OPTIMAL SATISFACTION OF TIMBER DEMAND IN THE HUNGARIAN ECONOMY

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FOREWORD

The objective of the Forest Sector Project at IIASA is to study long-term development alternatives for the forest sector on a global basis. The emphasis in the Project is on issues of major relevance to industrial and governmental policy makers in different regions of the world who are responsible for forestry policy, forest industrial strategy, and related trade policies.

The key elements of structural change in the forest industry are related to a variety of issues concerning demand, supply, and international trade of wood products. Such issues include the development of the global economy and population, new wood products and substitution for wood products, future supply of roundwood and alternative fiber sources, technology development for forestry and industry, pollution regulations, cost competitiveness, tariffs and non-tariff trade barriers,

etc. The aim of the Project is to analyze the consequences of future expectations and assumptions concerning such substantive issues.

The research program of the Project includes an aggregated analysis of long-term development of international trade in wood products, and thereby analysis of the development of wood resources, forest industrial production and demand in different world regions. The other main research activity is a detailed analysis of the forest sector in individual countries. Research on these mutually supporting topics is carried out simultaneously in collaboration between IIASA and the collaborating institutions of the Project. This article represents part of the detailed analysis of the Hungarian forest sector. In particular, optimal production, consumption, and trade plans for timber have been studied for the entire Hungarian silvicultural sector.

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1. INTRODUCTION

Timber demand in Hungary can be satisfied only by considerable imports, while at the same time one-quarter of the domestically produced timber material is exported. Thus, considerable openness is characteristic of the production and turnover of silvicultural and wood industry sectors.

In 1980 the net timber import was approximately one-third the domestic consumption, namely 9.4 million m^3 roundwood equivalents. The imported timber is almost exclusively coniferous, while the exported timber is mainly broadleaved. Hungary's forest stocks — due to the natural conditions — do not satisfy the demand of domestic production for coniferous timber. The demand for broadleaved timber is lower than the supply, and so surplus products must be exported.

About 86% of Hungary's forest stocks consist of broadleaved timber, the remaining 14% comprising the different types of coniferous trees that are common in Europe. As a result of forest plantation undertaken for several decades, the possible wood removal has gradually increased, with forest area now about 50% greater than thirty years ago, an areal extension that will continue.

An essential strategic objective of Hungary is to reduce the net timber import, so the possible ways of achieving this need to be established. The National Planning Office felt that mathematical programming methods should be used in the analyses. Initially, in 1973, the sector model "Complex Industrial Utilization of Timber" was constructed, in which 1971 data were used. The results of the model, and the model itself are included in the present study. It was thus possible to carry out a structural analysis of wood economics using 1971 data.

The reason for constructing a new model was to enable an in-depth investigation of production and foreign trade in the whole silvicultural sector. We aim primarily to analyze the four following targets:

(1) Maximal profit (wood sector returns at the national economic level).

(2) Minimal deficit in the balance of total foreign trade.

(3) Minimal deficit in the balance of dollar trade.

(4) Minimal input at the national economic level, where the actual (1980) import price is taken as the national economic cost; for simplicity, imported products are treated as if used directly by the consumer.

2. CHARACTERISTICS OF THE MODEL

The model is concerned with the utilization of timber raw materials, and the process and utilization of primary timber manufacturing. Timber foreign trade is an integral part of both the raw material and manufacturing phases. So the model determines the utilization of the domestically produced timber material by taking into consideration export possibilities for raw materials; it determines the raw material supply by taking into consideration both domestic and imported material; and finally it determines the sale of manufacturing products by taking into account domestic sales, and import and export possibilities.

The silvicultural sector is dealt with comprehensively but in a considerably simplified form. (However, it should be noted that in future studies the production structure will be developed.) The external market is divided – for practical reasons – into two groups: rouble trade and dollar trade. Such a division is essential because much of the internal turnover among CMEA countries occurs under conditions different to those of the dollar trade, although since 1980 prices have followed trends in the dollar trade.

The foreign trade turnover among the socialist countries is, however, based on long-term agreements. Dollar trade also includes turnover in currencies other than the rouble, and thus, the two areas overlap.

The model deals with 12 groups of products. Namely, five types of raw material (log, other industrial timber, pulpwood, roundwood-and-chips from trees for panels, and fuelwood), and seven types of manufac-

tured products (sawn goods, other sawn industrial (mixed) products, veneer sheets (plywood) and block board, particle board, fiberboard, woodpulp, paper and paperboard, and nonmanufactured timber products).

However, the group "Nonmanufactured timber products" includes those raw materials that are *issued for final utilization at home* (for example, fuelwood and pitprops).

At the moment, products are not differentiated in the model by types of wood; later on, however, we plan — in agreement with the "Dynamic Model of the Hungarian Forest"[1] to develop this aspect in order to create a link between the models and to investigate the optimal utilization structure of wood removal determined by the Dynamic Model.

The five categories of raw material are those used in Hungary, but in practice they correspond (in an aggregated form) to those used by FAO. There is, however, one main difference; namely that roundwood-and-chips from trees is not a component of pulpwood, and includes raw material that is used for producing particle board and fiberboard in "agglomerated board production." The manufacturing categories differ slightly from those used internationally, which do not include "nonmanufactured timber products," a category which is essential for the operation of this model. Also, the category "other sawn industrial products" is not used internationally, but is here because of the different price and cost parameters of these products.

1) This model was elaborated by István Vályi and Ferenc Tóth.

In the model *all products are given in roundwood equivalents*, which provides a uniform treatment of the different manufacturing products and raw materials, a better survey of the processes, and rationalizes control of the data and the results. The verifying factors are not built into the model, but in further work we will link the roundwood equivalent to the normal unit of measure of manufacturing products.

The model is a general linear programming one. Its capacity bounds correspond to actual manufacturing capacities available in 1980 (upper bounds), and to actual domestic timber utilization (lower bounds).

Variables in the model are given below. Subscripts m and n refer to the different manufactured products and raw materials, respectively (both are listed above). The subscript f refers to different trading areas, namely H, the domestic; S, the rouble; and T, the dollar. X_n, S_n, and T_n are the volume vectors of raw materials from the domestic, rouble, and dollar trading areas, respectively. X_{nET} is the volume vector of raw materials exported to the dollar trade, where "ET" indicates the direction of sales on the external markets which, in compliance with present practice, can only be to the dollar trade for raw materials. X_{nmf}, S_{nmf}, and T_{nmf} are the volume vectors of marketing to the f trading area m manufactured products from n raw materials produced domestically, imported from the rouble area, and imported from the dollar area, respectively. I_{Smf} and I_{Tmf} are the volume vectors of manufactured products from the rouble and dollar trading areas, respectively.

Parameters of the model are as follows. P_{Xn}, P_{Sn}, and P_{Tn} are price vectors of raw materials produced domestically, from the rouble area,

and from the dollar area, respectively. P_{XnET} is the price vector of raw materials marketed to the dollar trading area.

The components of the domestic price vector of manufactured products obtained from different trading areas are set equal:

$$P_{XnmH} = P_{SnmH} = P_{TnmH} \ .$$

Similarly, for the price vectors of manufactured products obtained from different trading areas and marketed in the rouble and dollar areas, we set, respectively:

$$P_{XnmS} = P_{Snm} = P_{TnmS} \ , \text{ and}$$

$$P_{XnmT} = P_{SnmT} = P_{TnmT} \ .$$

c_{Xn} is the cost vector of domestically produced raw materials, and the vectors of processing costs of manufactured products from different trading areas are set equal,

$$c_{Xnmf} = c_{Snmf} = c_{Tnmf} \ .$$

P_{lSm} and P_{lTm} are the price vectors of manufactured products from the rouble and dollar trading areas, respectively. Note that in the case of foreign trade turnover, free on board prices are used.

We used the four target functions described earlier, two sets of conditions, and two sets of price parameters. In the first set of conditions we specified domestic wood removal, the volume of raw materials imported from the rouble trading area, and (with the exception of sawnwood) the domestic use of manufactured products as equal to the actual 1980 values.

In the second set of conditions, we specified as an upper bound for domestically used raw materials the wood removal potential of 1983 and 1984, and that smaller quantities of raw materials could be imported from the rouble trade than in 1980. Also, the actual (1980) values of domestic use were set as a lower bound, while the import of manufactured products from the dollar trade was set as an upper bound.

The *two sets of price parameters* are the prices of 1971 and 1980. When using the 1971 prices we optimalized the product structure only according to the first set of conditions, but at the same time values were calculated for all production structures.

Using this model we wanted to answer the following questions:

(1) What is the optimal possibility of satisfying domestic demand for timber, given the 1980 price conditions, actual domestic wood removal, timber manufacturing capacity, and import and export conditions? The *optimization criterion* is thus *"the most favorable foreign trade balance at the national economic level."*

(2) To what extent and how can the return from timber utilization and manufacture be improved, and, as well as optimal profit, what kind of a change would take place in the production structure of foreign trade and in the balance of timber foreign trade? The *optimization criterion* is thus *"returns at the national economic level."*

(3) How would the income of the silvicultural sector develop at the national economic level, and how would the balance of timber foreign trade change, if domestic demand (supposing the

import and export turnover to be that of 1980) were satisfied by minimalizing the total input of the sector at the national economic level? The *optimization criterion* here is thus the *"minimal input at the national economic level."*

(4) Finally, using the 1973 model, what impact do the changes in timber prices have on domestic and external markets and what was the impact of changing prices of timber removal and manufacturing between 1971 and 1980 on the optimal production structure? (This investigation was carried out using the above three targets.)

As a result of the optimization for two different price parameters (1971 and 1980) according to the four target functions and the two sets of conditions, and also of putting actual 1980-data through the first set of conditions, we analyzed 12 different optimal product structures.

3. RESULTS OF MODEL CALCULATIONS

Results of the linear programming analyses are summarized in the tables appended to this paper. From these results the following inportant conclusions canbe drawn:

(1) With the actual wood removal in 1980 a product structure could have been developed within which the balance of both the total and dollar foreign trade could have been improved. According to the analyses the net import could have been reduced by a maximum of 10%.

(2) The results using the second set of conditions indicate that utilization of wood removal possibilities and the extension of manufacturing lead to a further improvement of foreign trade balance.

(3) By comparing the results using the four target functions, it is seen that for price and cost parameters of 1980 and 1971 an improvement in foreign trade balance also has a negative effect. While the foreign trade balance is reduced, the returns at the national economic level decline as well.

(4) An increase in the returns can be realized by increasing raw material export and lowering domestic production, while negative balance of trade can be greatly improved by increasing domestic production and reducing the import of manufactured products.

(5) The results using 1971 price and cost parameters indicate that the optimal procurement, production and marketing structure has, essentially, not been influenced by the price changes between 1971 and 1980; only the product-mix of raw material imports was strongly affected by these changes. Thus, considering the products of the sector in total, no significant change in the price structure occurred.

(6) The results indicate that (considering the forest sector as a whole) the income at the national economic level (between 1971 and 1980) exceeded the cost by about 25 percentage points, so the income situation of the sector improved during

this period.

Thus, the model, despite heavy aggregation, can, by using different sets of conditions, price and cost parameters, and optimalization criteria, provide the opportunity to draw useful conclusions regarding the further development of this sector.

Linking this model with the Dynamic Model of the Hungarian Forest will enable study of the optimum procedures for removing timber in terms of the "silvicultural model" and the results of these investigations will aid the National Planning Office in the preparation phase of decision making.

Since the product structures of the two models do not significantly differ, their harmonization will be relatively simple. The product structure will also be compatible with that of the Global Trade Model of IIASA.

The calculations were carried out at the Computer Centre of the National Planning Office. I thank Mrs. Hennel and Mrs. Poór for their active participation in this work.

APPENDIX

Table 1. Results (in percent of 1980 (1) attainment) from the model analysis of the targets (1) to (4) listed on page 2.

A. 1980 values and prices, first set of conditions

	(1)	(2)	(3)	(4)
Income	100.0	100.4	100.5	95.2
Total import surplus	100.0	99.6	98.9	111.3
Dollar import surplus	100.0	96.7	98.3	132.1
Cost	100.0	101.1	101.1	97.0
Profit	100.0	98.0	98.4	89.2

B. 1980 values, 1971 prices, first set of conditions

	(1)	(2)	(3)	(4)
Income	53.5	53.9	54.0	50.7
Total import surplus	74.5	74.3	73.1	80.0
Dollar import surplus	82.3	77.5	79.9	98.1
Cost	61.2	62.5	62.3	59.9
Profit	27.4	26.2	27.1	21.1

C. 1980 values, second set of conditions

	(1)	(2)	(3)	(4)
Income	99.3	98.2	97.9	93.6
Total import surplus	86.2	82.7	81.8	92.3
Dollar import surplus	70.6	59.3	62.2	87.1
Cost	95.0	94.1	93.6	89.9
Profit	113.1	111.4	111.7	105.4

Table 2. Utilization of wood raw materials for targets (1) to (4).

A. 1980 values and prices, first set of conditions

	(1)	(2)	(3)	(4)
	1000 m^3EQ[a]	%[b]	%[b]	%[b]
Export	671	99.4	99.4	122.4
Sawn wood production	2481	100.0	100.0	90.4
Other sawn industrial products	196	88.3	100.0	92.9
Veneer sheets, plywood and blockboard products	72	125.0	125.4	100.0
Particle board products	319	114.1	116.3	111.9
Fiberboard products	248	100.0	100.0	86.7
Woodpulp products	275	100.0	100.0	98.9
Nonmanufactured	3231	100.0	100.0	100.0
Stock change	172	100.0	100.0	100.0
Total	7665	100.5	100.9	98.7

a) Roundwood equivalents.

b) Percent of target (1) in 1980.

B. 1980 values, 1971 prices, first set of conditions

	(1)	(2)	(3)	(4)
		%		
Export	100.0	100.0	100.0	122.4
Sawn wood production	96.1	100.0	99.9	90.6
Other sawn industrial products	100.0	88.3	100.0	86.7
Veneer sheets, plywood and blockboard products	125.4	125.0	125.4	109.7
Particle board products	114.1	114.1	123.2	111.9
Fiberboard products	110.5	100.0	110.5	86.7
Woodpulp products	100.0	100.0	100.0	98.9
Nonmanufactured	100.0	100.0	100.0	100.0
Stock change	100.0	100.0	100.0	100.0
Total	99.9	100.5	101.5	98.7

Table 2. (Cont.)

C. 1980 values, second set of conditions

	(1)	(2)	(3)	(4)
			%	
Export	131.0	117.5	115.5	101.6
Sawn wood production	104.6	105.9	104.6	99.8
Other sawn industrial products	104.1	88.3	104.1	90.3
Veneer sheets, plywood and blockboard products	125.4	125.4	125.4	120.8
Particle board products	121.6	134.2	136.4	112.5
Fiberboard products	100.0	100.0	110.5	71.8
Woodpulp products	100.0	100.0	100.0	100.0
Nonmanufactured	100.0	100.0	100.0	100.0
Stock change	100.0	100.0	100.0	100.0
Total	105.5	104.8	105.1	99.6