A POLICY ANALYSIS MODEL AND THE DEVELOPMENT OF THE FINNISH FOREST SECTOR

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Abstract. The study aims to assess the potential of the forest sector to maintain its leading role in the Finnish economy. The long range future alternatives are simulated by means of a System Dynamics model called MESSU. It is shown that within the limits set by the availability of wood and the low profitability of the forest industry, the growth of total production in the forest industries cannot meet the projected increase in international demand with the present product mix.

MESSU covers the whole forest sector (forestry and the forest industry), which makes it possible to study the interaction between the different parts of the sector. The model is built up of seven submodels (modules): forest, forest ownership, roundwood market, harvesting, forest industry, end product market and capital market.

MESSU does not only consider economic features of the forest sector, even though they are a central part of the model. Biological (timber growth) and technical (e.g. efficiency of forest industry production and harvesting) features are also included. Further, sosio-economic issues, such as population, urbanization and labor supply dynamics, are considered.

BACKGROUND

Because of the rapid expansion of the production capacity of the primary forest industries in Finland, the annual allowable cut was temporarily exceeded at the beginning of the 1960s. This led to increased investments in forestry to guarantee sustainable yields in the future. Concern over the optimal allociation of forestry inputs was the first step towards building a forest sector model.

It became evident, however, that it was not reasonable to concentrate on wood production in isolation from the forest industry. Therefore, a project to construct a policy analysis model for the whole forest sector (comprising both forestry and the forest industry) was initiated in 1974. The aim of the project was to develop a tool for decision makers to study and evaluate the long-term consequences of different policy options. The model was completed in 1979.

STRUCTURE OF THE MODEL

In principle, the model is a System Dynamics one. The system Dynamics approach has, however, been applied in a rather liberal way. This means that the model is not closed but several exogenous variables based on historical data and estimated by regression analysis are linked to the basic structure of the model. The partial lack of a feedback system produces results which are more straightforward and less "surprising" than produced by an orthodox closed model.

The model, called MESSU, is built up of seven submodels (modules) shown in Fig. 1 (Seppälä, H. et. al. 1980).

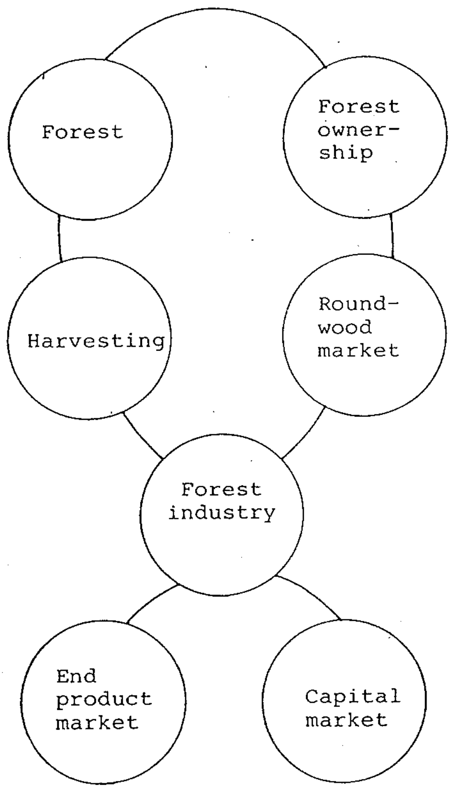

Fig. 1 The general structure of the MESSU model.

Forest describes the growth and the total standing volume of the forests in Finland and gives the physical limits to the domestic wood raw material available for the forest industry. With this submodel it is possible, for example, to investigate the consequences of different inputs to forestry and their effects on forest industry production in the long run.

Forest ownership. About 80 per cent of the cutting possibilities in Finland are in private non-industrial forests. This module describes the supply of roundwood from these forests. In addition to the allowable cut, the actual wood supply is determined in the model by forest ownership structure and income level.

The supply of and demand for roundwood meet on the Roundwood market. The stumpage price and the roundwood quantity exchanged are determined in this module. The relative market power of buyers and sellers is a decisive factor in prices. The demand for wood depends on the available production capacity. The supply depends, in the long run, on the allowble cut, forest ownership structure and general income level, as determined in the forest ownership module.

The submodel for Harvesting includes logging and transportation. In this module, a crucial problem is the relative development of capital and labor costs and their effect on the speed of mechanization of forestry operations. Also the supply of forestry labor is generated in this module and it is based on the degree of urbanization given by a population submodule.

The production capacity of the Forest industry is aggregated into one product and measured in equivalent tons. Only primary production of the forest industry (sawn timber, wood-based panels, pulp, paper, and board) is included. Although production is aggregated into one product, the structural changes in production can be taken into account with exogenous variables describing variable production costs and the refinement of product mix.

Capital market allocates external capital to the forest industry. In principle, income finance is used first, and only when this is not enough does the forest industry enter the capital market. The amount of external finance available is regulated by two different mechanisms.

End product market. The demand for and price of products are exogenous to the domestic forest industry. Changes in the market share affect the price, however, because it is assumed that the whole of production is always sold. Further, it is assumed that the competitors grow at the same rate as demand.

GENERAL FEATURES OF THE MODEL

MESSU is a long-range simulation model. The time horizon used stretches from 1955 to 2015. Business cycles do not appear in the model. Simulating the period from 1955 to 1980 gives a validity test to the model. The long-range approach in the forest sector is relevant because of the long rotation time of trees in Finland.

MESSU is an interactive model. The user of the model can, with independent decisions, influence the functioning of the model. This may take place either by using scenario techniques or by communicating directly with the model through a terminal.

MESSU is a typical policy analysis model. It is meant to give information about the structure and behavior of the forest sector. It does not necessarily give forecasts but produces alternatives for the future, based on different sets of assumptions.

MESSU is a holistic model. It considers the forest sector as a whole, which makes it possible to study the interaction between the different parts of the sector. The model produces information about the problems and bottlenecks to which research and decision making should pay special attention.

MESSU does not only consider economic features of the forest sector, even though they are a central part of the model. Biological (timber growth) and technical (efficiency of forest industry production and harvesting capacity) features are also included. Further, sosio-economic issues, such as population, urbanization and labor supply dynamics, are considered.

BASE SCENARIOS

A historical review shows that the 1960s appear to be a turning point in the development of the forest sector in Finland. The total drain (cuttings) and the market shares of the forest industries began to decline, while the real stumpage prices started to rise. Simultaneously, the real prices of forest industry products, especially those for pulp and paper, began to fall. Consequently, the sector's profitability began to show a downward trend.

Scenarios based on model runs show that the problems of the primary production of the forest industries in Finland have two main sources: domestic raw material constraint, and low profitability of the industry connected to a weak financial situation. The availability of wood raw material is not only constrained by physical availability (sustainable yield or allowable cut), but also by the decreasing supply from non-industrial forests and the scarcity of forestry labor.

The profitability and financial situation of the primary forest industries is in the long run closely connected to the availability of wood. Scarcity of wood tends to bid up the wood prices, which decreases industries' profitability. Scarcity of raw material can also cause the domestic forest industries to grow more slowly than competitors. Slow growth easily means relatively older production capacity than that of faster growing competitors. This can be prevented only with increased costs to replacement investments. In any case, total costs of production tend to rise, thereby decreasing profitability. Decreasing profitability may in due course become an even stronger limit to investments than the availability of the raw material. All this can cause the underutilization of forest resources, which weakens the state of forests and again decreases the cutting possibilities in the future. In an industry where production technology is international and tightly connected to the age structure of the production capasity (putty-clay technology), dropping from the markets' growth path may be fatal.

The above scenario suggests a somewhat depressing picture for the future of the Finnish forest sector. The run was based on some kind of a laissez-faire mentality, and the unfavorable development did not cause to stop it. Therefore, this scenario can be called a passive alternative.

In a number of other runs we have made a set of assumpions about actions that should be feasible in reality. In the passive alternative, both roundwood and forest labor supply, as well as the weak financial situation of the forest industry restricted the industrial capacity expansion. In an optimistic alternative we assumed that these restrictions can be dismissed in the future. The result was that we can only postpone the limits of growth because the physical raw material constraint (sustainable yield) will become effective sooner or later. This means that in Finland primary production has only limited growth prospects, and therefore, further refinement is the future strategic choice for the Finnish forest industry. We cannot, however, change the situation over night. Primary production will keep its dominating role until the end of this century and its problems cannot be overlooked.

SENSITIVITY ANALYSIS

Sensitivity analysis is one of the major problems with System Dynamics methodology. Usually system dynamicists, when doing sensitivity analysis, deal only with changes in individual parameters one by one.

Keloharju and Luostarinen (1982) have demonstrated how to use an objective function in a non-piecemeal sensitivity analysis. They also use an objective function to guide the automatic simplification of a model. The result is a model which has the simplest acceptable structure.

Luostarinen (1981) chose the MESSU model to probe the above simplification and sensitivity test idea in practice. The main result was that MESSU proved to be very insensitive to most of the simplification parameters as the model behavior remained practically unchanged. The most sensitive variables were those connected to the roundwood market. Especially, the mechanism which controls pricing in the roundwood market and the mechanism determining the supply of timber by forest owners were important. This indicates that by giving in the roundwood market module a more detailed structure, the whole model can be improved and might generate valuable new information for decision makers.

USER INVOLVEMENT

A policy analysis model has not very much value if it is not used. This might occur if the users have no trust in the model. An important precondition for the confidence is that the users are connected to the model building process (Seppälä, R. 1985). This was one of the main ideas when the project was started. For this purpose a reference group consisting of high level decision makers in different interest groups of the forest sector was established at the very beginning.

The selling of the MESSU model and its results succeeded very well. When the results were published, mass media and professional journals in Finland paid them a considerable attention. The members of the reference group distributed the message of the project efficiently and widely in their own organizations. The group itself continued its existence for several years after the completion of the model building. Thus, there is a good reason to believe that the user involvement succeeded in this project, and the model, and the scenarios produced by it have influenced decision making in the Finnish forest sector. This emphasizes the ethical responsibility of model builders who may have strong biases and paradigms.

CONCLUSIONS

Since the early 1960s, the modeling of separate parts of the forest sector has been increasingly popular in Finland. Timber growth models, harvesting simulation models, and land use models are examples or the numerous applications.

Nevertheless, models covering the whole forest sector were not common even worldwide before the 1980s. MESSU was among the first holistic models to be used in policy analyses.

The constuction of MESSU was partly based on a Nordic forest sector model SOS, developed by Randers et. al. (1978). There was an effort to "finlandize" the SOS model by re-parametrizing it, but this was not very succesful because of structural differences between the Finnish and the common-Nordic forest sectors (Kuuluvainen 1979). This experience demonstrates that the correct structure of a model is more important than precise parameter values.

The results based on model runs show that a passive, laissez-faire mentality may have severe consequences for the Finnish forest sector. The most crucial factor in the short run is the financial situation of the forest industry. Further, the human constraints in raw material availability should be properly taken care of if we do not want to waste the money invested in timber growing during the past two decades.

In the long run, physical raw material will be the ultimate constraint of the growth of the primary production of the forest industry. Further refinement is not tied to the raw material base in the same way. Also, raw material costs per unit of production can be considerably smaller than in primary production. A sound financial situation is, however, equally important in further refinement.

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