SILVA FENNICA Vol. 15, 1981, N:o 1: 38–64

EFFECTS OF PUBLIC FOREST POLICY IN FINLAND
An econometric approach to empirical policy analysis

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1. INTRODUCTION

Forestry legislation, forest taxation and incentives, research, education and training together with various measures of forestry promotion are the main instruments of public forest policy. The organization and implementation of these means aim at maximizing the utilities produced by the forest resources. The focus of forest policy goals and the mutual relationships between them vary in different countries with respect to the production of wood and other tangible forest goods, the conservation of the environment and the provision of recreational facilities. The differences in the preferences originate from the relative significance of forestry and forest industries in the national economy, or from the environmental and recreational functions the forests are serving, as well as the balance in the demand for these different utilities.

Wood production in different forms, however, has been the main objective of public forest policy in many European countries, Canada, USA, USSR and Japan. Forestry also has an increasingly important role in the growth policy of the economy in many developing countries. As an example of the main principles of forest policy formulation aimed at timber production we refer to the highly industrialized EEC-countries, where the aims of timber production, environmental conservation and the provision of recreation may be in some cases conflicting: "Assuming that it is in the public interest to foster the maintenance and development of a continuing forest resource, Member States must ensure that their systems of forestry taxation and incentives make it more profitable for forest owners to develop their forest resources rather then to neglect or even liquidate them." (Commission of the European Communities, 1979, p. 26). (Concerning the aims and means see, e.g. CLAWSON, 1979, p. 304–318; Statens offentliga utredningar, 1973.) These are, then, general principles to be found in the substance of forest policy in this paper, too.

The purpose of the present study is to explore the applicability of some methodological approaches to empirical policy analysis in evaluating the effectiveness of public forest policy. From the perspective of effectiveness analysis we can distinguish in forest policy, aiming at the promotion of timber production, two principal objective levels in forestry: the quantity of silvicultural investments and their allocation and the quantity (sufficiency) together with the structure of timber supply. RIIHINEN in this publication, investigates the effects of reforms in the forestry taxation system on timber supply. My paper is restricted to the exploration of the effects of forest policy measures directed to silvicultural investments in private forestry.

The study is methodologically subdivided in two distinct, but complementary parts. To begin with, the effects of state subsidies in silvicultural investments in private forestry are analyzed. The policy analysis here is, by its nature, the macro analysis of quantitative forest policy means, in which aggregated time series data are used as study material. In the other methodological experiment, path analysis is employed, by means of which an attempt is made to provide a causal interpretation of the impacts of qualitative forest policy means at the woodlot level. This micro analysis utilizes an approach characteristic to the behavioural sciences.

The aim of the application of these two approaches is – in addition to the discussion of the alternative methods of the empirical policy analysis and the methodological problems concerned – to complement each other in evaluating the complete effects of a certain forest policy means. In practical policy making the given policy goal is aimed at with a combination of several policy means rather than with a single policy measure. Thus separate analyses of the effects of one policy mean is not theoretically valid. In addition, the pragmatic objectives of policy analysis presuppose versatile study settings.

The econometric method is used here only for the preliminary analysis of the structural relationships. The estimated policy models are considered to contribute to the evaluation of the effectiveness of forest policy means, but the model specifications of the study are merely theoretical hypotheses rather than as basis for testing underlying assumptions. Thus the estimated models are not used for prediction or policy simulation experiments.

2. THE SPECIFICATION OF THE FOREST POLICY MODEL

2.1. Specification in econometric approach

The discussion of the interaction between the theory and the empirical facts and their mutual emphasis in the econometric approach can be linked with the purpose and problems of the model specification. One can claim that the theory and facts meet each other at their best via the validly specified model. The specification of the model is regarded the first and most important stage of the econometric research process. Specification includes the selection of the relevant variables, the mathematical formulation of the causal structure of the relationships between them, together with the determination of the stochastic process included in the model. (See DESAI, 1977, p. 11–13; INTRILIGATOR, 1978, p. 3–4; KOUTSOYIANNIS, 1977, p. 12–16).

The specification should be based on the underlying theory, and the structure of the model should be isomorphic with the propositions and relationships between them included in the theory. The effect of the study problem on the specification is, however, to be emphasized. The model is to be understood as a heuristic device in quantifying the economic and social relationships of the phenomenon being studied.

Traditionally, the significance of theory and the application of deductive procedure have been a characteristic of econometrics, where the theory building is relatively advanced. In this "orthodox approach" the interaction between the theory and facts is to a great extent unidirectional: the specified model plays a role of a hypothesis, the validity of which is tested in the given empirical context. The estimated parameters either support the known invariances or in the case of non-significant estimates the cause is sought in the specification error. However, we may state, as INTRILIGATOR (1978, p. 3), that the theory building and the development of rival theories are ultimately based on empirical evidence.

In the new and developing fields of economic theory and the research into economic policy, where the theory building is still in its early stages, the nature of the specification is more experimental. In the "experimental approach", which is nowadays widely employed in econometric research, the hypothetical model is not "fixed" but is established on the basis of preliminary results. The structure of model as well as the variables and the causal relationships can be revised. (Cf. KOUTSOYIANNIS, 1977, p. 22–25). Also in the "facts-only"-approach it is to be remembered that facts do not really speak for themselves, but the function of the specification is to give, by means of the estimated parameters, a meaningful theoretical interpretation to the empirical facts.

The model specification in the present investigation is directed by the conceptual frame for the policy analysis. On the other hand, the characteristic features of the object of the policy determine the special theories, on the basis of which the general structure of the policy model is formed.

2.2. Public incentives in stimulating investments in private forestry

Public forest policy measures are aimed at goals pertinent to the sustained yield of timber production, and especially its increase. The means aim to affect the investment behaviour of private forest owners. The identification of the target variable is determined theoretically firstly, concerning which aggregate level of forestry or the economy the effectiveness of a policy will be examined. The target variable should identify both the goal of the forest policy and the behavioural response of the forest owner and its changes in relation to the implemented policy. A more accurate specification for the variable selection is then derived from the substance of the policy being analyzed.

Generally, we may specify the target variable to concern the quantity (the extent) of the silvicultural investments of the private forest owners at the aggregate level of the economy or it may be restricted to the level of certain administrative region. Depending on the empirical objectives of the policy analysis, certain types of silvicultural measures, or combinations of the silvicultural activities, are regarded as a target variable. In this paper the amount of seedling stand improvement work, carried out by private forest owner, is examined as a target variable of the policy model, being an empirical example of policy analysis.

Thus:

(1) Target variable: SSI_t = seedling stand improvement work, in hectares, in the year t.

The purpose of the effectiveness analysis is to examine if the extent of the silvicultural investments in the private forests could have been influenced by certain forest policy measures.

In many forestry countries there has been an attempt to steer and stimulate the investment behaviour, directly or indirectly by means of forestry taxation, state subsidies such as direct grants and subsidized loans, by arranging professional aid, extension services and forestry training for forest owners together with organizing cooperation in different forms (forest management associations, forestry cooperation areas etc.) (cf. e.g. Commission of the European Communities, 1979; GREGERSEN et al., 1975).

The most central of the means directly linked to the investments are the different kinds of state financial measures, which according to TINBERGEN's theory of economic policy can be classified with respect to their properties to the quantitative forest policy means. The aim is to improve the profitability of the silvicultural investments to the forest owners, by subsidizing directly the labour and material costs of the investment. The silvicultural measures may be profitable from the point of view of the national economy, but due to the differences in the time horizons of society and the individual private forest owner the measures may either not to be carried out or be of smaller extent than expected in relation to the set goals.

It is not necessary to describe the legislation on the state subsidies in different countries or to make a comparative analysis of the forms and applications, interesting though it might be. We may state in short that in Finland like many other European countries and North America, for instance, the forest owners get, on the basis of forest improvement legislation, direct grants and loans, whose repayment time is deferred and the interest rate is subsidized. The amount of the subsidies varies according to the type of silvicultural measure, the properties of the woodlot, as well as by region.

In the aggregate analysis, where the effectiveness is analyzed at the macro level, two main types of specification can be presented on the policy variable to measure the state subsidies:

- relative subsidy
- total subsidy.

A policy maker is able to use the forest policy instrument concerned in two ways: firstly, he may control the application terms of the state subsidies by changing the proportion of the subsidies in relation to the total costs of a project or incentive program, or by manipulating the interest rate and the

repayment time of the forest improvement loan. Secondly, he is able to control the absolute amount of the grants or loans within the limits of the budget constraint.

In practice these two types of quantitative policy means are coupled together by both a technical and behavioural relationship: increasing relative subsidies results in the growth of the total subsidies. In addition, the improved terms for obtaining financial support for silvicultural investments cause an increased demand for the subsidies.

We generally define a policy model in which the extent of the seedling stand improvements in private forestry, SSI_t, is explained by the relative state subsidies:

(2) $SSI_t = f_1\,(GL/TC_t)$ or alternatively

(3) $SSI_t = f_2\,(GL^d_t/SSI_t)$,

where GL = the total amount of the state grants (G) and loans (L);

TC_t = the total costs of seedling stand improvements;

GL^d_t = the total amount, deflated

In a causal sense a hypothesis is included into the policy model according to which a change in the policy variable, e.g. an increase in the share of the grants of the total investment costs, will produce a change in the target variable. The investment behaviour of forest owners acts as an intermediary mechanism, the determinants of which are directly controlled by means of state subsidies.

The policy variable concerning the total amount of state subsidies is specified in the function:

(4) $SSI_t = f_3\,(G1/3L^d_t)$.

In this model an explanatory variable is the total amount of real (deflated) state grants, with loans as a sum variable, in which the loans are weighted by the coefficient (1/3). The structure of the sum variable is based on the assumption that the direct grants have a more powerful effect on the investment decisions of forest owners than have the loans.

The policy variables are quite clear in their theoretical content. However, in the empirical analysis they may cause some problems. In practical forest policy making the change in the total amount of the state subsidies may be linked with the simultaneous change of some other policy instrument. Thus, the prerequisite for the realized real increase of the grants and loans may be, in addition to the improved terms of the subsidies, the increased inputs of the extension and training activities of forest owners. In that case the changes of the policy variable concerned would not be "autonomous", but in the causal sense dependent on the changes of the other means of the practical policy making and perhaps on the change of the demand for the total financing concerned. This may lead to difficulties in the causal interpretation of the parameter estimates and thus make it difficult to evaluate the effectiveness of the policy variables in question.

The construction of the equation including the target variable and the policy variable comprises the most central and necessary part of the model specification. However, this is not yet sufficient as a tool for policy analysis. The structure of the model should be extended to concern the main relationships within the object area of the policy. In the present case these would be the determinants of investment behaviour.

2.3. Expected income and propensity to invest

The literature on both macro and micro economic theory provides several determinants of investment behaviour, the specification being dependent on the level of analysis as well as the area of application. The premises and the main ingredients of investment theories are in one way or another connected with the interest rate and the marginal efficiency of investments (cf. BRANSON, 1979, p. 214–242). The relevance of other explanatory variables has been emphasized especially concerning the variable composition of empirical investment functions. McKENNA (1968, p. 113), for example, states:

"However other factors are probably more responsible for changes in investment than changes in interest rates; in other words, shifts in the schedule are more important than movements along it".

The level of investments or their changes (net investments) are explained, not only by interest rates, but also by the profits of the firms, capacity utilization, availability of credits, liquidity position of the firms and especially by different expectations coupled with the investment costs and returns. (See DESAI, 1977, p. 168–204). We may state, that the major explanatory variables are directly or indirectly linked with the costs and expected future returns of investments.

The theories of investment behaviour provide us with an approach to selection of relevant explanatory variables in specifying the structure of forest policy model. In examining the forestry behaviour of forest owners from the point of view of investment theories it is advisable to keep in mind that forestry has its own characteristic features, which to some extent differ from the other economic activities. Studies of forest owners' behaviour have given evidence that the silvicultural activity of forest owners is determined by many social and cultural factors, in addition to economic factors.

By means of the policy variable a change is produced in the investment behaviour by directly affecting the cost variables. An increase in investments is caused by reducing the investment costs of forest owners by means of direct grants and organizing professional aid and extension services or by improving the availability of financing in the form of subsidized state loans.

Along with the investment costs, the expected returns determine the marginal efficiency of the investment. Thus, the expectations play a central role as a determinant of the investment. In forestry, the expectations concerning the investment are directed toward future stumpage revenues, either as a claim on the return of a certain project or concerning the income stream of the whole woodlot, depending on the significance of the forest revenues in the total economy of the owner.

The inclusion of expectations in the econometric model creates several methodological problems. Firstly, one can claim that the future expectations cannot be operationalized, the uncertainty coupled with them cannot be specified and in addition, the time horizon of the expectations is difficult to determine. Secondly, including the income expectations in the model changes the analysis dynamic, where the specification of the lag structure forms a special problem.

One way to approach the problem is to start with the assumption that the income expectations, Y^e_t, are a function of the past income flows:

$$(5)\quad Y^e_t = f_1\,(Y^p_{t-i}).$$

The income expectations, which are based on the experiences and the knowledge of past income, Y^p_t, in the period t-i, is assumed to be an explanatory variable for the level of investments. Theoretically more promising, and from the perspective of the investment function probably more relevant, is the use of the notion of so called permanent income, which contains not only the past income developments but also the income expectations coupled with different future predictions. (On the theory of permanent income by FRIEDMAN, see e.g. BRANSON, 1979, p. 196–200; EISNER, 1967; PERLMAN, 1974, p. 135–138).

Thus we can substitute the past income of equation (5) for the permanent income, $Y^{p^*}_{t-i}$, in which case the expected income takes the form:

$$(6)\quad Y^e_t = f_2\,(Y^{p^*}_{t-i}).$$

In private forestry we may apply the permanent income hypothesis for the expectations concerning the stumpage revenues. Thus, expectations are influenced by past income flows, the estimated trend of stumpage prices, inflation (the development of real stumpage prices), forest taxation, the structure of growing stock and allowable drain of the forests together with previous and present silvicultural investments. There exists a simultaneous relationship between investments and income expectations, i.e. in the long run the investments are likely to increase the expected stumpage revenues. On the other hand, in the short run we may make the hypothesis, based on the permanent income, that the expected income influences the level of investment.

In forestry the income expectations obtain a concrete form in the short run in connection with timber sales. The calculated stumpage value for the marked timber approximates quite exactly the stumpage

revenues to be received when selling the timber. An increase in the expected stumpage revenues increases the willingness of forest owner to invest his revenues from the forests into silviculture. In this case, the decision is likely to be made, for example, to make a plan for seedling stand improvement work. A plan for the seedling stand improvement is accomplished during a certain period, when the investment is realized. This period from the change in the income expectations, and the investment decision due to it, to the realization of the investment is embodied in the distributed time lag to be included in the income expectation variable. The lagged distribution cannot be specified theoretically *a priori*, but it is to be experimentally identified and estimated.

The expected income concerning the stumpage revenues, in the sense of permanent income, is specified as a lagged variable as follows:

$$(7)\quad Y^e_{t-s} = (\lambda_1 SV^d_{t-1} + \lambda_2 SV^d_{t-2} + \cdots + \lambda_i SV^d_{t-i}),\quad \text{where}$$

SV^d_t = real (deflated) stumpage value of marked timber

λ_i = weight for the lagged distribution.

The variable specified above, Y^e_{t-s}, the deflated stumpage value of the marked timber as a lagged sum variable, is a proxy variable for the expected income of forest owners.

We now specify, in a general form, a behavioral equation for the hypothesis, according to which the expected income has an effect on the silvicultural investments, in this case on seedling stand improvements:

$$(8)\quad SSI_t = f_3(Y^e_{t-s}).$$

To incorporate alternative policy variables in the model, we have:

$$(9)\quad SSI_t = f_4(GL^d_t / SSI_t,\ Y^e_{t-s}) \quad \text{and}$$

$$(10)\quad SSI_t = f_5\,(G1/3L^d_t,\ Y^e_{t-s}).$$

In this context we may refer to another specification of the investment function derived from economic theory. By its premises it is more general than the previous one, but from the perspective of the theory of forest economics quite interesting. In this mode of specification the propensity to invest is linked with the total disposable income of forest owners, Y_t, instead of the expectations directed to the stumpage revenues. According to this investment theory the level of net investments depends on the changes of disposable income: $I_t = f_k\,(\Delta Y_t)$. As applied to private forestry the hypothesis indicates that given a constantly rising income level for forest owners, increased investments in the forestry do not necessarily follow. The empirical evidence of this hypothesis would have significant consequences for public forest policy. (Cf. RIIHINEN, 1968, p. 3).

2.4. Business cycles and the timing of investments

In the previous chapters, the structure of the policy model has been outlined by means of the explanatory variables connected with public forest policy, as well as the forest owner and his economy. On the basis of the economic theory concerning investments in general and empirical observations on practical forestry we may infer that the timing of the forestry investments is not merely casual, but is linked with certain economic cycles.

In an open economy, such as in Finland, investments and exports are the most variable components of aggregate demand. Because the value of forest industry products comprises one half of the value of net exports, changes in the demand for the exports of forest industry products are a major factor causing business cycles in the economy of Finland. The changes in the exports of forest industry products are reflected in the roundwood markets via the mechanism of derived demand. In forestry this means fluctuations in the volume of roundwood cutting, stumpage prices, stumpage revenues and employment.

The relationship between forestry investments and the business cycles is explained by the use of resources employed by the roundwood markets. During the boom, when the demand for roundwood increases the volume of cuttings, the commercial fellings are employing, in addition to forest workers, planning, extension and supervision resources of the forestry promotion organizations. In the recession, both labour force and resources of promotion organizations are underemployed. The contribution of professional aid for, and the extension and training of forest owners, is allocated to the promotion of silvicultural measures. By means of a stabilization policy the state subsidies become an attempt to increase investments and thus the aggregate demand, thereby employing the labour force being released from commercial fellings.

Thus, due to the interaction effect of the allocation of forestry promotion organizations' resources and the means of the stabilization policy, it is assumed that the area of seedling stand improvement will increase during a recession.

The construction of the business cycle variable can be based on the changes in the gross national product, in various branches of production, exports or employment. The specification depends on which economic phenomenon containing fluctuations is assumed to influence the variable explained in the investment function. In Finland, changes in the export demand for forest industry products are to be regarded as a central business cycle factor affecting forestry. In this paper the trend deviation of the volume index for the exports of wood industry, XW_t, is specified as a business cycle variable. The variable is composed by dividing the volume index concerned by its own trend.

By incorporating the business cycle variable in the policy model we have a function in a general form:

$$(11)\quad SSI_t = f_1\,(GL_t^d / SSI_t,\ Y_{t-s}^e,\ XW_t)$$

and for the policy variable to measure the total amount of the state subsidies:

$$(12)\quad SSI_t = f_2\,(G1/3\ L_t^d,\ Y_{t-s}^e,\ XW_t).$$

2.5. Forest policy model for silvicultural investments

On the basis of the theoretical frame of reference outlined above the forest policy model can now be specified. The seedling stand improvements in private forests are explained by the quantitative forest policy means, the expected income of forest owners and the business cycles measuring the general economic circumstances. The model specification is based on a behavioural equation, which is linear and additive in its functional form. The extent of seedling stand improvements at the aggregate level is assumed to be positively dependent on the policy variable and the expected income variable, but the impact of the business cycle variable on the target variable is assumed to be negative. The error term (residual) denoting the stochastic nature of the model is assumed and also presupposed to behave stochastically.

We define the policy models:

$$(13)\quad SSI_t = \alpha_0 + \alpha_1\,(GL_t^d / SSI_t) + \alpha_2\,(Y_{t-s}^e) - \alpha_3\,(XW_t) + \mu_t$$

$$(14)\quad SSI_t = \beta_0 + \beta_1\,(G1/3\ L_t^d) + \beta_2\,(Y_{t-s}^e) - \beta_3\,(XW_t) + \mu_t.$$

We may give a theoretical interpretation for the parameter estimates of the policy model. The parameter of the policy variable, α_1, and β_1 respectively, can be interpreted as a measure of effectiveness. (Cf. TINBERGEN, 1975, p. 53–63). The coefficient of the expected income, α_2, in the linear model, where the level of silvicultural investment is to be explained, may be interpreted as a certain kind of "marginal propensity to invest", not with regard to the actual and disposable income but rather the income expectations.

For good reason we could prefer the non-linear functional form for the linear one, especially with regard to the policy variable ($G1/3L_t^d$). This is because it is evident that increasing the intensity (quantity) of policy measure we are likely to reach a level, where the increase of investments, produced by policy means, decreases. On the other hand, arguments for the multiplicative relationship between the explanatory variables would be brought forward on the grounds that the realization of the investment could be assumed to be a result of the interaction effects of the explanatory variables rather than their additive relationships. This is valid especially with regard to the policy variable and the business cycle variable. This assumption can be tested in the estimation phase by transforming the multiplicative model into a logarithmic one.

3. DATA AND ESTIMATION METHODS

The problems of empirical policy analysis are often statistical in nature. First, the availability of relevant data restricts the carrying out of the empirical analysis. Statistics on the theoretically significant policy variable may be lacking entirely or the statistical series are imperfect due to e.g. an inadequate level of aggregation.

Thus, for example, the available time series regarding the policy analysis of the private forests in the whole country in Finland are too short. Consequently the time series are usually based on annual data; there are too few observations for the analysis in question.

The variance of the policy variable, being the object of the effectiveness analysis, may create difficulties for the dependence analysis. There may be too little variance in the policy variable and changes in the level of the variable occur relatively seldom. The problems in question are especially linked with the reforms of a policy and the qualitative policy means.

The data for the analysis of public forest policy in Finland consist of time series on private forests for the years 1954–79. The study area consists of the Forestry Board District of Kainuu. The time series are based on annual data. Consequently the observations of the policy variables only concern the state financing supervised by the District Forestry Board (and the forest management associations). Hence the analysis does not include the area of seedling stand improvement, which is carried out under the supervision of the local forest improvement district. The area of the seedling stand improvement in private forests, which is excluded from the study, comprised in recent years about 10–20 % of the total area in question. The data were obtained from the official statistics of Finland, as well as statistics compiled by the District Forestry Board of Kainuu. The time series of the variables are presented in Appendix 1.

The selection of the estimation method is based on both the causal structure of the estimated model (recursive vs. simultaneous models) and the principal econometric assumptions of the properties of the residual terms. The outcome of the estimations is quite sensitive for the specification errors. In this study, the single regression equations of the policy models were estimated by the OLS-method, which was assumed to yield the best (minimum variance), linear and unbiased estimates.

In the following chapter the estimation results of the policy models are presented. A preliminary stage in the estimation of the models is the formulation and estimation of the distributed lags of the explanatory variables. Here the method of cross correlation analysis is used. The parameter estimates of the policy models are evaluated by means of ordinary economic, statistical and econometric criteria. (See KOUTSOYIANNIS, 1977, p. 25–28).

4. ESTIMATION OF THE FOREST POLICY MODELS

4.1. Estimation of distributed lags

It is a characteristic of economic behaviour that there is a time lag in the relationship of the variables. The time lag in the relationships may be caused by an adaptation process included in the behavioural change, administrative or institutional factors together with the technical constraints. Usually we are dealing with a distributed lag, i.e. the values of the explained variable depend on past values of several observation periods of the explanatory variable. Thus the effect is distributed over time.

Economic theory as such seldom provides us with a priori information on the identification of the length and the weight structure of the lag being studied. So the specification of the lag distribution is to a great extent an empirical question. It is usual that the determination of distributed lags is based on estimation experiments with alternative lag structures. The one resulting in the best outcome with respect to statistical and

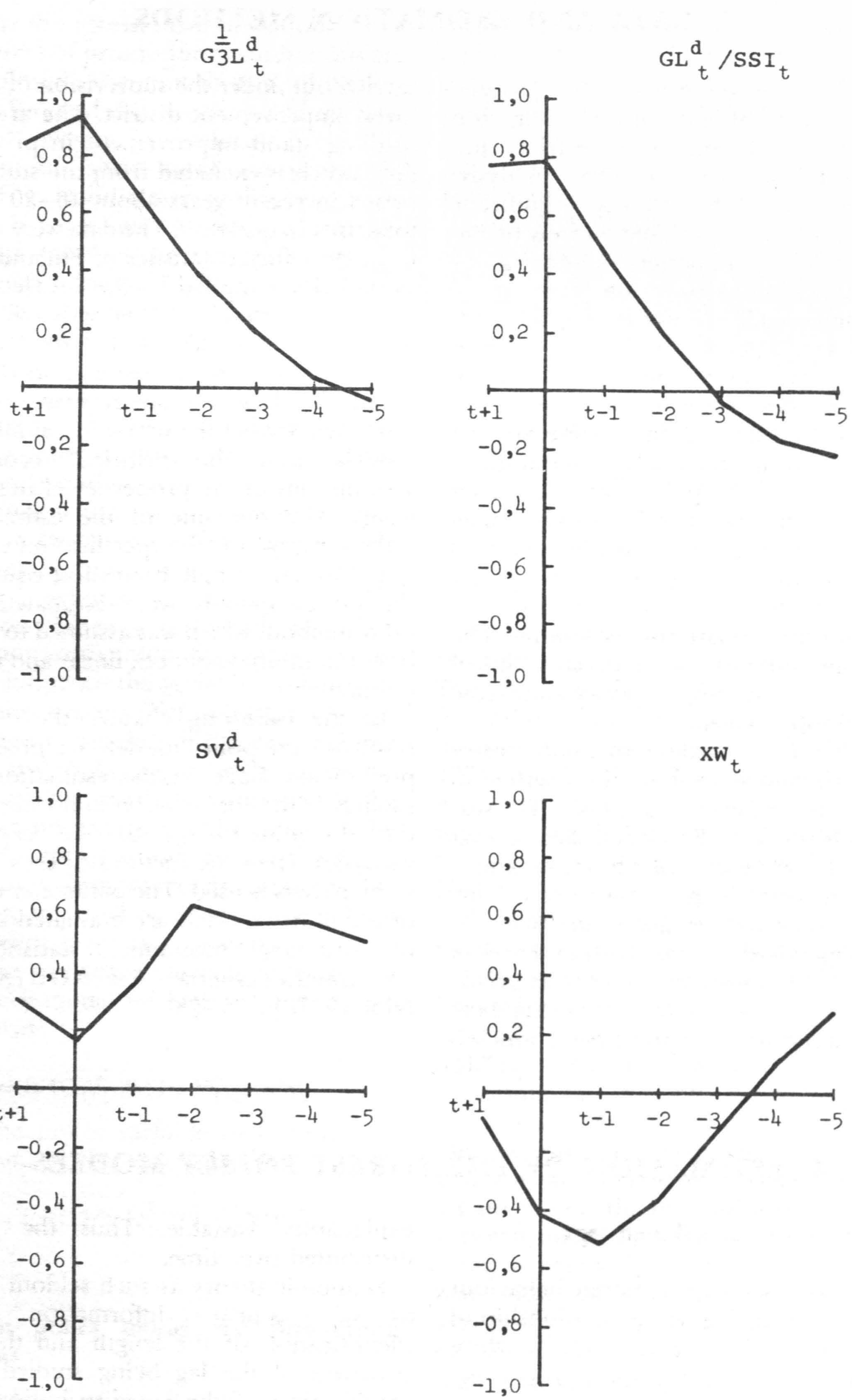

Figure 1. Cross correlations between the target variable, SSI_t, and the explanatory variables, $G1/3L^d_t$, GL^d_t/SSI_t, SV^d_t and XW_t.

econometriccriteria, is selected for the final model. (See e.g. DESAI, 1977, p. 170–178; KOUTSOYIANNIS, 1977, p. 294–327; STEWART 1979, p. 162–191).

Cross correlation analysis provides us with a valuable tool for the tentative exploration of the lag distribution. By means of cross correlation coefficients and graphical analysis based on them, we are able to examine the average lags between different time series. In addition we obtain clues concerning the weight structure to be used. (See BOX & JENKINS, 1976, p. 370–377; KANNIAINEN & SUVANTO, 1974).

The results of the cross correlation analysis between the target variable of the policy model, SSI_t, and the explanatory variables are presented graphically in figure 1. The size of correlation coefficient on the vertical axis and the length of the lag in years is measured on the horizontal axis. The target variable is measured in the period t, the time series of explanatory variables being lagged by t + 1, . . . , t – 5.

On the basis of the shape and peaks of the cross correlation graph we may estimate the average length of the lag and utilize it – together with the possible *a priori* or available empirical information – in formulating the experimental weight structure.

The results of the cross correlation analysis indicate that the correlation between the policy variables $G1/3L^d_t$, GL^d_t/SSI_t and the target variable SSI_t is strongest on the non-lagged values of the policy variables. The result agrees with the assumptions of the model specification, although it is to be noted that the quite strong correlation is partly caused by institutional factors connected with the funding of forest improvement work. The series of the deflated stumpage value of the marked timber correlates with the time series of seedling stand improvements as clearly lagged. On the basis of cross correlation analysis and the estimation experiments we came to the following distributed lag.

An inverted V-shaped weight structure was employed, the maximum lag being t – 3. The expected income variable to be used in the policy model thus took the form:

$$(15)\quad Y^e_{t\,13} = (1/4\ SV^d_{t-1} + 1/2\ SV^d_{t-2} + 1/4\ SV^d_{t-3}).$$

The correlation coefficients of the business cycle variable, XW_t, were highest with lags t and t-1 the relationship being negative as expected. In estimating the policy models, the business cycle variable was used both without lag and with one year lag.

4.2. Estimated policy models

4.2.1. Relative subsidies as a policy variable

The estimation of the policy models are presented in summarized form in both tables and graphical presentations. In the tables, the estimated policy models are presented as linear regression equations with their parameter estimates, standard errors of the coefficients $s(\hat{b}_t)$, student's t-test value t* for the parameter concerned, β-coefficients for the explanatory variables, the adjusted coefficient of multiple determination $\bar{R}^2$, the standard error of estimate S.E.E. and the Durbin-Watson test value D-W to test for the occurrence of autocorrelation.

The first model employs as explanatory variables the relative state subsidy, GL^d_t/SSI_t and the expected income, Y^e_{t13}. The model estimation is presented in table 1.

The estimation indicates that the signs of the parameters conform to the underlying hypotheses. From the statistical criteria we may conclude that the policy model is adequate as regards to the multiple correlation coefficient and the statistical significance (t* -values) of the parameters. However, the low value of Durbin-Watson statistics indicates the presence of positive autocorrelation of the residuals. Thus, even if the parameter estimates are unbiased, they are not efficient with respect to minimum variance. The autocorrelation of the sequential residuals may lead us to accept a model, all the coefficients of which are not in reality statistically significant.

We may assume that the autocorrelation of the policy model in question is caused by a "specification error", in that all the relevant variables are not incorporated in the model or the functional form is not adequate. In addition, the mode of construction of the variable Y^e_{t13}, where the compound variable was formed by combining successive obser-

Table 1. Estimated policy model for seedling stand improvements; expected income, Y^e_{t13}, and relative state subsidies, GL^d_t/SSI_t, as explanatory variables.

SSI_t	=	$-$ 6624,599	+ 94,732Y^e_{t13}	+ 65,768GL^d_t/SSI_t
$s(b_t)$	=	(1491,252)	(17,329)	(10,721)
t^*	=	(−4,4)	(5,5)	(6,1)
β	=		.443	.557
$\bar{R}^2$	=	.830 S.E.E. = 2358		D–W = 0,86
N	=	23		

Table 2. Estimated policy model for seedling stand improvements; expected income, Y^e_{t13}, relative state subsidies, GL^d_t/SSI_t, and business cycle variable, XW_t, as explanatory variables.

SSI_t	=	5781,099	+ 49,236Y^e_{t13}	+ 56,215GL^d_t/SSI_t	− 8073,281XW_t
$s(b_t)$	=	(5149,552)	(25,809)	(10,837)	(3865,933)
t^*	=	(1,1)	(1,9)	(5,2)	(−2,1)
β	=		.364	.586	.050
$\bar{R}^2$	=	.901	S.E.E. = 1799	D–W = 2,40	
N	=	23	Obs.: Hildreth-Lu -method; β-coefficients estimated before H–L -method.		

vations of primary variables, SV^d_t, may lead to autocorrelation.

By incorporating the business cycle variable XW_t into the model and reestimating the parameters by employing the Hildreth-Lu-method (see MADDALA, 1977, p. 277–284) we obtain the model estimation in table 2.

Adding the business cycle variable to the model and the reestimation by means of Hildreth-Lu -method, which takes account of the autocorrelation, improve the statistical properties of the model. The values of parameter estimates change somewhat, which is due to the Hildreth-Lu -method rather than the moderate multicollinearity between the explanatory variables. The constant term of the model, which in this equation is positive at the thought of a meaningful interpretation, is not however, statistically significant.

The actual (SSI_t) and the calculated values ($\hat{SSI}_t$) of the target variable are graphically represented in figure 2.

We may conclude from the results of the empirical policy analysis that annual variations of the seedling stand improvement area in private forests can be regulated by means of public forest policy by changing the proportion of state subsidies of total investment costs (per hectar). The state subsidies have a significant effect in stimulating investments, but the realization of investments is conditional with regard to the decision making of forest owners. The parameter estimate for the propensity to invest, being positive in sign, supports the hypothesis that the investments in silviculture are likely to increase, when the income expectations of forest owners are strengthened. So, seedling stand improvement works in Finland tend to be timed for the recession phase of the business cycles as determined by the exports of forest industries.

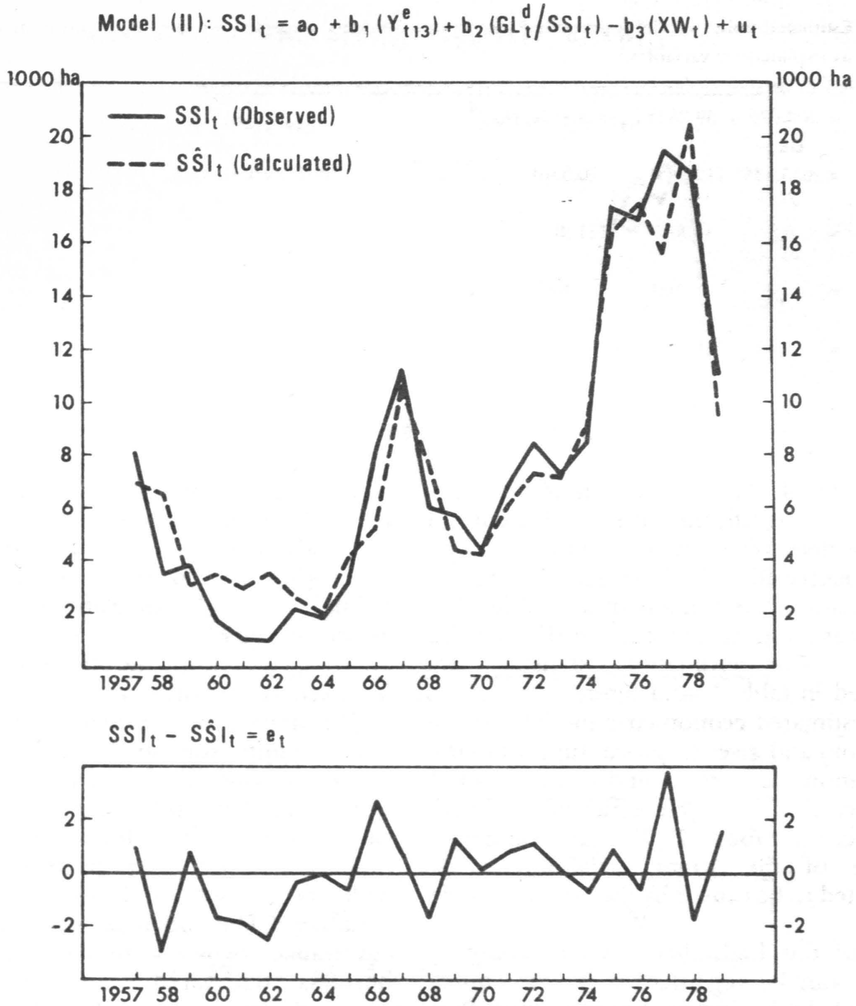

Figure 2. Policy model for seedling stand improvements; expected income, relative state subsidies and business cycle variable as explanatory variables. Observed and calculated values of target variable, SSI_t.

4.2.2. Total subsidies as a policy variable

As with the policy model concerning relative subsidies we will first estimate an equation comprising two explanatory variables using the total subsidies, $G1/3L^d_t$, as a policy variable. The estimation results are presented in table 3.

The parameter estimates for the propensity to invest and effectiveness of state subsidies are statistically significant at the 0,999 level. The estimate for the constant term is nonsignificant. The behaviour of the residual of the model is indicating a slight positive autocorrelation.

Concerning the adequate model specification, incorporating the business cycle variable in the model should improve the model with respect to both the autocorrelation and the goodness of fit. In addition, by employing this kind of stepwise procedure, in which the number of explanatory variables are either added or subtracted, we are able to obtain an idea of the stability of the parameters. If the multicollinearity is serious, the parameter estimates together with their variances may be sensitive to changes in the structure of the model.

The properties of the model improve by including the business cycle variable, XW_{t-1},

Table 3. Estimated policy model for seedling stand improvements; expected income, Y^e_{t13}, and total state subsidies, $G1/3L^d_t$, as explanatory variables.

SSI_t	= 209,076	+ 59,282Y^e_{t13}	+ 3,837$G1/3L^d_t$	
$s(\hat{b}_t)$	= (655,538)	(12,393)	(0,350)	
t^*	= (0,3)	(4,8)	(11,0)	
β	=	.160	.840	
$\bar{R}^2$	= .930	S.E.E. = 1511	D–W = 1,62	
N	= 23			

in the model. The constant term becomes statistically significant, the coefficient of multiple determination, $\bar{R}^2$, is improved and the autocorrelation is decreased. The values of the parameters remain quite stable. The model was reestimated using the Hildreth-Lu method. The estimation statistics are presented in table 4. and figure 3.

The estimated econometric model is quite satisfactory and gives empirical support to the specification of the underlying causal structure. From the β-coefficients we may conclude, that about 73 % of the explained variance of the target variable can be interpreted to be caused by the policy variable $G1/3L^d_t$.

Part of this high share of the explained variance can be regarded to be the consequence of the institutional relationship. Part of it, however, can be interpreted in terms of productive causality.

High values of multiple correlation ($\bar{R}^2$) are usual in econometric models based on time series data. This may merely be an outcome of the fact that the economic series employed in the analysis are either rising or declining, in which case there might be a common trend behind the high correlations. In research aimed at causal analysis, as in effectiveness analysis, recognizing the effects of such trends is of crucial importance.

The impact of a potential trend on the study results was analysed by estimation models in which the trend was eliminated by transforming the time series of the original variables into first differences. Difference models were estimated by using equations with both two and three explanatory variables. The obvious outcome of the covariance between the changes of the business cycle variable and the changes in expected income was that the parameter estimate of the business cycle variable was non-significant ($t^* = -1.3$). Table 5 presents the estimation of a difference model with two explanatory variables, i.e. changes of

Table 4. Estimated policy model for seedling stand improvements; expected income, Y^e_{t13}, total state subsidies, $G1/3L^d_t$, and business cycle variable, XW_{t-1}, as explanatory variables.

SSI_t	= 7765,263	+ 65,694Y^e_{t13}	+ 3,359$G1/3L^d_t$	– 7561,425XW_{t-1}	
$s(\hat{b}_t)$	= (2226,827)	(9,060)	(0,306)	(2158,298)	
t^*	= (3,5)	(7,3)	(11,0)	(–3,5)	
β	=	.223	.732	.045	
$\bar{R}^2$	= .950	S.E.E. = 1277	D–W = 1,76		
N	= 23				Obs.: Hildreth-Lu -method; β-coefficients estimated before H–L -method.

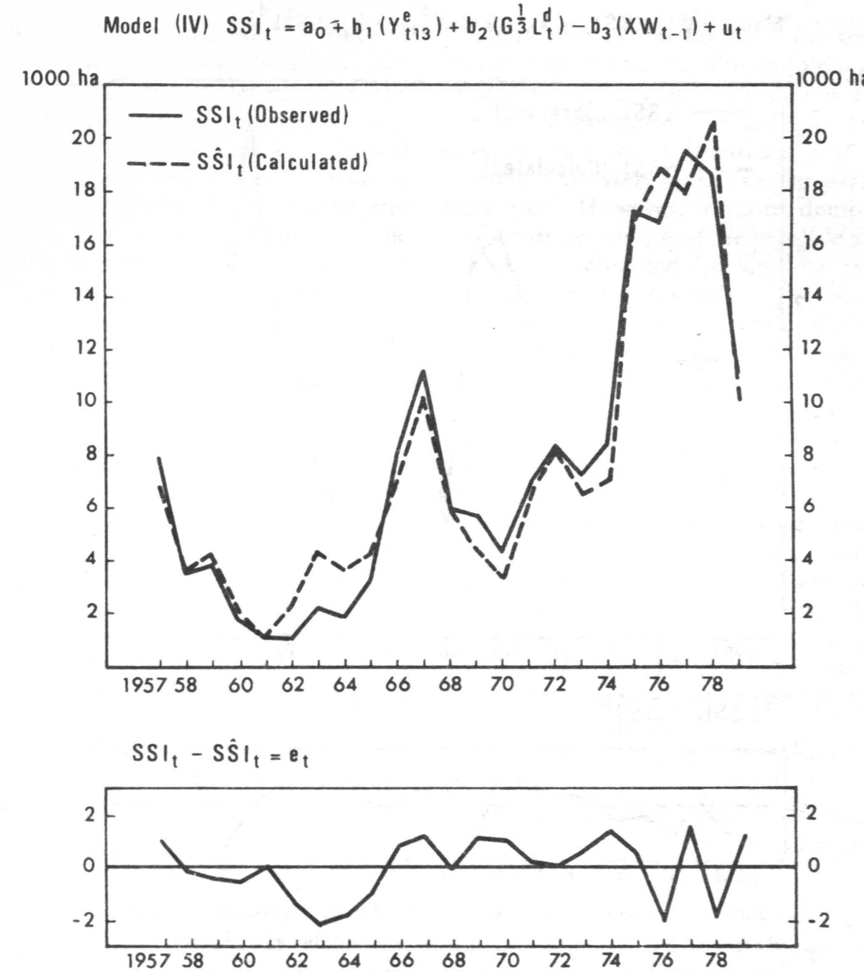

Figure 3. Policy model for seedling stand improvements; expected income, total state subsidies and business cycle variable as explanatory variables. Observed and calculated values of target variable, SSI_t.

Table 5. Estimated policy model for the changes of seedling stand improvements; changes of expected income, ΔY^e_{t13} and changes of total state subsidies, $\Delta G1/3L^d_t$, as explanatory variables.

SSI_t	= –73,642	+ 35,204 ΔY^e_{t13}	+ 5,163 $\Delta G1/3L^d_t$	
$s(\hat{b}_t)$	= (188,177)	(10,622)	(0,373)	
t^*	= (–0,4)	(3,3)	(13,8)	
$\bar{R}^2$	= .930	S.E.E. = 821	D–W = 2,26	
N	= 20			Obs.: Observations of 1978 and 1979 not included in estimation.

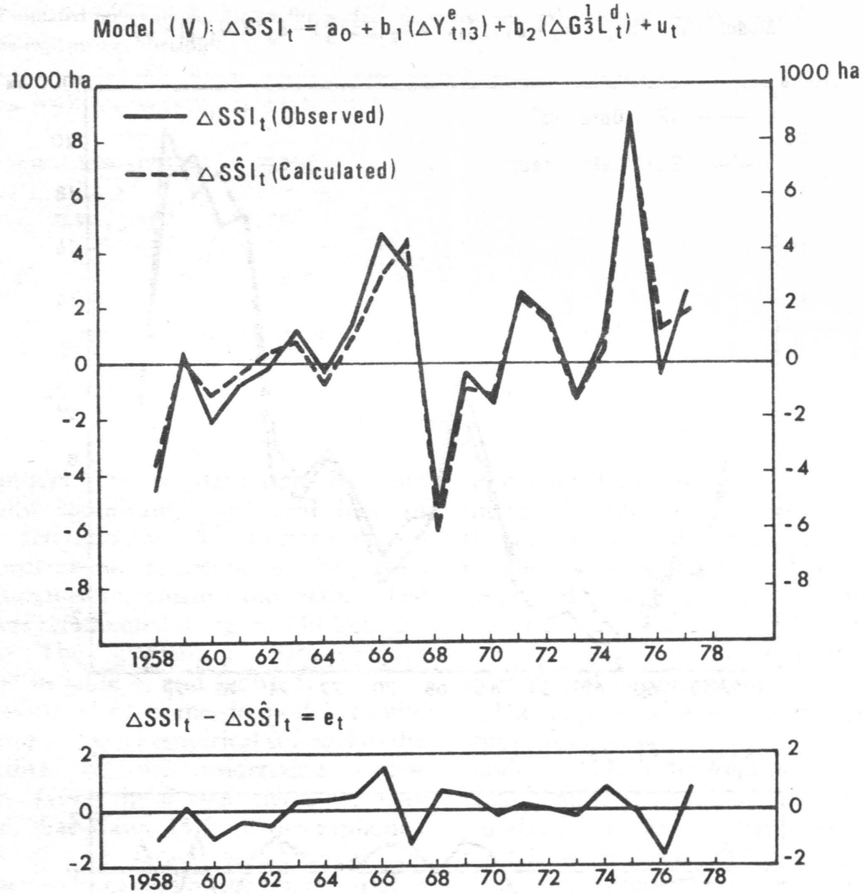

Figure 4. Policy model for changes of seedling stand improbements; changes of expected income and changes of total state subsidies as explanatory variables. Observed and calculated values of target variable, Δ SSI_t.

expected income, Δ Y^e_{t13}, and changes of quantitative policy measure, Δ $G1/3L^d_t$.

The first differences were obtained by transformation Δ $G1/3L^d_t$ = $G1/3L^d_t$ − $G1/3L^d_{t-1}$).

We have a reason to infer from the estimation results of the difference model, that the dependences included in the policy model are not spurious, due to the common trend of the variables, but true, denoting the underlying causal structure. The estimation result of the difference model is represented graphically in figure 4.

The difference model can also be regarded as a specification of the policy model to evaluate the short run changes. The effectiveness parameter of the model measures the change in investment produced by the (annual) change in the policy means employed by policy decisions.

The estimation experiments on the policy models being specified into the multiplicative form resulted in a better goodness of fit than the linear models, but due to the multicollinearity not all the parameter estimates were statistically significant. Estimation of the models was based on logarithmic transformations. However, the details of the logarithmic models will not be discussed here.

4.2.3. Changes in effectiveness over time

By means of the parameter estimate of the effectiveness of a policy model, we aim to evaluate the strength of the effect produced by policy means. Also, by means of the standard error of the parameter estimate, the determination of the goal-means relationship is evaluated. Along with these principal questions of effectiveness analysis – what is the impact of a policy means employed and how reliable the estimate is to measure the impact – in policy planning and decision making it is presupposed knowledge also on the stability of the effect. By examining the stability of parameters we try to find out if the effectiveness changes with time.

Because econometric analyses usually employ as long time series as possible, it is obvious, that the structure of the model changes in the course of time, especially in using annual data. If the estimated structural model is used for forecasting the effects, testing the stability is the more important. The parameter estimate obtained from the entire estimation period measures the average strength of the effect in the period concerned and the shifts of the function measuring the dependence do not appear. The determination of which factors at a particular time are causing the change with respect to the policy measure is the task of a separate analysis.

There are several methods for testing the stability of estimates. The simplest and very commonly employed approach is to divide the whole estimation period into two parts and to run the estimations for the two models, separately for the earlier part and the later part. However, a more demonstrative and accurate picture of the possible structural changes is obtained by stepwise regression analysis. In this procedure the observation period, being shorter than the original estimation period, is made to slide stepwise along the entire period by adding one or more observations to the end of the study period and removing corresponding number from the beginning. As an outcome of this procedure we obtain a time series of parameter estimates, the changes in which are explored to obtain an understanding of the stability of the estimates. Different tests have also been developed for detecting changes in the parameters. (See BROWN et al., 1975; ROUHIAINEN, 1979, p. 52–59). In this study the method of stepwise regression analysis was employed.

The changes in effectiveness were explored by reestimating policy model (IV) so that the model was first estimated for the study period 1957–69, then 1959–71 etc., the last period

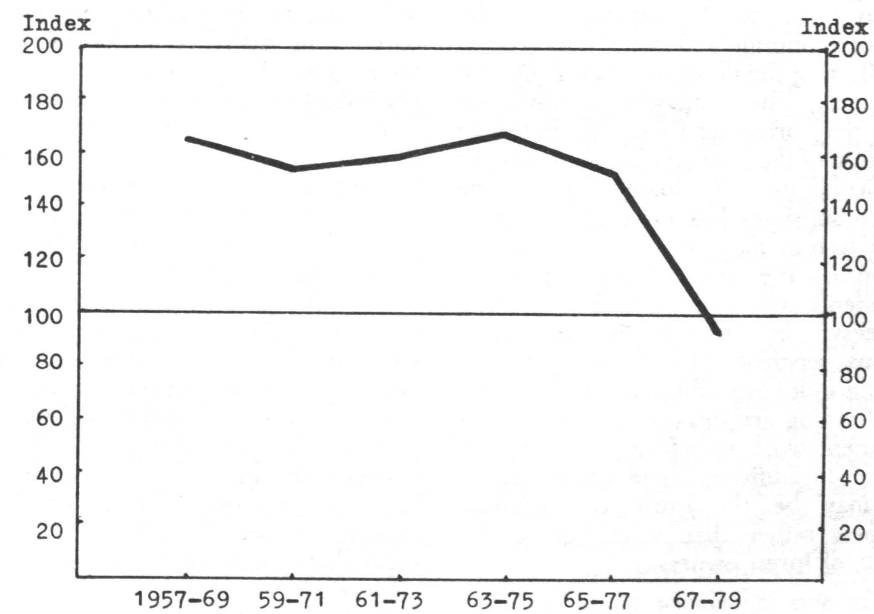

Figure 5. The stability analysis of the effectiveness parameter. The changes of the regression coefficient of the policy variable $G1/3L^d_t$ in 1957–79, as index numbers.

consisting of the years 1967–79. In order to have a more illustrative picture of the changes in the effectiveness parameter, the estimates were transformed into index numbers in such a way that the regression coefficient for the entire estimation period (1957–79) = 100. The results of the stability analysis concerning the effectiveness parameter of policy variable $G1/3L_t^q$ are presented graphically in figure 5.

An examination of the changes of the parameter estimate of the policy variable $G1/3L_t^q$ suggests that a systematic change in the effectiveness of the policy measure has occurred since the second half of the seventies. The change refers to a declining trend in the effectiveness: i.e. the increase in investments produced by increasing the total amount of state financing measures, has started to decrease.

In testing the stability, it should be noted that when the estimation period shortens, the multicollinear effects on estimation results are likely to increase. Thus, the values of the estimates are quite sensitive to the selection of the time span for estimation, i.e. the number of observations.

The background to the weakening effectiveness can be related to several causes. The change in the parameter as such may reflect the change in the investment behaviour, which, in turn, can be explained by the changes of economic and social background factors affecting the decision making. On the other hand, the changed behavioural response may originate from the change in the structure of the policy measure proper. In this particular case, the loans' share of the total state subsidies has increased. Thirdly, technical factors may be coupled with the expansion of the area of seedling stand improvements, which explain the declining effectiveness: by proceeding to more labourious working objects and circumstances the unit costs and hence the amount of state funding are increasing. The area of improvement work therefore increases at a lower rate. In addition, some administrative factors may be the cause of declining effectiveness rather than a change in the behaviour of forest owners.

4.2.4. Concluding remarks

From the results of empirical policy analysis concerning the effectiveness of public forest policy in Finland we can conclude that the quantitative forest policy means are of considerable significance in obtaining the forest policy goals pertinent to timber growing. By the regulation and allocation of the total amount of state funding and the proportion of subsidies to the investment costs, a policy maker is able to steer the extent and the type of silvicultural investments in private forests in the direction of the set goals.

In the years 1975–78, when the record of 18 000–22 000 hectars' annual level in seedling stand improvement was reached in the private forests of the Forestry Board District of Kainuu, the state funding (in real prices) was increasing heavily. There were also changes in eligibility terms of the grants, and loans began to accommodate seedling stand improvements. Testing the temporal changes in effectiveness referred to the increase of investments produced by the means concerned is obviously diminishing.

Allocation of public funding and resources to the promotion of private forestry does not alone guarantee the planning and execution of silvicultural measures. Part of the silvicultural activities, such as reforestation, belonging to the ordinary silviculture, are covered in many countries by legislation. Some silvicultural activities are, however, dependent on the decision making of forest owner, and on his propensity to invest. The forestry behaviour of forest owners is the intermediary causal mechanism, which ascribes to the interdependence between forest policy goals and means the nature of a behavioural relationship.

The estimation results gave empirical support to the hypothesis that the level of seedling stand improvement investments is dependent on the expectation of the future stumpage revenues. Also the difference model proved to be quite adequate in explaining the changes in the area of seedling stand improvements on the basis of changes in expected income. The inference can thus be made that changes in the expectation of forest owners due to e.g. the stumpage prices or shifts in forest taxation, are likely to cause a change in the investment behaviour.

The policy models also indicate that along with the factors attached to the public forest policy and the forest owners' economy, general economic factors have an impact on the extent of silvicultural measures. The fluctuations of seedling stand improvement works are coupled with the business cycles in the forestry and timber economy. The works are consciously allocated, because of employment aspects, in recession phases, when planning and labour force resources are released from roundwood marketing activities. The state subsidies appear to have an effect as an instrument of stabilization policy aimed at employment objectives.

With respect to practical forest policy planning the adequate timing and realization of state subsidies in relation to the business cycles presuppose qualitative forest policy means. Effectiveness in changing the terms of state subsidies, or of the budget, and hence the potential granting and loaning funds, may remain rather insignificant unless the contribution of professional aid, extension and training services to forest owners is associated with them.

Such a combination of measures, consisting of quantitative as well as qualitative policy means, which appears frequently in practical policy making, causes some methodological problems for the effectiveness analysis. By examining the effects of quantitative instruments at the aggregate level using time series data it has to be assumed that there is always incorporated in these effects the impacts of qualitative policy means. In the analysis of the separate effects of these various measures of administration and promotion organizations causal analysis at the micro level, i.e. the woodlot level, employing methods adapted from behavioural sciences, might be more suitable than the aggregate econometric approach.

The causal analysis at the woodlot level, originating from the behavioural sciences, is briefly reviewed in the following chapter. An estimated path model is employed to attempt to evaluate the effects of some qualitative forest policy means.

5. POLICY ANALYSIS AT THE MICRO LEVEL: EVALUATION OF THE EFFECTS OF QUALITATIVE POLICY MEANS

5.1. Path analytic approach

In the analysis of the effectiveness of public forest policy we are now shifting from dynamic macro models to static micro analysis. Micro level analysis aims at amending the contribution of time series analysis concerning the effects of quantitative policy means by means of examining the impacts of some qualitative means associated with forestry promotion activities. At the same time, we enter the field of behavioural sciences.

With regard to the policy analysis at the woodlot level, it is to be stressed the main theoretical and methodological principles of effectiveness analysis, i.e. the behavioural phenomena of the object of forest policy and the underlying causal structure including the impact mechanism of the policy itself, are to be identified. The purpose of policy analysis is to specify this causal structure and its modelling.

Valid specification is the central theoretical question – and also the main problem – of structural analysis. The deficiencies at the specification stage, as already stated in connection with the time series analysis, produce unreliable parameter estimates and may lead us to false inferences. Interdependences of explanatory variables are often linked with specification error. Strong multicollinearity enlarges the variance of estimates and may also have an effect on the size and even the signs of parameter estimates.

These central methodological problems have influenced the selection of the analytical method employed here. As an instrument for empirical policy analysis and a tool for causal interpretation of effectiveness, the technique of constructing multiequation models, known in behavioural sciences as path analysis is applied here. Path analysis is regarded in the field of social sciences as one of the most suitable tools of multivariate analysis for constructing causal models (cf. VAN METER

& ASHER, 1975, p. 65). In comparison to the ordinary regression models, by employing path analysis we are able to explore the indirect causal connections in addition to the direct effects (paths). Thus we have better possibilities to specify the causal structure and to make causal inferences on the impact mechanism. The adequacy of the model structure can be empirically tested on the basis of the basic theorem of path analysis and the specification of relationships revised on the basis of testing results.

By analyzing the direct and indirect interconnections we are also able to reduce the problems caused by multicollinearity. It may be emphasized, however, that path analysis is only a tool for quantifying and testing the theoretical model specification, and it by no means creates the causal structure of the model.

The result of path analysis, an estimated path model, is by its mathematical formulation usually a recursive multiequation model. The causal structure of the path model is presented by means of an arrow diagram, where the effects of explanatory variables on the variables to be explained are expressed by path coefficients. The path coefficients of the final path model, the specification of which is empirically tested and the structure of the model possibly reformulated, are standardized (partial) regression coefficients. Evaluation of the strength of direct and indirect paths is based on estimated path coefficients. The path coefficients of the policy variables may be interpreted as standardized counterparts of effectiveness parameters. With regard to the underlying assumptions, the properties and the methods of path analysis see e.g. BLALOCK (1971) and SCIOLI, Jr. & COOK (1975).

5.2. Specification and estimation of path model

The selection of the variable set for the forest policy model at micro level and the determination of their mutual interdependences are based on theories concerning the behaviour of forest owners. On this basis we may conclude that the productive resources of forest property together with the economic and social background factors of forest owners are the main explanatory factors for the timber sales and silvicultural behaviour. (see TIKKANEN, 1976, p. 380–385). Further theoretical consideration of the model specification will not be discussed here but the structure of the model and the contents of the variables used are briefly examined in connection with the presentation of the estimation results. The study material was obtained by a postal inquiry to the forest owners of two communes in Middle and South Finland (Nilsiä and Vihti communes).

The construction of the path model was begun with an examination of the exogenous background variables explaining the silvicultural behaviour of forest owners. In order to facilitate the causal interpretation of the model it was considered advisable to condense the information included in the covariance of several exogenous variables to describe it by means of a few basic dimensions. The original variables measuring productive resources of the woodlot and socio-economic background of the forest owner were therefore transformed by principal component analysis into compound variables, which were orthogonal principal component scores by their mathematical construction. In addition to the theoretical aspects concerning the use of principal component scores as exogenous variables in a path model there are also methodical arguments. The scores are statistically independent of each other and they therefore avoid the problem of multicollinearity. (Cf. KOUTSOYIANNIS, 1977, p. 251-252, 424–436).

Five principal components were employed, selected on the basis of both formal criteria concerning the changes in eigen values and the interpretative properties of the varimax solution. The five components' varimax model explained c. 60 % of the total variation of the variables in the principal component matrix, and is presented in Appendix 2.

The first principal component of exogenous background variables, P_1, was considered to describe a dimension measuring the amount of forest property (highest loadings on variables forest area of the farm, X32, total area of the farm, X29, total forest area owned by the interviewee, X33), the yield of forest property (assessed net yield of forestry, X25) and its quality (fertility of forest soil, X34). The second principal component, P_2, can be named after the variable measuring the place of residence of forest owner, which describes the accumulation of socio-economic properties connected primarily with non-farmer forest owners having a permanent residence in the town outside the farm. The high loadings on the third principal component, P_3, have the variables measuring agricultural prosperity and the capital intensity coupled with it. This is a characteristic of the study region describing the circumstances in South Finland. The variables measuring the age of the forest owner, the possession time of the estate and the living time at countryside are loaded on the principal component P_4. The fifth principal component, P_5 may be named after variable describing the social activity of forest owner.

The causal order of the endogenous variables in the path model is determined – along with the underlying hypotheses – by the objectives of policy analysis. In analyzing policy impacts, policy variables are placed as intervening variables in relation to exogenous background variables and the target variable. Thus the policy variables are also assumed to be determined by the environmental factors. The structure of the policy model thus enables the comparison of the direct effects of policy means with the direct and indirect effects of exogenous variables proceeding via policy variables. (Cf. DYE & POLLACK, 1975, p. 114).

The versatility of silvicultural measures (the number of different measures taken) on the farm (Y_9) is regarded as a target variable of the forest policy in the cross section analysis. The following qualitative forest policy means affecting the silvicultural activity are examined in the model: the professional aid offered by promotion organizations of private forestry (X_8 – the frequency of the visits of forestry expert on the farm) and the forestry extension and training addressed to forest owners (X_7 – participation of forest owner in forestry extension and training meetings). The operational counterparts of the policy variables used here are not "pure" policy variables with regard to their controllability. They can, however, be employed as proxy variables for the policy means in question.

In the first stage of the path analysis, path coefficients were estimated on all hypothetically relevant causal relations. The relationships which proved to be statistically non-significant were removed from the model and the structure of the model was respecified and estimated. Estimation experiments were also run on the direction of the causality between endogenous variables with alternative specifications. This was because it was reasonable to assume that the mutual relationships between intermediate variables were simultaneous rather than asymmetric and thus recursive in a causal sense. The result of the estimations, however, indicated, that the causal direction established on theoretical grounds in the model specification was also empirically stronger.

It is always advisable to include in path analysis tests of the behaviour of the residual terms. The outcome of the correlation analysis of residuals was that the residuals are linearly independent of the explanatory variables in each equation, as well as of each other. The graphical study of residuals instead was referring to that some ralationships would be nonlinear. The revision of the functional form by means of addition of the second order terms of variables, did not, however, improve the goodness of fit of the path model.

The estimated recursive path model for the impacts of forest policy on woodlot level is presented in figure 6. The estimation results of the equations are to be found in Appendix 3. The estimation results are evaluated by ordinary statistical criteria. We are also able to test the adequacy of the causal structure of estimated path model by comparing the empirical correlations between the variables to calculated correlations. Calculated correlations are reproduced on the basis of the basic theorem by summing up the path coefficients expressing both the direct and indirect causal relations. The comparison between the empirical correlations and the reproduced indicated that the structural analogy was in general quite satisfactory. (See Appendix 4.). The greatest differences were found between the variables X_6 and Y_9 and between X_7 and Y_9, which suggests that the causal structure within those connections is inadequately specified and is in need of additional explanatory variables in the model as well as a possible revision of the causal structure.

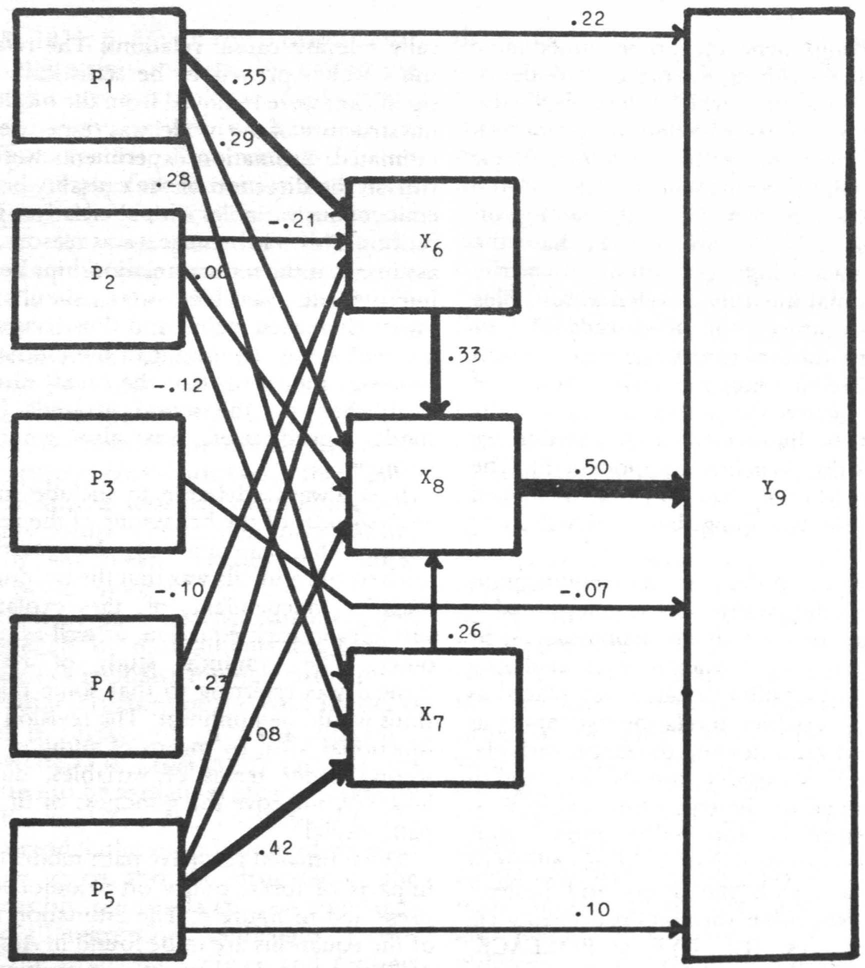

Figure 6. Path model for silvicultural activity. Effects of qualitative policy means at woodlot level.

5.3. Results of model estimation: effects of qualitative forest policy means

The causal interpretation of the path model is based on standardized path coefficients, the estimates of which are represented in the path scheme. Causal inferences on the policy variables of the estimated path model are directed to three main perspectives: the analysis of the determinants of policy means ("the demand factors"), and the examination of the strength of policy impacts, together with the study of the affecting mechanism.

Beginning with the exogenous determinants, we may infer from the size of the path coefficients that both policy variables, the use of forestry expert (X_8) and the participation in extension and training meetings (X_7) are to a considerable degree determined by the amount of forest property (P_1). Participation in forestry training is likely to be increased by the general social activity and the exposure to communication of forest owners (P_5). The disengagement from forestry through both the occupation and residence (P_2) reduce the activity and possibilities to participate in extension meetings.

The policy variable X_8 is a central intermediate variable in the causal structure of the path model. With regard to its determinants the estimation results indicate that, along with the forest property as a main exogenous explanatory variable, the frequency of timber sales, X_6, together with the other policy variable, X_7, explain the use of forestry experts. Increased frequency of timber sales is likely to increase the demand for professional aid, while participating in forestry extension and training further increases the willingness to use the services offered by the promotion organizations.

On evaluating the effects of the policy variables, we may conclude that the visits of the forestry expert to the woodlot is the most significant factor explaining the variance of the target variable Y_9. The frequency of forestry expert's visits is found to have a direct effect on the extent of silvicultural activities on the woodlot. The extension and training activities of the forestry promotion organizations, as a tool of public forest policy, appear to have a less direct impact on silvicultural investments. Rather, its effect is indirect, via the former policy variable. Among the exogenous background conditions the amount of forest property is, as expected, the most important explanatory variable of silvicultural measures. A significant part of its impact is indirect, rather than direct, proceeding via both the policy variables mentioned as well as via the timber selling behaviour.

Timber selling behaviour plays a central role, together with the measures of public forest policy, in explaining the silvicultural activities taken by forest owners. This obvious invariance at the micro level coincides with the results of the aggregate level econometric analysis. From the path model we may note that the frequency of timber sales increases with the increase of forest property and with the increase in forest owners' social activity. A negative relationship exists instead between the timber sales and the economic and social factors linked with the principal component, P_2, which measures primarily the properties of non-farmers. Non-farmer private forest owners, often living permanently outside their estate and whose socio-economic status is at a higher level than average, are not selling timber as frequently and regularly as the farmers do.

This dependence can be understood on the basis of information from outside the model, i.e. through teleological explanation originating from the goals of the forest owners. Among the goals pertinent to the forest property, the significance of forests as a source of money income is of greater importance to farmers than to non-farmers. In the non-farmers' economy the marginal nature of stumpage revenues is further emphasized when their income level increases. Similarly, the goals coupled with the multiple functions of forests are relatively more important to non-farmers than to farmers. Thus, differences between the timber selling behaviour of different forest owner groups may be explained by reference to the forestry goals for forest owners, also. (See TIKKANEN, 1978).

To summarize, the results of the policy analysis at the woodlot level contribute to the picture of the effects of public forest policy in Finland, produced by econometric time series analysis. Like quantitative forest policy means the qualitative means, coupled with the activities of the forestry promotion organizations play a significant role in attaining the timber production goals. Of these, the professional advice given by forestry experts, has a direct effect on silvicultural activities. Extension and training activities have an indirect effect by increasing the willingness of forest owners to employ experts on their woodlots.

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APPENDIX 1. Observed values of the variables used in policy models

	SSI_t hectares	G_t 1000FIM	L_t 1000FIM	Wholesale price index -79	GL^d_t/SSI_t FIM	$G1/3L^d_t$ 1000FIM
1954				.197		
55	2819	74		.193	136	383
56	5779	167		.205	141	815
57	7934	215		.222	122	966
58	3455	86		.240	104	358
59	3827	103		.241	111	427
1960	1775	57		.252	128	227
61	1049	33		.253	124	131
62	960	30		.257	122	117
63	2165	71		.265	124	267
64	1841	56		.286	106	196
65	3333	115		.298	116	385
66	8008	298		.305	122	978
67	11312	586		.314	165	1869
68	5977	273		.348	131	785
69	5702	251		.360	122	697
1970	4352	141		.375	86	376
71	6803	232		.394	86	588
72	8418	345		.427	96	807
73	7217	370		.503	102	735
74	8416	440	50	.626	93	730
75	17275	1286	727	.710	164	2151
76	16859	1573	1203	.791	208	2494
77	19491	2144	1787	.875	231	3132
78	18649	3761	1338	.919	297	4577
1979	11108	1552	364	1.000	172	1673

	SV^d_t FIM, millions	Y^e_{t13} FIM, millions	XW_t	ΔSSI_t	$\Delta G1/3L^d_t$	ΔY^e_{t13}
1954	37		1.102			
55	31		1.058			
56	20		.820	2960	433	
57	22	30	.881	2155	151	
58	21	23	.858	– 4479	– 608	– 7
59	21	21	1.027	372	69	– 2
1960	52	21	1.210	– 2052	– 200	0
61	55	28	1.159	– 726	– 96	7
62	31	45	1.048	– 89	– 14	16
63	43	48	1.043	1205	151	4
64	49	40	1.050	– 324	– 71	– 8
65	48	42	.948	1492	189	1
66	35	47	.879	4675	593	6
67	16	45	.842	3304	891	– 2
68	29	33	.952	– 5335	– 1084	– 11
69	84	24	1.058	– 275	– 89	– 9
1970	101	40	1.072	– 1350	– 321	16
71	70	75	1.060	2451	213	35
72	50	89	1.115	1615	219	15
73	180	73	1.160	– 1201	– 72	– 16
74	126	88	.903	1199	– 6	15
75	50	134	.679	8859	1421	47
76	102	121	.839	– 416	343	– 13
77	45	82	.909	2632	637	– 39
78	68	75	1.082	– 842	1446	– 7
1979	120	65	1.250	– 7541	– 2904	– 10

APPENDIX 2. Five principal components varimax solution of exogenous background variables of forest owners.

Original variables	P1	P2	P3	P4	P5	h_5^2
(02) study region			−.57			.49
(04) occupation of forest owner (social class by Rauhala)	−.54					.36
(05) permanent place of residence		.84				.73
(06) age of forest owner				−.89		.80
(07) educational background of forest owner		.58				.53
(08) activity in organizations					.75	.59
(09) number of newspapers read regularly					.68	.48
(10) level of household equipment		.40			.59	.57
(11) number of communication facilities					.62	.51
(12) duration of living in countryside		−.34		−.79		.76
(13) permanence of living on the estate		.76				.62
(15) shortest distance from residence to forest		.62				.43
(16) distance to nearest shop		−.54				.30
(18) distance to main village center		−.63				.46
(19) distance to nearest town		−.75				.67
(21) duration of possession of the estate				−.80		.65
(24) taxable total income		.42	−.33			.37
(25) assessed net yield of forestry	.81					.73
(26) assessed net yield of agriculture			−.77			.70
(27) total assets	.45		−.73			.76
(28) debts and liabilities			−.74			.61
(29) total area of estate	.94					.93
(31) arable area	.43	−.34	−.35			.54
(32) forest area (of estate)	.95					.91
(33) total forest area	.87					.77
(34) fertility of forest soil	.77					.62
(48) share of forestry income of total income	.40					.21
Eigen value	5.70	4.45	2.38	1.99	1.57	
Eigen value %	21.1	16.5	8.8	7.4	5.9	
Cumulative %	21.1	37.6	46.4	53.8	59.6	

APPENDIX 3. Regression Equations for Path Analysis

	Use of Forestry Expert (X8)	Participation in Forestry Extension Meetings (X7)	Frequency of Timber Sales (X6)	Amount of Forest Property (P1)	Place of Residence (P2)	Agricultural Prosperity (P3)	Age and Occupancy (P4)	Social Activity (P5)	100 R^2
Silvicultural Measures (Y9)									
– regr. c	0.5347	X)	X)	0.0029	X)	−0.0009	X)	0.0013	44.2
– its st. d.	0.0456			0.0005		0.0005		0.0005	
– stand. c (path c)	0.496			0.220		−0.066		0.100	
– t-value	11.7			5.4		−1.9		2.7	
Use of Forestry Expert (X8)									
– regr. c		0.2566	0.4143	0.0034	0.0008	X)	X)	0.0010	44.8
– its st.d.		0.0402	0.0496	0.0005	0.0004			0.0005	
– stand. c (path c)		0.264	0.335	0.285	0.063			0.080	
– t-value		6.4	8.4	7.2	1.7			2.0	
Participation in Forestry Extension Meetings (X7)									
– regr. c			X)	0.0035	−0.0015	X)	X)	0.0051	26.8
– its st.d.				0.0005	0.0005			0.0005	
– stand. c (path c)				0.281	−0.121			0.417	
– t-value				6.9	−3.0			10.3	
Frequency of Timber Sales (X6)									
– regr. c				0.0034	−0.0021	X)	−0.0010	0.0022	23.0
– its st. d.				0.0004	0.0004		0.0004	0.0004	
– stand. c (path c)				0.347	−0.212		−0.102	0.230	
– t-value				8.3	−5.1		−2.5	5.5	

X) path eliminated, not significant
N = 449

APPENDIX 4.

A Comparison of Reproduced Correlation Coefficients and Empirical Correlations.

Reproduced correlations are calculated from the basic theorem of path analysis, in which the empirical correlation can be decomposed into the sum of direct and indirect effects:

$r_{ij} = \sum_q p_{iq} r_{jq}$, where

i = the index of explanated variable

j = the index of explanatory variable

q = the index runs over all the variables from which paths lead directly to X_i.

(See e.g. DUNCAN, 1971, p. 121)

	P_1	P_2	P_3	P_4	P_5	X_6	X_7	X_8
Correlations calculated from the path model (Y_9)	.46	–.02	.07	.02	.23	.17	.13	.50
Empirical correlations (Y_9)	.46	–.03	.08	.04	.23	.35	.33	.63