77	0.13	0.18
	(0.77)	(-1.08)	(1.07)	(-0.27)		
Capital (SK)	0.016*			-31.18*	0.33	0.12
	(1.27)			(-1.21)		
Interest (SK1)	0.048			-93.04	0.96	-0.10
	(20.72)			(-20.44)		
Materials (SM)	0.002			-0.35	0.39	-0.01
	(2.82)			(-0.22)		
Energy (SF)	0.026			-51.42	0.85	0.17
	(3.03)			(-2.99)		
Stumpage (ST)	-0.034			68.70	0.76	-0.06
	(-4.71)			(4.70)		
Taxpart	-0.024			-49.46	0.54	0.10
	(-2.54)			(2.58)		
Profit (SP)	-0.073			146.1	0.33	-0.01
	(-2.67)			(2.70)		
REAL FACTOR PRICES						
Labour (rw)	0.025			-49.00	0.94	-0.02
	(22.19)			(-22.21)		
Capital (rr)	0.005**			-9.85**	0.36	0.08
	(0.24)			(-0.25)		
Capital (rr)	-0.004	-312.63	0.15	8.55	0.71	0.1
	(-0.31)	(-6.24)	(6.22)	(0.32)		
Materials (rpm)	0.006			-13.2	0.67	0.05
	(-1.80)			(1.81)		
Energy (rpe)	0.005**			10.77**	0.87	-0.07
	(-0.31)			(0.32)		
Energy (rpe)	-0.05	-252.63	0.13	101.03	0.93	-0.09
	(-7.14)	(-9.13)	(9.13)	(7.17)		
Tax (rpx)	-0.024			47.87	0.50	0.11
	(-2.22)			(2.23)		
FACTOR PRODUCTIVITIES						
Labour	0.024			-48.52	0.96	-0.003
	(20.13)			(-20.12)		
Capital	-0.017			33.27	0.86	-0.05
	(-6.22)			(6.23)		
Materials	-0.009			17.80	0.74	-0.008
	(-2.35)			(2.35)		
Timber	0.026			-51.40	0.69	0.03
	(2.72)			(-2.72)		
Energy	-0.031			61.57	0.94	-0.06
	(-3.59)			(3.61)		

[1]t-ratios are in parentheses; for 26 degrees of freedom (df), critical values for

one-tailed test are t,.05=1.706 and t,.1=1.315;
DEPENDENT refers to dependent variable in a regression equation;
TIME refers to the coefficient of time, the only independent variable;
DUM1 refers to dummy variable;
DUM2 refers to (DUM1*YEAR) variable;
CONST refers to coefficient of intercept term;
R^2 is coefficient of determination which is required to be interpreted with caution (see section 2.3.1);
RHO refers to autocorrelation coefficient of residuals;
Asterisk (*) signifies that relevant result is significant only at the 10% or 15% level; and Double asterisk (**) suggests that relevant result is not significant even at the 15% level.

Table III.8: The Paper & Allied Industries: Regression Parameter Estimates and Summary Statistics for Annual Growth Rates in Relative Factor Shares, Real Factor Prices and Factor Productivities[1]

DEPENDENT	TIME	CONST	R^2	RHO
	RELATIVE FACTOR SHARES			
Labour (SL)	-0.007**	1.83**	0.52	0.17
	(0.35)	(0.48)		
Capital (SK)	0.013*	-23.85	0.27	0.08
	(1.07)	(-0.98)		
Interest (SK1)	0.045	-88.20	0.97	-0.05
	(13.03)	(-12.87)		
Materials (SM)	0.0001**	-3.54	0.55	0.09
	(0.13)	(1.48)		
Energy (SF)	0.017*	-31.70	0.95	0.02
	(0.91)	(-0.85)		
Taxpart	-0.05	-104.12	0.86	-0.09
	(-6.68)	(6.76)		
Profit (SP)	-0.064*	127.86*	0.55	0.12
	(-1.33)	(1.35)		
	REAL FACTOR PRICES			
Labour (rw)	0.022	-42.90	0.88	0.09
	(4.88)	(-4.92)		
Capital (rr)	0.01**	-19.91**	0.31	0.08
	(0.85)	(-0.87)		
Materials (rpm)	0.050*	-10.50*	0.61	-0.04
	(1.53)	(-1.55)		
Energy (rpe)	0.02	-47.98	0.93	0.03
	(3.78)	(3.77)		
Tax (rpx)	-0.05	103.30	0.86	-0.09
	(-6.68)	(6.71)		
	FACTOR PRODUCTIVITIES			
Labour	0.02	-44.10	0.91	0.09
	(8.26)	(-8.28)		
Capital	-0.003	6.79	0.18	0.01
	(-1.34)	(1.35)		
Materials	0.004	-9.69	0.57	0.05
	(2.13)	(-2.15)		
Energy	-0.006	-13.01	0.70	-0.03
	(3.35)	(-3.35)		

[1]t-ratios are in parentheses; for 26 degrees of freedom (df), critical values for one-tailed test are t,.05=1.706 and t,.1=1.315;
DEPENDENT refers to dependent variable in a regression equation;
TIME refers to the coefficient of time (%/a), the independent variable;
CONST refers to coefficient of intercept term;
R^2 is coefficient of determination which is required to be interpreted with caution (see section 2.3.1); RHO refers to autocorrelation coefficient of residuals;
Asterisk (*) signifies that relevant result is significant only at the 10% or 15% level; and Double asterisk (**) suggests that relevant result is not significant even at the 15% level.

Table III.9: The Forest Industries: Regression Parameter Estimates and Summary Statistics for Annual Growth Rates in Ratios of Relative Factor Shares, Factor Prices and Factor-Factor[1]

DEPENDENT	TIME	CONST	R^2	RHO
RATIOS OF RELATIVE FACTOR SHARES				
RLK	-0.015*	31.666	0.36	0.05
	(-1.22)	(1.27)		
RLM	-0.022	43.95	0.79	0.02
	(-3.60)	(3.59)		
RLT	0.029	-55.11	0.80	-0.08
	(5.94)	(-5.64)		
RLF	-0.024	48.62	0.94	0.07
	(-2.70)	(2.79)		
RKM	0.002**	2.99**	0.45	0.06
	(-0.10)	(0.07)		
RKT	0.04	-80.96	0.58	-0.02
	(2.67)	(-2.62)		
RFK	0.007	15.28	0.19	0.04
	(-0.74)	(0.77)		
RMT	0.055	-104.0	0.90	0.27
	(12.48)	(-12.12)		
RMF	0.003	-4.60	0.62	-0.02
	(0.56)	(-0.39)		
RFT	0.05	98.87	0.83	0.13
	(-5.95)	(5.88)		
RATIOS OF FACTOR QUANTITIES				
KLR	0.03	-63.79	0.94	0.09
	(11.17)	(-11.19)		
MLR	0.047	-87.08	0.91	0.11
	(4.91)	(-4.68)		
TLR	0.003**	-6.17	0.56	-0.05
	(0.27)	(-0.27)		
FLR	0.032	-62.57	0.85	-0.002
	(4.57)	(-4.58)		
MKR	0.014	-23.11	0.68	0.07
	(1.43)	(-1.20)		
TKR	-0.027	55.87	0.62	0.14
	(-2.80)	(2.81)		
KFR	-0.003**	-6.01**	0.11	0.07
	(0.71)	(-0.71)		
TMR	-0.047	-88.79	0.69	0.30
	(3.94)	(-3.77)		
FMR	-0.0147	-24.66	0.38	-0.08
	(1.96)	(-1.67)		
TFR	-0.032	-64.04	0.53	-0.01
	(3.34)	(-3.35)		
RATIOS OF FACTOR PRICES				
WRR	0.018	-36.71	0.40	0.13
	(1.74)	(-1.73)		
WPMR	0.026	-50.92	0.96	0.18
	(11.97)	(-12.0)		

WPTR	0.032 (5.66)	-63.19 (-5.67)	0.97	-0.05
WPER	0.0156 (1.86)	-31.05 (-1.89)	0.66	0.09
RPMR	0.01 (0.77)	-20.21 (-0.78)	0.30	0.05
RPTR	0.018* (1.46)	-35.20* (-1.47)	0.34	0.07
PERR	0.008* (-1.22)	15.43* (1.19)	0.22	-0.05
PMPTR	0.0077 (4.87)	-15.09 (4.88)	0.94	0.14
PMPER	-0.017* (-1.32)	32.45* (1.31)	0.64	-0.009
PEPTR	0.024 (2.07)	-45.90 (-2.06)	0.70	-0.01

[1]t-ratios are in parentheses; for 26 degrees of freedom (df), critical values for one-tailed test are t,.05=1.706 and t,.1=1.315;
DEPENDENT refers to dependent variable in a regression equation;
TIME refers to the coefficient of time, the only independent variable;
CONST refers to coefficient of intercept term;
R^2 is coefficient of determination which is required to be interpreted with caution (see section 2.3.1);
RHO refers to autocorrelation coefficient of residuals;
Asterisk (*) signifies that relevant result is significant only at the 10% or 15% level; and Double asterisk (**)suggests that relevant result is not significant even at the 15% level;
RATIOS OF RELATIVE FACTOR SHARES refers to ratio of one relative share to another, e.g. RLK=SL/SK, RKM=SK/SM ans so on;
RATIO OF FACTOR QUANTITIES refers to ratio of one factor to another e.g. KLR=K/L, KTR=K/T and so on;
RATIO OF FACTOR PRICES refers to ratio of one factor price to another e.g. WRR=W/R, PMPTR= PM/PT and so on.

Table III.10: The Logging Industry: Regression Parameter Estimates and Summary Statistics for Annual Growth Rates in Ratios of Relative Factor Shares, Factor Prices and Factor-Factor[1]

DEPENDENT	TIME	CONST	R^2	RHO
RATIOS OF RELATIVE FACTOR SHARES				
RLK	-0.021	42.13	0.46	0.10
	(-2.37)	(2.46)		
RLM	-0.034	68.88	0.95	0.08
	(-17.23)	(17.50)		
RLT	0.013	-24.66	0.65	-0.10
	(2.40)	(-2.25)		
RLF	-0.021	44.78	0.88	-0.04
	(-3.52)	(3.73)		
RKM	-0.013*	24.98	0.48	0.13
	(-1.47)	(1.44)		
RKT	0.03	-62.56	0.59	0.0001
	(2.62)	(-2.61)		
RFK	-0.002**	3.97	0.27	-0.09
	(-0.20)	(0.26)		
RMF	0.014	-26.31	0.69	0.006
	(2.51)	(-2.38)		
RFT	0.032	-64.91	0.76	0.01
	(3.66)	(-3.71)		
RATIOS OF FACTOR QUANTITIES				
KLR	0.04	-78.08	0.88	0.02
	(9.92)	(-9.94)		
MLR	0.065	-128.55	0.97	-0.04
	(7.37)	(-7.39)		
TLR	0.021	-42.32	0.57	-0.04
	(2.23)	(-2.24)		
FLR	0.037	74.09	0.840.05	
	(5.03)	(5.07)		
MKR	0.028	-54.85	0.83	0.04
	(6.27)	(-6.27)		
TKR	-0.019	39.26	0.67	-0.04
	(-3.02)	(3.03)		
KFR	0.01	19.97	0.59	0.08
	(-1.64)	(1.62)		
FMR	-0.03	60.56	0.86	-0.04
	(-4.70)	(4.71)		
TFR	-0.013	24.80	0.69	-0.01
	(-4.56)	(4.59)		
RATIOS OF FACTOR PRICES				
WRR	0.02	-41.31	0.56	0.09
	(2.09)	(-2.09)		
WPMR	0.031	-60.46	0.92	0.005
	(3.87)	(-3.88)		
WPTR	0.031	-60.46	0.92	0.005
	(3.87)	(-3.88)		
WPER	0.022	-44.46	0.73	0.16
	(2.23)	(-2.26)		

RPMR	0.012	-25.02	0.41	0.12
	(1.84)	(1.85)		
RPTR	0.012	-25.02	-0.41	0.16
	(2.23)	(-2.26)		
PERR	0.01	19.40	0.40	-0.04
	(1.47)	(1.43)		
PMPER	-0.027	53.05	0.86	0.01
	(2.08)	(-2.07)		
PEPTR	0.027	-53.05	0.86	-0.01
	(2.08)	(-2.07)		

[1]t-ratios are in parentheses; for 26 degrees of freedom (df), critical values for one-tailed test are t,.05=1.706 and t,.1=1.315;
DEPENDENT refers to dependent variable in a regression equation;
TIME refers to the coefficient of time (%/a), the independent variable;
CONST refers to coefficient of intercept term;
R^2 is coefficient of determination which is required to be interpreted with caution (see section 2.3.1);
RHO refers to autocorrelation coefficient of residuals;
Asterisk (*) signifies that relevant result is significant only at the 10% or 15% level; and Double asterisk (**) suggests that relevant result is not significant even at the 15% level;
RATIOS OF RELATIVE FACTOR SHARES refers to ratio of one relative share to another, e.g. RLK=SL/SK, RKM=SK/SM ans so on;
RATIO OF FACTOR QUANTITIES refers to ratio of one factor to another e.g. KLR=K/L, KTR=K/T and so on;
RATIO OF FACTOR PRICES refers to ratio of one factor price to another e.g. WRR=W/R, PMPTR= PM/PT and so on.

Table III.11: The Wood Industries: Regression Parameter Estimates and Summary Statistics for Annual Growth Rates in Ratios of Relative Factor Shares, Factor Prices and Factor-Factor[1]

DEPENDENT	TIME	CONST	R^2	RHO
RATIOS OF RELATIVE FACTOR SHARES				
RLK	-0.016*	33.50	0.35	0.06
	(-(1.12))	(1.19)		
RLM	-0.013	1.84	0.45	-0.02
	(-2.53)	(1.89)		
RLT	0.036	-67.32	0.75	-0.03
	(4.53)	(-4.31)		
RLF	-0.025	52.52	0.96	0.03
	(-3.46)	(3.64)		
RKM	0.018*	-38.30	0.34	0.04
	(0.99)	(-1.06)		
RKT	0.052	-100.04	0.56	-0.04
	(2.54)	(-2.50)		
RKF	-0.015	30.38	0.35	0.0009
	(-2.47)	(2.53)		
RMT	0.037	-68.89	0.78	-0.04
	(4.90)	(-4.62)		
RFT	0.056	-110.22	0.82	0.02
	(5.20)	(-5.16)		
RMF	-0.0227	47.95	0.88	0.04
	(-3.22)	(3.46)		
RATIOS OF FACTOR QUANTITIES				
KLR	0.042	-81.99	0.98	0.01
	(18.20)	(18.21)		
MLR	0.035	-68.35	0.96	0.02
	(10.96)	(-10.97)		
TLR	-0.001**	3.17**	0.57	0.004
	(-0.16)	(0.16)		
FLR	0.058	-114.66	0.97	-0.07
	(8.04)	(-8.06)		
MKR	-0.007	14.97	0.50	-0.01
	(-2.07)	(2.07)		
TKR	-0.044	87.43	0.76	-0.04
	(-4.76)	(4.77)		
KFR	0.017	-33.17	0.84	0.03
	(1.85)	(-1.86)		
TMR	-0.037	73.19	0.78	-0.04
	(-4.90)	(4.91)		
FMR	0.024	-48.12	0.85	0.03
	(7.04)	(-7.07)		
TFR	0.062	-121.46	0.84	-0.01
	(7.74)	(-7.76)		
RATIOS OF FACTOR PRICES				
WRR	0.028	-54.40	0.47	0.11
	(2.28)	(-2.27)		
WPMR	0.031	-62.39	0.99	0.03
	(8.81)	(-8.83)		

WPTR	0.031	-62.39	0.99	0.03
	(8.81)	(-8.83)		
WPER	0.033	-65.84	0.96	-0.17
	(1.98)	(-2.00)		
RPMR	0.009**	-18.56**	0.27	0.03
	(0.62)	(-0.63)		
RPTR	0.009**	-18.56**	0.27	0.03
	(0.62)	(-0.63)		
PERR	0.01	-21.83	0.17	0.008
	(1.14)	(-1.17)		
PMPER	0.003**	-6.25**	0.86	0.21
	(0.22)	(-0.23)		
PEPTR	-0.003**	6.25**	0.86	0.21
	(-0.22)	(0.23)		

[1]t-ratios are in parentheses; for 26 degrees of freedom (df), critical values for one-tailed test are t,.05=1.706 and t,.1=1.315;
DEPENDENT refers to dependent variable in a regression equation;
TIME refers to the coefficient of time (%/a), the independent variable;
CONST refers to coefficient of intercept term;
R^2 is coefficient of determination which is required to be interpreted with caution (see section 2.3.1);
RHO refers to autocorrelation coefficient of residuals;
Asterisk (*) signifies that relevant result is significant only at the 10% or 15% level; and Double asterisk (**) suggests that relevant result is not significant even at the 15% level;
RATIOS OF RELATIVE FACTOR SHARES refers to ratio of one relative share to another, e.g. RLK=SL/SK, RKM=SK/SM ans so on;
RATIO OF FACTOR QUANTITIES refers to ratio of one factor to another e.g. KLR=K/L, KTR=K/T and so on;
RATIO OF FACTOR PRICES refers to ratio of one factor price to another e.g. WRR=W/R, PMPTR= PM/PT and so on.

Table III.12: The Paper & Allied Industries: Regression Parameter Estimates and Summary Statistics for Annual Growth Rates in Ratios of Relative Factor Shares, Factor Prices and Factor-Factor[1]

DEPENDENT	TIME	CONST	R^2	RHO
RATIOS OF RELATIVE FACTOR SHARES				
RLK	-0.017*	34.72	0.33	0.01
	(-1.05)	(1.08)		
RLM	-0.002*	-4.34	0.53	0.22
	(-1.31)	(-1.57)		
RLF	-0.02	41.22	0.94	0.14
	(-2.03)	(2.09)		
RKM	0.016*	-32.99	0.28	0.05
	(1.02)	(-1.07)		
RFK	0.008**	15.71	0.19	0.04
	(-0.72)	(0.73)		
RMF	-0.019	40.75	0.94	0.01
	(-2.38)	(2.51)		
RATIOS OF FACTOR QUANTITIES				
KLR	0.025	-49.51	0.92	-0.02
	(11.31)	(-11.34)		
MLR	0.019	-37.45	0.94	0.06
	(9.37)	(-9.37)		
FLR	0.016	-31.18	0.86	0.02
	(6.24)	(-6.25)		
MKR	-0.006	12.16	0.33	0.08
	(-1.94)	(1.95)		
KFR	-0.009	19.10	0.52	-0.005
	(-3.69)	(3.69)		
FMR	-0.004	7.30	0.40	0.03
	(-2.15)	(2.12)		
RATIOS OF FACTOR PRICES				
WRR	0.013	-24.79	0.32	0.11
	(1.16)	(-1.16)		
WPMR	0.018	-36.88	0.94	0.05
	(5.69)	(-5.71)		
WPER	0.005**	-10.61	0.79	0.20
	(0.88)	(-0.91)		
RPMR	0.009**	-19.17	0.27	0.04
	(0.73)	(-0.73)		
PERR	-0.016*	30.18	0.34	0.03
	(-1.31)	(1.29)		
PMPER	-0.02	39.96	0.92	-0.09
	(-2.12)	(2.10)		

[1]t-ratios are in parentheses; for 26 degrees of freedom (df), critical values for one-tailed test are $t_{,.05}=1.706$ and $t_{,.1}=1.315$;
DEPENDENT refers to dependent variable in a regression equation;
TIME refers to the coefficient of time (%/a), the independent variable;
CONST refers to coefficient of intercept term;
R^2 is coefficient of determination which is required to be interpreted with caution (see section 2.3.1);

RHO refers to autocorrelation coefficient of residuals;
Asterisk (*) signifies that relevant result is significant only at the 10% or 15% level;and Double asterisk (**) suggests that relevant result is not significant even at the 15% level;
RATIOS OF RELATIVE FACTOR SHARES refers to ratio of one relative share to another, e.g. RLK=SL/SK, RKM=SK/SM ans so on;
RATIO OF FACTOR QUANTITIES refers to ratio of one factor to another e.g. KLR=K/L, KFR=K/F and so on;
RATIO OF FACTOR PRICES refers to ratio of one factor price to another e.g. WRR=W/R, PMPER= PM/PE and so on.

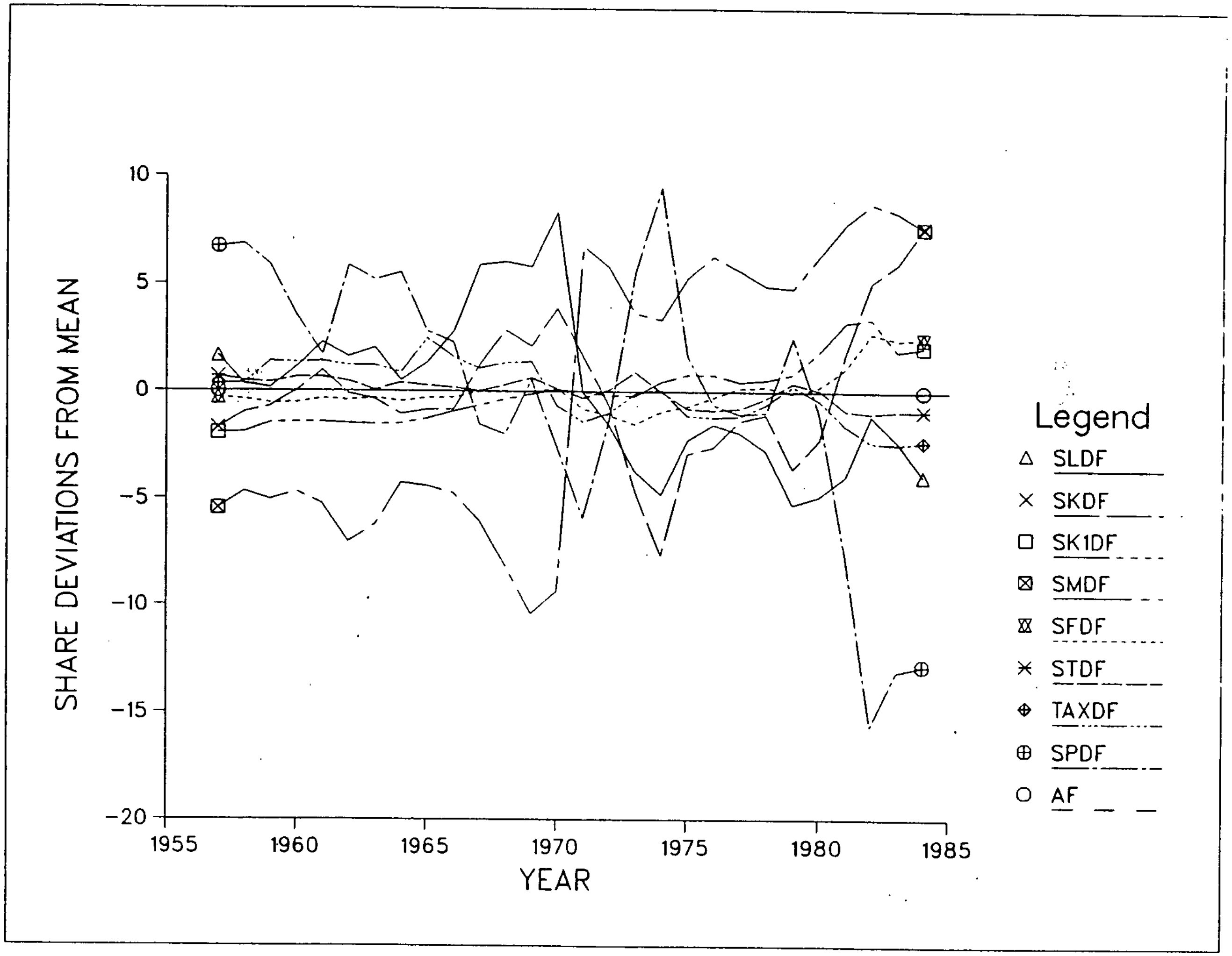

FIGURE III.1: Deviations of the relative factor shares from their means in the Forest Industries, 1957-84

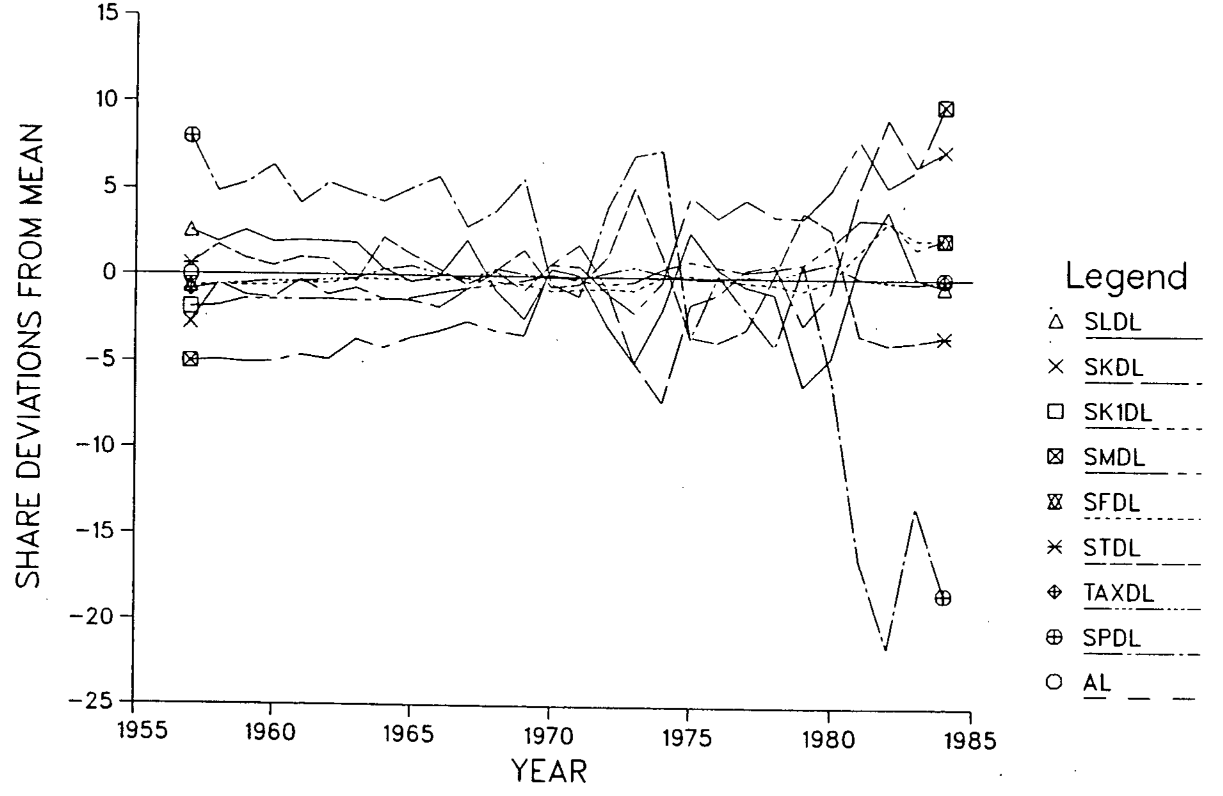

FIGURE III.2: Deviations of the relative factor shares from their means in the Logging Industry, 1957–84

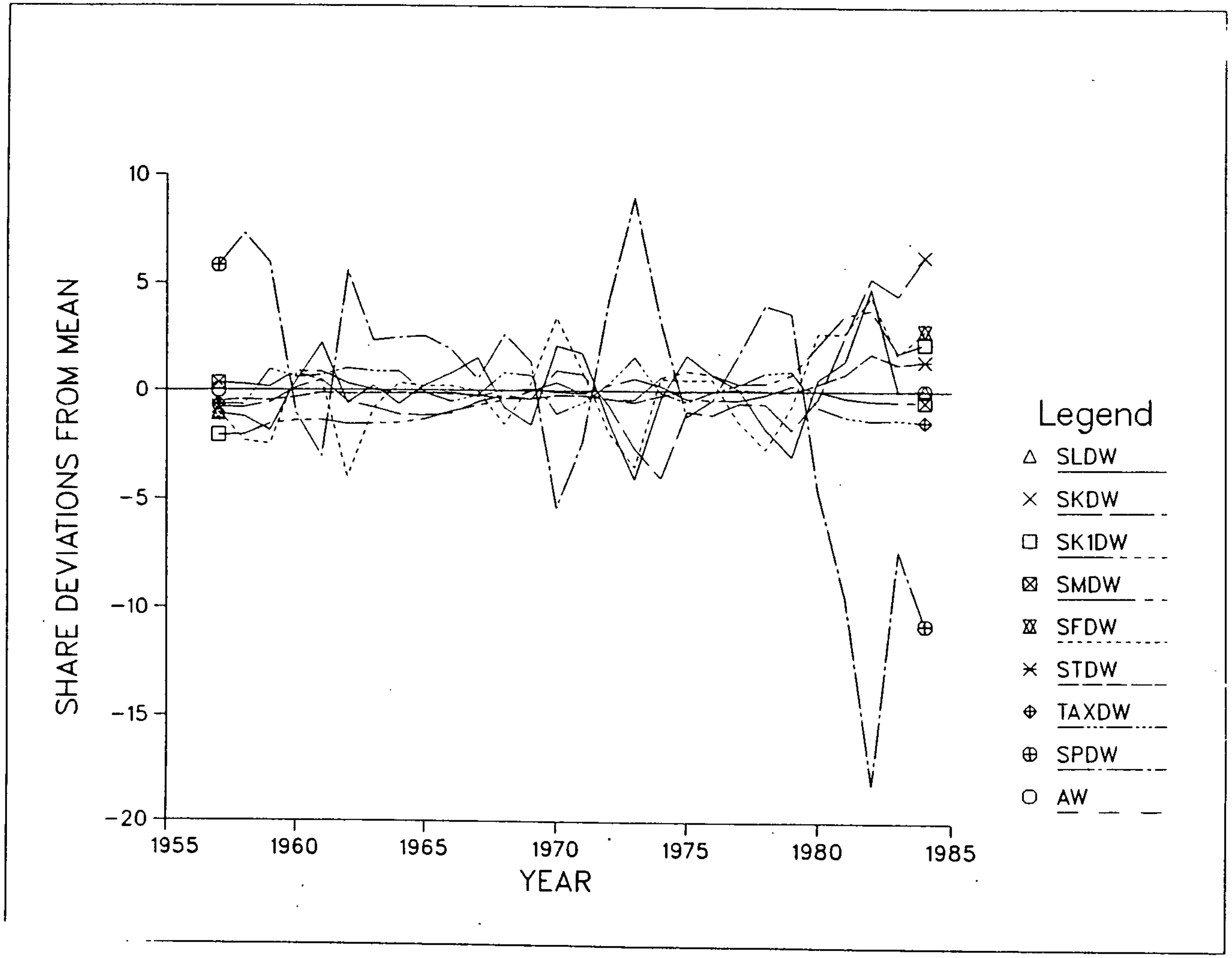

FIGURE III.3: Deviations of the relative factor shares from their means in the Wood Industries, 1957-84

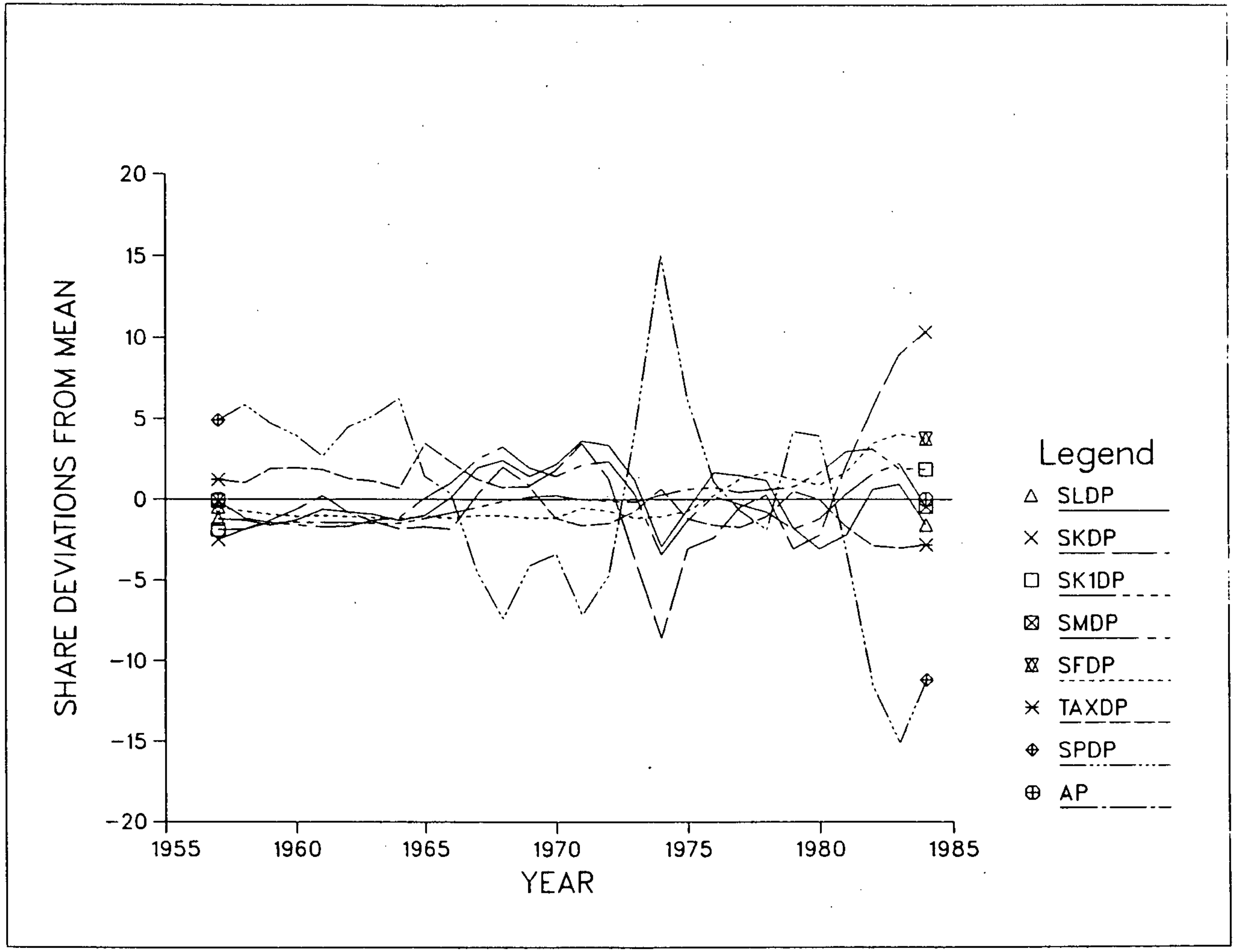

FIGURE III.4: Deviations in the relative factor shares from their means in the Paper & Allied Industries, 1957-84

APPENDIX IV

COMPOSITION OF FACTOR INPUTS

1. LABOUR includes production workers, office employees, executives and working owners and parters.

2. LABOUR COMPENSATION includes pay for time worked (including production incentive bonus), paid absence, miscellaneous direct payments such as taxable benefits, and employer contribution to employee welfare and benefit plans such as workmen's compensation, unemployment insurance, Canada pension plan and other benefits.

3. MATERIALS refers to raw materials and services and includes purchased items at laid down cost, including transportation and handling charges and duties.
MATERIALS in the LOGGING INDUSTRY represent only operating, maintenance and repairs supplies (excluding fuel) and materials supplies etc. of small establishments (excluding proportional payment for royalties and stumpage). That is, materials component in this industry includes column 4 and part of column 6 in table 4 of Stat Can. Cat.No.25-201.
MATERIALS in the WOOD and PAPER & ALLIED INDUSTRIES include wood, used wood products, chemicals and other supplies and services. Wood (as output of logging industry) constitute substantial proportion of materials in both these industries. For example, in the Wood Industries, wood constitutes about 66% of total cost of materials and services. This estimate is based on an average of two years: 1980 and 1984. Similarly, the cost of wood and wood residue, used in the Pulp and Paper Industry (SIC 271) is more than 50% of total cost of materials and services in this industry.

4. FUEL represents consumption of purchased fuel and electricity. It excludes data for small establishments and power generated by all establishments. The cost of fuel is laid down cost.

5. STUMPAGE represents payments for stumpage and royalties by the logging industry and logging firms integrated with saw mills etc. It does not include implicit stumpage for harvesting firms' private lands. This is different from delivered wood cost. In this study, 'timber' has been used as 'forest input' for the logging industry and logging firms integrated with saw mills etc. It is different from wood which is defined as output of the logging industry.

6. TIMBER PRODUCTIVITY is defined here as logging output/forest input. Logging output is an index of output of the logging industry. Stumpage rate is an implicit raw material price index, prepared by Stat. Can. for this industry. An index of forest input (timber) is obtained by dividing total stumpage paid by implicit raw material price index.

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