ON THE PRICE ELASTICITY OF THE SUPPLY OF SAWNWOOD FOR EXPORT

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SUOMENKIELINEN SELOSTE:

SAHATAVARAN VIENTITARJONNAN HINTAJOUSTO

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Foreword

The present investigation was prompted in a way in 1953 when I completed the study of the fluctuations in sawnwood imports by the U.K. (Comm. inst. forest. fenn. 41.7). My intention was to supplement this by studying the sawnwood market from the standpoint of the exporting country and the producer.

By 1954 I had outlined the general plan of the investigation and began to collect empirical material. It appeared, however, that the empirical part of the work required material from a longer period after World War II than could be obtained at that time. The completion of the work was consequently postponed. In the meantime, ERVASTI published in 1959 a study (Acta forest. fenn. 68.2) which dealt in part with the same problems as the present paper. I decided nevertheless to complete and publish the work hoping that it will make a contribution to the views, in particular theoretical views, concerning the price elasticity of the supply of sawnwood and the cyclical problems of the sawnwood market.

I owe a great debt of gratitude to Professor PENTTI PÖYHÖNEN who gave me expert assistance in the statistico-mathematical part of the investigation, and to Mr. HANNU VÄLIAHO who made the calculations. The Finnish Sawmill Owners'Association and some of its member firms have aided this investigation by giving me or helping me to collect empirical material. Mr. EINO HOLOPAINEN assisted me in the collection and computation of the material. Mr. VEIKKO PALOSUO read the first draft of my manuscript and made some valuable comments on it.

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Contents

1. Introduction. The purpose and method of the investigation

The reactions of supply and demand associated with fluctuations in prices and income have attracted great attention in recent market research. Econometric methods have been used successfully in the analysis of these reactions, especially in analysing the demand for agricultural products. Examples of publications in this field are the investigations of WOLD (1940) and in Finland PIHKALA (1941), KOIVISTO (1953), HAIKALA (1956) and KAARLEHTO (1959).

Econometric methods have been applied on a very small scale only in analysing the demand phenomena affecting the timber market. One reason for this is probably the specific nature of the demand for forest products. These commodities generally do not serve consumption as directly as e.g. many agricultural products (milk, eggs, butter, etc.). They are used chiefly as raw materials or intermediate products in the production of dwellings and other buildings, means of transportation etc., packaging and so on. The absence of reliable data on utilisation, sales and stocks, also, has made calculations difficult.

The forest-products demand analyses made so far have concentrated principally on the long-term correlation between utilisation and certain variables (national income, prices, etc.) with the especial aim of drawing up prognoses of need and use (see FAO 1953, STREYFFERT 1957). Relatively little use has been made of mathematico-statistical methods.[1]

As far as marketing is concerned, a review of the influence on marketing of the different marketing tools (e.g. price) has a special interest in addition to these relatively long-term forecasts. Countries which have a considerable international trade in forest products take, moreover, a notable interest in the question: what reactions do variations in the different marketing tools, e.g. prices, cause in the import and export quantities? This kind of study is greatly facilitated by the fact that fairly reliable statistics are available on foreign trade for most countries.

Certain progress has been made in recent times with the application of econometric methods to the problems of international trade. Attention has been paid to the ways in which the supply of and demand for various commodities

[1] When the present paper was nearly ready for the press I had access to the interesting investigation by GREGORY (1960) in which use was made of regression analysis in surveying the demand for forest products also over a short period.

and commodity groups respond to changes in price and income in different countries. An example of empirical studies in this field is the work by CHANG (1951) in which the income and price elasticity of commodity groups was assessed for Great Britain and its trading associates and balance of payments problems etc. were studied on the basis of the results obtained.

It is customary to distinguish between several different elasticities in studies of the theory of foreign trade, especially exchange rates and balance of payments. ROBINSON (1950) distinguished the following four elasticities:

1. the foreign elasticity of demand for export;
2. the home elasticity of supply for export;
3. the foreign elasticity of supply for imports;
4. the home elasticity of demand for imports.

All four are price elasticities.

CHANG (1951, pp. 40, 48) differentiated between four elasticities in the cyclical changes of imports:

1. the income elasticity of demand for imports;
2. the price elasticity of demand for imports;
3. the price elasticity of substitution of home-produced goods for imports;
4. (in some cases) the export elasticity of demand for imports.

For the variations in the quantity of exports of a country Chang used as variables:

1. changes in the level of world real income;
2. changes in the export prices of that exporting country;
3. changes in the prices of substitutes supplied by the competitors in world market.

Chang also determined empirically the import elasticities in the foreign trade of Great Britain for the period 1924—38.

The examples cited show that the price elasticities of both exports and imports are generally accepted concepts in economics. On the other hand, elasticity is a central concept also in marketing. By knowing, for instance, the elasticity of their product the vendors can estimate the opportunities available for using the price factor in sales policy.

The present investigation is concerned with the price elasticity of one of the most important products in the marketing of forest products, i.e. sawnwood. For reasons elaborated in Chapter 2 the present work concentrates on the price elasticity of sawnwood *supply* for export.

The supply of sawnwood for export refers here to the *joint attitude* to price changes of all producers participating in the market. Price elasticity defined

in this way is associated with the "marketing strategy" of the buyer rather than the seller, it is true, but this point of view also merits attention in market research.

The price elasticity (E_p) of sawnwood supplies for export can be expressed briefly by the following formula (ROBINSON 1950):

$$E_p = \frac{\frac{dQ}{Q}}{\frac{dP}{P}} \qquad (1)$$

in which

dP = a (small) increase (decrease) in the export price (P) of sawnwood,
dQ = a corresponding increase (decrease) in the supply of sawnwood for export.

Before it is possible to make sense of the empirical results concerning the price elasticity of sawnwood supplies it is important to establish a basic theory for the problem. This involves finding an answer especially to the following questions:

1. Is the price factor in its relation to the sawnwood supply so "given", so "independent", that its use as self-dependent variable is justified?
2. What possibility does production, i.e. technical-economic conditions of the sawmill industry, offer for the adaptation of supply to price changes?
3. How can the price elasticity of supply be measured empirically? With this question is associated:
4. What is the reaction time of supply, i.e. the time within which supply responds to price changes?
5. Which factors other than changes in export prices (e.g. domestic sales) affect the changes in supply?

These basic questions will be considered first. Principally, the aim is to contribute to the study of the underlying factors of this particular elasticity problem. The empirical calculations at the end of the paper are made to check the conclusions reached.

2. Price elasticity of demand or of supply?

The concept price elasticity of supply implies implicitly the idea that price variations are a "given" factor independent of supply. It is just the mode of reaction of supply to the changes of the independent variable price that is measured by the elasticity coefficients.

This point of departure is in a way contradictory to the general view that price formation is the result of the joint effect of supply and demand. It is perhaps more justifiable in the sawnwood market than, for example, in the market for the majority of consumer goods. This is so firstly for the reason that the *utilisation of sawnwood is* — within certain limits — *relatively independent of prices.* In its most important fields of use — housing, non-residential building, shipbuilding, packaging, etc. — sawnwood usually constitutes such a small part of the manufacturing costs of the end product that its price fluctuations exert no appreciable effect on the decision to manufacture the end product. Building, for instance, and at the same time the amount of sawnwood used for building, depend first and foremost on the general economic situation. The annual use is thus determined decisively by the sawnwood user's decision to proceed with a job, and this is largely independent of prices. On the other hand, as will appear from Chapter 3, sawnwood supply can vary relatively greatly.

When examining the relation between import demand and *supply for export*, there is another characteristic of the international market for sawnwood that should be remembered: the most important buyers (Great Britain, Germany, U.S.A.) are leading countries in world economy and commerce and thus possess a great trading power, whereas — the U.S.S.R. excepted — the most important exporters (Sweden, Finland, Austria and Canada) are relatively small countries. The economic conditions regulating the demand for sawnwood are thus fairly independent of any measures that the exporting countries might take, i.e. the exporting countries must adapt their supply at a given time to the market in the buyer countries.

The primary position of demand in price formation of sawnwood appears also in practice in that the importer usually makes an offer first — often on the basis of the seller-producer's stocknote — and it is accepted or rejected by the latter or changes are proposed by the latter.

The *price elasticity of* sawnwood *utilisation* in the short-term view is thus — when the range of price fluctuations is moderate — relatively small. The situation is somewhat different in the long-term view, for a long-term price climb in relation to the prices of other materials can lead to the use of substitutes. Furthermore, a price climb may lead to more effective economy of materials (cf. FAO 1957, pp. 47—48). Technical factors, traditions, etc., however, tend to discourage substitution and it may be assumed that the effect of substitution — so-called cross elasticity — is negligible in a short period, e.g. 1—5 years. It begins to have significance in the course of for instance a ten-year period.

Between the end use of sawnwood and export demand are interposed the *stocks* held by importers and dealers. These, and partly also users' stocks, make it possible to conform purchases to some extent to suit the fluctuations in prices, and they also have the effect that *the price elasticity of import demand may be greater than the price elasticity of user demand.* My empirical studies

(1953, pp. 80—81) of the price elasticity of the sawnwood imports of Great Britain, however, suggest that there is not always a logical correlation between the annual series of prices and import quantities.[1]

Demand and in a great degree also price are thus primary factors in the marketing of sawnwood. To these factors supply reacts differently in different situations, and thus reaction can naturally cause "secondary" price effects. Ruist and Svennilson (1948, pp. 44—45), examining the timber markets in the inter-war years from the standpoint of Sweden (Norrland), also emphasised the importance of the general market situation, independent of exporters, in the price formation of sawnwood. Reference was made to this circumstance from the Finnish viewpoint e.g. by Halme (1955, pp. 22, 58). This means also that price has no notable role in the marketing strategy of the exporters, taking them collectively. Producers cannot exert any great effect on total sales by price manipulation. Their action parameters consist primarily of the adaptation of the quantity offered and the production costs to the prevailing market and price conditions (cf. Schneider 1960, p. 67).

It is thus justifiable to adopt as the starting-point the way in which sawnwood supply rather than sawnwood demand reacts to prices, i.e. the price elasticity of supply. This point was emphasised also by Ruist and Svennilson (1948, pp. 44—45, 110).

It should be stressed that the price paid by the user in the importing country and the price set by the exporter are two different things. As sawnwood is marketed by the Nordic countries chiefly on fob (or more correctly fas) terms, the exporter is interested above all in the fob price in the currency of the exporting country (in sawnwood trade the fas price) and its fluctuations. Freight variations in particular can cause changes in the price to the user even when the fob price is stable. On the other hand, *changes in the exchange rates* can cause variations in the fob price of a certain country which need not affect the user's price in the importing country. These price changes are in fact, for supply for export, a unique "given" price factor which should be considered in studying the elasticity of supply.

The view that demand determines price in the sawnwood market is an oversimplification. The disturbance of equilibrium leading to the price change can also originate in supply. Besides, the number of important exporter countries is so small that unexpected changes in the exports of just one of them can disturb the balance of supply and demand and affect prices. An example of such development is the vigorous increase — indifferent to prices — in exports

[1] The correlation between prices and imports is complicated by the fact that sawnwood import contracts are often made several months before delivery. This can be largely obviated in annual series, however, by using the mean import price to illustrate the yearly price fluctuations.

by the U.S.S.R. in the 1920s. Other instances in which the attitude of supply influences price formation will be cited below. The view should be modified to read as follows: demand plays the primary and supply the secondary role in the formation of sawnwood prices.

3. Production conditions (structure of production costs) in the sawmill industry and elasticity of supply

The conclusion reached is that the utilisation of sawnwood is fairly "insensible" to moderate price fluctuations in the short-term view. To be able to draw conclusions concerning the elasticity of supply it is necessary to examine the extent to which production conditions in the sawmill industry make elastic supply possible. The following factors especially are of significance in this respect:

a. the capacity of the sawmill industry in ratio to its "normal" (average) output, i.e. the degree of utilisation of capacity;
b. structure of the production costs;
c. length of the production process.

Factors a and b will be discussed in this chapter.

There is generally a fairly great amount of unutilised production capacity in the sawmill industry in a "normal situation", i.e. average production and demand. Proof of this is e.g. the great yearly fluctuations in output. Several sawmills operate below capacity, and a number do not work at all. This is true of sawmills working for the export, but even more so of sawmills providing for local needs. Many of the latter type of sawmill can be used when necessary for export sawing.

The following example is illustrative of the capacity conditions of the sawmill industry. According to a calculation made in 1954 by the Finnish Sawmill Owners' Association (FSOA 1954, p. 23), the 207 sawmill companies in Finland regularly engaged in export work had 330 sawmills. The number of sawmills engaged temporarily in export work was 2 200, 700 of them mills with frame saws (according to the 1953 Census of Production). Farms had 810 frame saws and 11 460 circular saws (according to the 1950 agricultural census), and there were an additional 8 000 mobile circular saws in the country.

There are great variations in the output of small sawmills in particular. This appears from the statistics collected and made available by the FSOA on the annual changes in output of sawmills of different size classes (Table 1). The

Table 1. Changes in the annual output of Finnish market sawmills, by size classes, 1951—59.
Taulukko 1. Eri suuruusluokkiin kuuluvien markkinasahojen vuosituotoksen vaihtelut v. 1951-59.

Year — *Vuosi*	Size class (according to annual output) *Suuruusluokka (vuosituotoksen mukaan)*			
	A (—3 000 stds)	B (3 000 — 10 000 stds)	C (10 000 + stds)	Total — *Yhteensä* A — C
	Output — *Tuotos* (1955—59 = 100)			
1951	70.4	160.4	107.8	111.3
1952	77.0	100.4	88.2	89.2
1953	..	..	..	91.8
1954	..	..	..	108.7
1955	135.4	109.5	102.0	112.9
1956	81.4	91.3	83.0	85.5
1957	57.5	82.7	99.0	87.0
1958	108.0	101.4	101.2	104.2
1959	117.7	115.0	114.8	117.1

Source: Finnish Sawmill Control Organisation.
Lähde: Sahojen Valvontayhteisö.

different behaviour of large and small sawmills is attributable primarily to the different structure of costs: the proportion of fixed costs is greater in large than in small sawmills. Another factor affecting the situation is that large sawmills often form a part of large-scale forest industry establishments (enterprises e.g. using chips from sawmills in the production of chemical pulp). In addition, the large sawmills generally have well-established and well-known brands which improve their sales opportunities compared with the less well-known brands of small sawmills.

It should be emphasised that the participation of a small sawmill in export production is probably more dependent on price changes than is the case with large mills. The social obligations of a large-scale company probably also have a role in the matter.

Production capacity is thus generally not an obstacle to elastic supply. The question is primarily whether *production costs* permit it. To evaluate this point I collected material on the structure of sawnwood production costs in three companies engaged in the sawmill industry. The data were given as answers to a questionnaire in which the grouping of costs was taken from the cost calculation worked out by the FSOA (Sahateollisuuden kustannuslaskenta, 1946).

The cost figures refer to one sawmill of each company. The sample sawmills were in different parts of the country. Sawmill A was close to the southern coast (received its raw timber partly by floating, partly by motor transport, and sent the finished goods by rail to the export harbour). Sawmill B was in Northern Finland on the coast (received its raw timber almost exclusively by floating, shipped the goods direct from the mill timber yard). Sawmill

C was relatively far from an export harbour in the eastern part of Southern Finland (received its raw timber chiefly by floating but partly also by motor transport, and sent the finished goods by rail to the export harbour). Sawmills A and B were medium-sized or large export sawmills which sold a part of their production at home; sawmill C was a fairly small establishment. The sample sawmills thus illustrated the different production conditions in Finland, but the cost structure as seen from these samples must not, of course, be taken to represent the means for the different areas and sawmill sizes.

The production costs fas per standard of sawnwood (excluding cdd) were distributed into cost items of different nature according to the means for 1955 and 1959 as shown in Table 2.

Table 2. Sawnwood production costs, fas (distribution of costs per standard, %).
Taulukko 2. Sahatavaran tuotantokustannukset laivansivussa (fas).
(Kustannusten jakautuminen standarttia kohden, %)

	Establishment — *Saha* A	B	C
A. According to cost categories — *Kustannuspaikkojen mukaan*			
1. Stumpage price — *Raakapuun kantoraha*	41	25	..
2. Logging, haulage and long-distance transport *Hakkuu, ajo ja kaukokuljetus*	17	38	..
3. Other raw timber costs — *Muut raakapuukustannukset*	4	3	..
1-3. Total raw timber costs (price) at the sawmill *Yhteensä raakapuun kustannus (hinta) sahalla*	62	66	57
4. Actual cost of processing *Suoranaiset valmistuskustannukset*	29	22	33
5. Selling, despatch and shipping costs *Myynti-, lähetys- ja laivauskustannukset*	9	12	10
1-5. Total of costs fas — *Yhteensä kustannukset laivansivussa*	100	100	100
B. According to the nature of the costs *Kustannusten luonteen mukaan*			
1. Price of sawlogs at the sawmill *Raakapuun kustannus (hinta) sahalla*	62	66	57
(Of this the share of fixed costs) *(Tästä kiinteiden kustannusten osuus)*	(2)	(3)	(..)
2. Variable costs — *Muuttuvat kustannukset*	29	27	31
3. Fixed costs — *Kiinteät kustannukset*	9	7	12
1-3. Total of costs fas — *Yhteensä kustannukset laivansivussa*	100	100	100

In calculating the costs the production costs of sawnwood prepared for sale in a certain year included the real costs of the raw timber etc. which had been met earlier, i.e. the pricing of e.g. raw timber was the price when it was logged and not when the end product was sawn.

It may be mentioned that the forest industry's costs in 1953 were studied by a State committee. It found that sawnwood costs were made up as follows (see Puunjalostusteollisuuden . . . 1953):

1. Wood raw material costs	68 per cent
2. Direct production costs	18 » »
3. Overhead costs	6 » »
4. Sale and export costs	8 » »
Total	100 per cent

The committee probably did not use a material fulfilling the requirements of a scientific basic material. Moreover, the report was concerned with another period and the costs were classified somewhat differently from those of sawmills A-C. Hence the results are not fully comparable. For all that, they reveal a certain similarity.

SAARI's (1932, p. 109) investigation gives an idea of costs during the inter-war years. He found that the proportion of different cost items in the selling price of sawnwood at the sawmill was on an average as follows in the southern half of Finland in 1924—27:

1. Cost price of the logs at the mill	66 per cent
2. Wages of the mill labour	20 » »
3. Other items and profit or loss	14 » »
Total	100 per cent

The share of stumpage price in 1924—27 was 33 per cent on an average.

According to RUIST and SVENNILSON (1948, p. 20), the average structure of the production costs of the sawmill industry in Norrland, Sweden, in the 1930s was as follows:

1. Raw timber (sawlogs)	60 per cent
2. Wages	20 » »
3. Interest, depreciation, etc.	15 » »
4. Other costs and profit	5 » »
Total	100 per cent

Ruist and Svennilson gave no further particulars concerning the bases of calculation, but it seems probable that items 3—4 together correspond to Saari's item 3. If this can be assumed, the two Swedish authors and Saari show a fairly similar cost structure although the investigations are concerned with different periods before World War II.

The costs show a feature common to all sawmills: *the preponderance (generally over 60 per cent) of raw timber price in production costs. The fixed costs* of actual sawing *have a small role* (c. 1/10 on an average of the production costs).

The changes in sawnwood production and supply, e.g. an increase in supply in consequence of a price climb, occur in different ways. Firstly, the output of export sawmills already in operation can be increased, especially by changing from one- or two-shift working to two- or three-shift working. Secondly, sawmills which ceased to produce during a recession can be started up again. Thirdly, export goods can be produced in sawmills which normally only work for domestic needs, partly even non-commercial. The modernisation of sawmills also tends to increase production capacity.

Increasing the number of shifts and opening up sawmills not generally in use involve a small increase in per-unit costs of processing, since wages rise and it becomes necessary to employ less skilled labour. In addition, sawmills that have been idle for some time are on the whole more uneconomical than other sawmills either in the technical respect and / or in their location. On the other hand, the increase in the degree of capacity utilised reduces the fixed costs of the unit of product (interest and depreciation of producer's capital, general administrative costs). Their share is small in the sawmill industry, but the decrease in these costs may perhaps compensate for the possible increase in the above-mentioned costs of the sawing process in the operating sawmills as long as there is no danger of overemployment. It might perhaps be assumed that the cost items discussed constitute no obstacle to elastic supply.

The decisive factor influencing the elasticity of supply is thus *raw timber costs* the proportion of which is especially great in the sawmill industry. The question arises: *what is the elasticity of the supply of roundwood (sawlogs)?*

The elasticity of the supply of roundwood has been studied very little, and the present investigation is not concerned with its empirical determination. However, a few principles and results reported elsewhere are reviewed here.

The sawlog resources of the forests are many times — according to Ilvessalo (1956, p. 108), c. 34 times in 1951—53 in Finland — the annual sawlog utilisation (c. 320 million cu.ft.).[1] The supply can thus vary very considerably in a year. When sales are made against delivery contracts, however, manpower and other factors limit somewhat the expansion of supply, and even for stumpage sales manpower and financing problems limit sawlog purchases.

The costs of sawlogs delivered to the sawmill are composed in the main of the following items:

1. stumpage;
2. cost of extraction (logging and forest haulage);
3. cost of long-distance transport;
4. other raw timber costs.

[1] Exports of heavy timber and the domestic use of large-sized timber for purposes other than sawing make the annual utilisation slightly greater.

Items 2—4 are chiefly wages and they can consequently be regarded as relatively stable. In relation to the elasticity of supply, however, they depend to some extent on the type of forest ownership and the labour force. This aspect will be discussed later. A very considerable part — c. $^2/_3$ at sample sawmill A — of raw timber costs consists of the *stumpage price*, and it is on this factor that the supply of sawlogs depends essentially.

The price elasticity of sawlogs supply has been studied empirically to some extent. Ruist and Svennilson (1948, p. 87) obtained 1.4 as the average price elasticity of sawlogs in private forests in Norrland in 1922—39. The price variable employed was the price of barked logs after sorting at the various river mouths. This price thus included stumpage plus costs of logging, floating and sorting. If the cost of extraction can be assumed to be stable, i.e. the changes in the price as a whole occurred in the stumpage price, the "stumpage price elasticity" of supply would have been considerably lower. It is probable, however, that the logging, haulage and floating costs also varied, although more moderately, with the market conditions (Ruist and Svennilson 1948, p. 94) and that the elasticity value given is illustrative also of the elasticity of the forest owner's supply. The elasticity was fairly great: a 10 per cent price advance, for instance, with this elasticity coefficient means a 14 per cent increase in the supply of sawlogs.

The conclusion drawn by Ruist and Svennilson shows that raw timber logging was fairly elastic in Norrland and made the elastic supply of sawnwood possible.

The average price elasticity of the primary supply of roundwood depends on the nature of forest ownership and thus on the structure of forest ownership in the country. As State-owned forests are generally cut according to advance logging plans, the supply from them, while not rigid, has a relatively small elasticity. By contrast, the supply from the forests owned by forest industry establishments is very elastic over a short period.

Privately-owned forests hold a central position in the supply of roundwood in all the Nordic countries and especially in Norway and Finland, The roundwood sales from these forests, chiefly farmer-owned, and the earnings from the logging of timber for sale constitute a considerable part of the annual income of the farms and, for many farm holdings, are an indispensable source of income. In considering the elasticity of sawlog supply this justifies attention not only to the price elasticity of *supply* but also to the influence on *income* of roundwood sales, to its "income elasticity", especially as they are in some way interconnected.

It is probable that the upward price elasticity of supply is considerable after a depression of some length. On the other hand, if good markets prevail for some years, i.e. so long that the receipts of private forest owners grow on account of improved demand for wood and rising prices, the price elasticity of supply

diminishes upwards but increases downwards. In other words, a certain expansion of supply requires an increasingly greater price climb, but even a small price drop decreases supply appreaciably.

Ruist and Svennilson (1948) did not actually calculate the income elasticity of sawlog supply, but the above conclusion is supported by their observation (p. 87) that the forest owners' propensity to sell increased after a period when sales had been smaller. The observation made by Saari (1932, p. 109) is another pointer in this direction; he found that the proportion of raw timber costs in the sales value of sawnwood rose to as much as 77—79 per cent at the beginning of the Great Depression in 1929—30. The principal reason for this according to Saari was, it is true, the sawlog stocks bought before the year 1930 at high prices (and were included in costs), but another probable factor was that new raw timber was not sold on an adequate scale at the desired (lowered) prices.

The raw timber supply of farm forests is thus not determined solely by prices. It also depends on the forest owner's income. It was pointed out that the money earnings of the agricultural population in the Nordic countries depends largely on forest earnings. Good demand for wood thus creates "endogenously" a situation in which the elasticity of supply diminishes. Sawlogs have so far been the most important element in the formation of forest income.[1] It must be noted, however, that good demand for pulpwood, even for firewood, can provide the necessary increase in income and thus affect the price elasticity of sawlogs.

The money earnings received by owners of farm forests depend not only on the state of forest market but also on the earnings from actual farming, and here weather for instance can cause fluctuations.

This picture of the elasticity of raw timber supply must be filled in with some important additional features. Firstly, the state of the forest market strongly influences investments by farmers. This is especially true in Finland (see Piha 1957) but presumably also applies in the Scandinavian countries. It is possible that when a recession starts many forest owners have uncompleted building projects etc. under work and need additional funds to finish the job. The raw timber supply of these forest owners does not diminish when prices begin to fall, i.e. supply is inelastic. Secondly, according to investigations carried out in Norway, the elasticity of supply depends on the size of the forest unit, being greater in small forest holdings than in large.[2] The low income level of small forest owners and their poorer ability to predict the development of the market obviously make them more sensitive to price changes than big forest owners.

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[1] According to a study conducted by the author, the share of sawlogs in the stumpage earnings of private forest owners in Finland in the felling years 1955/56 and 1956/57 was 47 per cent.

[2] Preliminary information provided by Professor Frits Jørgensen from an investigation conducted in the Institute of Forest Economics of the Agricultural College of Norway.

In accordance with this, the elasticity of roundwood supply is perhaps greater in Finland which has many more small forest units than Sweden and Norway.

The organisation of the marketing (channels of marketing) probably influences the raw timber costs of the sawmill industry and thus also the price elasticity of sawnwood supply independently of the price elasticity of the supply of roundwood. The raw timber price level follows the export market price more closely in countries in which the price of raw timber from private forests is agreed upon yearly in bilateral negotiations between buyers and sellers than in countries in which competition prevails between the sellers. Of the Nordic countries, Norway represents the former and Finland the latter type, and Sweden comes between the two. Individual raw timber marketing probably makes for a greater elasticity of supply than central marketing.

Forest ownership on the small scale, which has become common in Finland, probably makes for a fairly considerable elasticity also in forest wages. When he sells timber against delivery contract and performs the work himself, the small farmer — if no other money earnings are available — prices his wages below the established level.

4. The route of price reactions and the time lapse

Let us assume that the use of sawnwood in an important buyer country, say the UK, increases for some reason, e.g. because of increased building activity. This leads to greater purchases from non-importing merchants and sawnwood importers. Sawnwood *stocks in the importing countries* are generally fairly large although they do fluctuate (Holopainen 1953, p. 85) not only because of variation in the degree of use but also because of the rate of interest policy etc. pursued in the buyer country. A small increase in utilisation can thus be satisfied from stocks. A continuing and fairly great increase in utilisation, however, causes a greater than "normal" need to replenish stocks.

The effect of increased use on import demand depends not only on the inventories held by importers and merchants but also on their prediction of the development of utilisation. If it is assumed that utilisation will rise for a longer period to an entirely new level, there are at least three reasons to increase stocks:

1. the need, due to increased sales, to replenish stocks;
2. building up stocks to correspond to the level of the new use;
3. speculative increase of stocks to above the normal level before prices advance notably.

The stimulus of utilisation on import demand — e.g. because of the factors 2 and 3 — may result in a price climb. Assuming that this happens, how will the exporter's supply react? It is presumed that the exporter is, following the usual practice, at the same time the producer.

Many factors influence the mode of reaction of export supply and especially the speed of the reaction:

1. the stocks of finished goods for export;
2. sawlog stocks;
3. the time of the year of the increase in demand and price;
4. the forecast of profitability of production and, in the same connection, the forecast of price and cost movements;
5. the exporter's prediction of how demand will develop and possible speculation based on the conclusion.

Overlarge *stocks* of finished goods, especially of sawnwood ready for shipment, make it possible to meet increased demand immediately, giving relatively great elasticity. The speed with which deliveries are made (time of delivery) depends, thus, on the shipping available and the buyer's wishes.

Even if the stocks of finished goods were at their customary level, exporters could satisfy the increased demand relatively rapidly provided they had purchased large stocks of sawlogs either ready at the sawmill or within quick delivery range (e.g. by road) of the sawmill. The time of delivery in such cases would be slightly longer as sawing and especially seasoning of the wood requires a certain time. Air seasoning, depending on the time of the year, takes from c. 1 1/2 months (in the spring) to over 6 months (in the autumn). Only in the following spring generally, i.e. after 7—8 months, can wood sawn in September be seasoned to shipping dryness by air drying. It is possible to shorten the production process considerably by means of kiln drying (drying time only 3—6 days), but the kiln capacity of sawmills is relatively small.[1] Furthermore, several buyers prefer air-dried sawnwood. Thus in seasoning, the "capacity" of the sawmill industry may become an obstacle to elastic supply.

The time of delivery depends not only on the drying but also on the shipping facilities and the location of the sawmill.

It would be as well in this connection to consider the stocks of ready goods and raw timber as an entity. They both show considerable seasonal variation, but broadly speaking in opposite directions, which means that the sum of stocks in terms of finished goods remains roughly the same. The stocks of both commodities are moreover "of equal value" in the sense that the meeting of increased

[1] Professor F. E. Siimes estimated it to be 250 000 stds per annum at the Finnish market sawmills. This is c. 1/4 of the annual output.

demand does not involve shippers in cost risks. The goods are either ready or the raw material already procured ensures their delivery (on fob terms) at roughly the prevailing cost level.

When the stocks of finished goods and/or sawlogs are smaller than average, the elasticity of supply within a certain delivery period depends on the *season*. In the most important producer countries (most of Finland and Norway, Northern Sweden and Northern Russia) the production process of the sawmill industry has its own seasonal rhythm. The programme for felling sawlogs at the beginning of winter is made in September—October (e.g. 1960), the logs are felled and hauled from the forest during the winter 1960/61, floated in the course of the spring and summer 1961, sawn in summer 1961 and the winter season 1961—62, dried in summer 1961 and early spring 1962 and shipped partly in 1961, partly in 1962. The length of the production process varies from eight months to two years reckoned from the time the sawlog purchasing programme is drawn up to the moment when the prepared sawnwood is ready for shipment.

The production rhythm is especially typical of the large mills of the coastal areas (in Finland e.g. Kotka, Pori, Oulu, Kemi; in Sweden e.g. the coastal sawmills in Norrland) whose raw timber is extracted chiefly from forests long floating distances away.[1] The production process is generally shorter (6—18 months) inland, even in sawmills to which the logs are floated, and in mills which obtain their raw timber overland, like many of the small sawmills in the interior, it is only a few months. An illustrative feature of Finnish conditions is that, according to Lindfors (1960), an average of 71 per cent of the total of sawlogs procured by the member firms of the Central Association of the Finnish Woodworking Industries in 1955—58 was delivered by floating, 24 per cent by motor transport (includes negligible quantities transported by horse-drawn transport). The increase in the use of motor transport since World War II period has speeded up the production process considerably and increased the elasticity of supply.

The duration of the production process in the sawmill industry of Norrland, Sweden, was generally 1—2 years in 1922—39, according to Ruist and Svennilson (1948, pp. 71—72).

As was emphasised, for instance, by Ervasti (1959, pp. 9—12), autumn (August—October) is the "critical season" in the sawnwood market, since *production schedules* for the next year are then established. Development of building and other industrial activity as well as information on the amount of stocks in the main importing countries provide a basis for production decisions, especially concerning the large producers. In addition, producers try to obtain

[1] In a large enterprise on the coast of Southern Finland, approximately a half of the goods made from sawlogs bought in the logging year 1959/60 can be shipped in 1960 and the other half in 1961.

an idea of the likely outlet, prices and profitability by means of so-called *opening sales* and *opening prices*, i.e. on the basis of the first sales for delivery in the following calendar year. The opening sales and opening prices are a very realistic starting point from the producer's point of view and the drawing up of the programme for the procurement of saw logs — which fixes the production schedule — is often postponed until the opening has been made.[1]

Raw timber logging operations are naturally influenced also by other factors than the price of the finished product, especially financing. An endeavour is made to improve financing by means of the early opening sales and the advance payments they earn. In certain situations the financing problem may weaken an increase in sawnwood supplies. This happens especially in the initial phase of upswing and during crises. When exports are well under way, financing improves. The weather conditions of the winter and the availability of labour also affect the schedule of logging operations planned.

If the price increase caused by increased demand coincides with the time of preparing the logging programme or the immediately preceding period (August—October), producers can enlarge the logging programmes and supply is elastic provided that weather conditions and other factors do not bring any surprise difficulties.

The markets do not open early enough every year to make it possible to predict raw material requirements solely on this basis. For instance, sales from Finland for delivery in 1956 and 1957 were not opened until December 1955 and 1956.

Producers can generally still revise their raw timber logging plan around the turn of the year if export prices and the pending orders should undergo a change. But it is difficult to make essential changes in the plan if the changes in demand and price occur between February and late summer. If the production of the current year has in large part been sold, *increased demand can be satisfied only by* eating into the raw timber stocks of the following logging year, i.e. *by lengthening the times of delivery*. Delivery times of such length are generally not adopted and the consequence may be a continued price climb. This is so especially when the rising trend has continued for a couple of years and producers have perhaps underestimated their raw material requirements in the preceding years (cf. Ruist—Svennilson 1948, p. 46).

In such a situation *speculative* motives, i.e. a belief in the further advance of prices, are an additional reason for the seller's restraint (Alexander, Cross and Cunningham 1956, pp. 31—32). The elasticity of supply is probably small and the consequence may be a vigorous price climb until the "revival" of idle sawmills, mills working for the home market etc. increases production and

[1] It may be mentioned that in 1958 the Finnish Forest Service postponed the State sawlog auctions on the grounds that the opening sales of sawnwood for delivery in 1959 were delayed.

augments supply. When this happens, supply may exert a notable effect on the price development.

The relatively long production process of the sawmill industry is a ready source of false predictions. For instance, the predicted demand and need for raw timber may be over-optimistic, with the result that stocks of sawnwood and/or sawlogs will grow beyond the estimated requirement. If the demand by foreign importers falls further concurrently and prices take a downturn, producers will find it difficult to contract supplies immediately, i.e. supply is inelastic. The situation often deteriorates further if importers and merchants in the buyer countries also have fairly large stocks and postpone purchases in the expectation of a further price drop. A price development of this kind causes a contrary reaction among the sellers: they try to promote selling by lowering prices, a measure which often leads to a cumulative decrease in prices.

The adaptation time of supply to a *falling* price trend also (the potential elasticity of supply) depends to some extent on the time (season) of the price changes. Here, again, elastic supply is most difficult if the price drop occurs in the first months of the year, i.e. in the period when raw material purchases have already been made for a large-scale outlet. The financing of production alone demands that sales continue. It is easier to adapt supply to a price drop that occurs towards the end of summer and in the autumn. Producers may be holding quite large stocks, then, when prices begin to fall and the process of adapting supply to the changed conditions consequently requires a relatively long period.

5. Domestic sawnwood sales and the price elasticity of supply for export

As pointed by Robinson (1950) and others, the home elasticity of supply for exports is influenced by the *home* elasticity of demand for exportable goods. The effect this has on the supply of sawnwood for export will be surveyed briefly here. In addition to the goods sold as sawnwood, domestic sales include in this case also products processed further by the producer enterprises (e.g. doors, windows, etc.) for sale and the sawnwood utilisation of these firms for their own needs.

It can be assumed that the changes in export prices are reflected in domestic prices provided they are not neutralised by controls, subsidies, etc. Export price changes might be expected at first sight to have a contrary effect on domestic sales to that on exports, i.e. a rise in export prices would reduce domestic sales and vice versa.

This immediate impression, however, requires correction. It can be assumed, firstly, that the price elasticity of the *home use* of sawnwood is relatively small — for the reasons stated in Chapter 2. The use of sawnwood per building unit is, on the average, greater in the exporter than in the importer countries, but the proportion of sawnwood in the building costs is small.[1] The use is determined in a greater degree by other factors governing the building operations, the packaging industry, etc. than by sawnwood prices.

Among these other factors special mention must be made of the *income effect of export sales* (*exports*). To understand this, let us imagine a country in whose national income exports play an important role and in which an appreciable part of the export earnings comes from sawnwood sales. An increase in sawnwood exports because of expanding demand and a climb in prices leads to more employment especially in the sawmill industry and forestry, higher earnings for the workers and a bigger income for the forest owners. This *directly* stimulates building activity and the use of sawnwood, especially in the rural districts.

The economists have also paid attention in recent times to the *indirect* or multiplier effect of exports. It can be illustrated by the following formula:

$$dI = \frac{1}{1 - c} \cdot dE \qquad (2)$$

in which

dE = the original income injection caused by the increase in exports[2]
c = marginal propensity to consume (see e.g. MACHLUP 1943)
1 — c = marginal propensity to save
dI = increase in the national income.

If, for instance, $c = {}^4/_5$ the multiplier is 5, i.e. an original income increase (multiplicand) of 1 000 million marks causes — ceteris paribus — an increase of 5 000 million marks in the national income.

The income-creating effect of the increase in exports is not so simple in reality. In the first place, an increase in the national income soon results in a growth also of *imports*, weakening the final income effect of exports considerably. In fact many economists incorporate as a separate factor in the multiplier analysis of foreign trade the "marginal propensity to import" (q) and investment activity (V). Using the symbols of formula 2, the following formula is obtained according to CLARK and CRAWFORD (1938):

$$I = (V + E) \frac{1}{1 - c + q} \qquad (3)$$

According to the formula, the income effect (multiplier) caused by an increase of a certain magnitude in exports depends first and foremost on the marginal propensities to consume and to import. A greater propensity to consume (c) increases, and a greater propensity to import (q) diminishes, the national income.

Many complicating factors discussed e.g. by MACHLUP (1943), CHANG (1951, p. 8) and MEADE (1951) are associated in practice with multiplier analysis. Let it suffice here to state that in spite of certain simplifications it is a considerable aid in clarifying the income and employment effects of the variation in exports. As far as the present study is concerned it is important to establish that the increase in sawnwood exports, directly increasing the earnings of income-earners, has a stimulating effect on the branches of production, especially building activity, that use sawnwood (TAMMINEN 1945, pp. 15—18, 30—32; HALME 1955, pp. 37—46, 57—58). The expansive impact of this income effect ("income elasticity") on the domestic demand for sawnwood is obviously greater than the restraining influence of the rise in sawnwood prices.

The origin and composition of export income differs in different countries. In some sawnwood exporter countries sawn goods have a focal importance in the formation of export earnings. In Finland, for instance, the rises and falls in sawnwood exports generally sufficed to explain export market fluctuations in all phases of the business cycle before World War II, according to HALME (1955, p. 314). In Sweden and Austria, too, for instance, sawnwood exports are of considerable significance in the formation of export earnings, although not as much as in Finland. The fluctuations in sawnwood exports can in these two countries also, either of themselves or as important partial factors, create market conditions affecting the home use of sawnwood. This hypothesis is supported for Sweden by CHANG's (1951, p. 166) investigation. Besides, the fluctuation in sawnwood exports usually coincides with the fluctuations in other export markets as both arise from the same original source: the variations in economic activity in the principal importer countries (U.K. etc.). RUIST and SVENNILSON (1948, p. 44) established this clearly in the market development in Sweden in the period between the two world wars.

Hence, *fluctuations in sawnwood exports are probably accompanied by similar fluctuations in domestic use.* At any rate, it is unlikely that domestic use will contract when exports increase and expand when exports contract.

It is to be expected, however, that changes in domestic sales will lag slightly behind the changes in export demand.

[1] In Finland's building cost index e.g. (from 1951) the weight of wooden materials as a whole is only 87/1 000. The value is derived, however, from multi-storied houses in towns in which the use of sawnwood is less than the average.

[2] Strictly speaking, the total value of exports minus the value of imported raw materials to be embodied in exports should be used as the multiplicand. However, the significance of imported raw materials is negligible in the sawnwood exports of most countries and especially of Finland.

It is difficult to support these conclusions statistically, since there are no reliable statistics on the domestic sales and use of sawnwood. The difference between output and exports can be regarded as a sort of acceptable "substitute series" for the purpose. It is substitute firstly because output statistics do not include the production of small sawmills for home use or even commercial circular sawmills which are rather important producers of sawnwood, especially in rural districts (cf. ERVASTI 1956). Secondly, it is not expressive of the changes in stocks. In spite of these drawbacks, the time series calculated here perhaps give some idea of the fluctuations in *domestic market demand* for sawnwood. Fig. 1 shows the apparent domestic sales, calculated as described above, for the periods 1922—38 and 1951—59.

In order to eliminate entirely incidental fluctuations in production, exports and stocks, the following adjustment was made: to the figure for a certain year was added half of the quantity for the preceding and the following years, and the sum obtained was divided by 2. For example, the figure for 1922 was

$$\frac{1/2 \times \text{the figure for 1921} + \text{the figure for 1922} + 1/2 \times \text{the figure for 1923}}{2}$$

The figures in the question are thus in a way moving averages for short periods. They do not eliminate, however, cyclical fluctuations.

The figure shows that the fluctuations in domestic sales coincide significantly with the fluctuations in exports. Thus, domestic sales grew during the boom towards the end of the 1920s (1925—28), while the depression around 1930 led

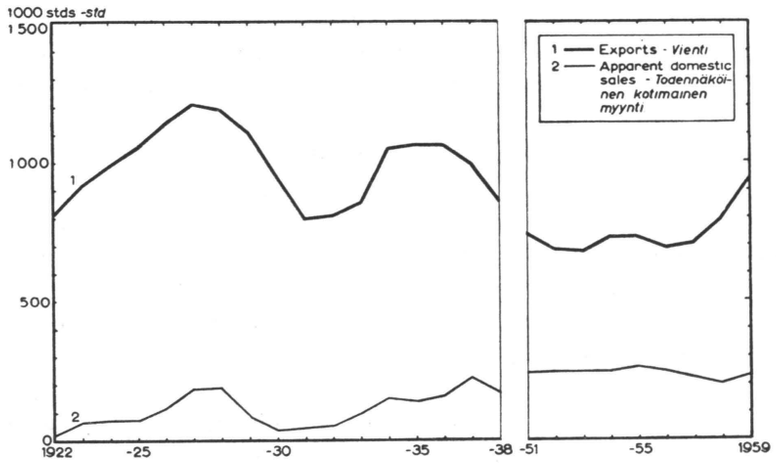

Fig. 1. Finnish exports and apparent domestic sales of sawnwood in 1922—38 and 1951—59.
Kuva 1. Suomen sahatavaran vienti ja todennäköinen kotimainen myynti v. 1922—38 ja 1951—59.

to a contraction in both exports and domestic sales. The increase in exports in the 1930s was accompanied by an increase in domestic sales.

It is principally because of the variations in stocks, but partly also for other reasons, that the parallel course of exports and domestic sales does not emerge clearly in each individual year. The 1951—59 similarity is not equally clear, for several reasons. Firstly, it may be that the small sawmills, especially circular sawmills, which are not included in the statistics of the FSOA used have enjoyed a growing importance since the war in the home marketing of sawnwood, i.e. the statistics illustrating domestic sales have been inadequate. It is also possible that the effective State building and employment policy has changed the economic character of building. The third reason is perhaps the diminished share of sawnwood exports in the value of Finnish exports compared with the 1920s and 1930s (17 per cent e.g. in 1956—58 and 28 per cent in 1936—38).

The result is supported by TAMMINEN's (1945, pp. 30—32) series illustrating the contemporaneousness of the fluctuations in sawnwood exports and urban residential housing production. The above-mentioned "lag" phenomenon, however, cannot be observed in either Fig. 1 or Tamminen's series.

The following question is of interest for the present study: how do domestic sales affect the elasticity of supply for export? It can be concluded from the foregoing that they generally *reduce* the elasticity of supply for exports. But considerable differences can be expected in the intensity of this effect in the different exporter countries. The effect depends on several different factors, such as

1. the ratio between domestic sales (use) and exports;
2. the proportion of sawnwood exports in the country's export earnings and national income;
3. the manner in which the additional income arising from exports is channelled into branches of production increasing the use of sawnwood and into other branches (e.g. imports); i.e. the propensities to consume, to save and to import.

It has already been stated that there are no statistics in the exporter countries on the domestic sales and use of sawnwood which could be used to confirm the conclusions drawn above. According to HARTIKAINEN (1934), the share of domestic sales in Finland in 1932 was 13 per cent of the output of the sawmills ("market sawmills") covered by industrial statistics. A considerable quantity of timber, however, was sawn for domestic use in small sawmills not covered by industrial statistics and in some degree also in the sawmills covered by industrial statistics in the form of "rental sawing". Hartikainen estimated, nevertheless, that no appreciable amount of sawnwood came to the market from this output.

The share of domestic use in the total sawnwood output has increased since

World War II thanks to expanded building operations and, again, because exports have contracted. According to the calculations of the FSOA, domestic use averaged one-third of the output of market saws in the first half of the 1950s.

The amount of sawnwood sold on the domestic market has probably also increased in absolute terms. There has been, for instance, an increasing shift also in rural building operations to the use of prefabricated doors, windows and other constructions. Domestic sales probably accounted for approximately one-fifth of the output of market sawmills in the period in question.

It must be noted, however, in the first place, that a considerable proportion of domestic use still derives from sawmills which do not saw at all for export. Secondly, perhaps the bulk of the market sawnwood used is of inferior quality which would often be difficult to place abroad. The effect is this: when exports vary, the concurrent change in domestic sales weakens the elasticity of supply for exports less than might be expected from domestic use and sales. However, domestic sales probably reduced the price elasticity of exports more in the 1950s than before World War II. On the other hand, the share of sawnwood in total exports and at the same time its significance as a market factor in Finland has diminished, principally owing to the increase in the share of chemical pulp, paper and metal products, especially in the latter half of the 1950s. Consequently, the correlation between exports and domestic use is not as clear as before the war.

6. Empirical determination of elasticity

61. Classification of elasticity according to the time factor

Different types of elasticities can be distinguished according to the speed with which supply reacts. The traditional distinctions in economic science are:

a. instantaneous elasticity, in which the behaviour of supply in short periods is studied, e.g. monthly. The supply reactions are based on existing *stocks;*
b. elasticity of a period of medium length, e.g. annual. It is assumed that there is time for *production* to expand and contract in response to price changes from the existing capacity at the time of the changes;
c. "elasticity of a prolonged period", when changes in *production capacity* can be taken for granted. The time over which this elasticity is measured varies in different branches of production, but it is generally longer than a year (see TAMMINEN 1948, pp. 86—87; SCHNEIDER 1960, p. 507).

Concerning the flexibility of sawnwood supplies, the present author arrived

at the following, slightly different, classification:

a. elasticity based on existing stocks of finished goods and sawlogs;
b. elasticity of adaptation of sawlog procurement to demand and the effect of exports on the domestic demand for sawnwood;
c. elasticity of the sustained supply of raw timber to producers and allowance for the likelihood that users will substitute other materials for sawnwood.

Attention is drawn especially to the omission in this classification of the changes in the capacity of the sawmill industry as a factor affecting elasticity. This omission was considered to be justified on the grounds — already detailed — of overcapacity and the possibility of expanding sawing production. If capacity has to be taken into consideration in the determination of elasticity, the reaction time is comparable with that mentioned under item b.

The elasticity of item a. can be measured within a short period, say, 1—3 months. It is true that sawnwood production to the stage of readiness for shipping can take longer, but the producer can sell the goods without notable cost risks.

The time interval in item b. varies according to the time of the year. An average of nearly 12 months can be regarded as sufficient.

The elasticity of item c. can be measured only over a long period (e.g. a decade).

62. Determination of elasticity

Owing to inadequate statistics, it was not possible to make empirical calculations of elasticity to the desired extent. The determination was made in two stages, applying two different methods.

The first aim was to obtain a preliminary idea of the mode of reaction of supply to price changes, and especially of the type of influence this factor had and the duration of the reaction time. Next, the elasticity coefficient was determined by applying regression analysis.

The first part of the empirical calculations was performed by a fairly approximative method, examining the variations of Finland's sawnwood (only softwood) sales occurring around *major and sudden price changes.* For example, there was a sharp price fall (c. £ 20.—. per std. or 23 per cent) in the middle of May 1952 and a steep price increase in terms of marks (39 per cent) after the devaluation of the Finnmark in the middle of September 1957. Elasticity (e_s) was calculated from the formula:

$$e_s = \frac{\frac{S_1 - S_2}{S_1}}{\frac{P_1 - P_2}{P_1}} \qquad (4)$$

where

S_1 = the amount sold prior to the price change
S_2 = the same after the price change
P_1 = the price prior to the change
P_2 = the price after the change.

The *price* series, the so-called basic price (the price of 2″ × 7″ u/s redwood battens weighted by the sales quantity) was collected from the export sales contracts of a big forest industry company in Southern Finland. This gave a more homogeneous price series than e.g. the mean prices of the sawmills of the whole country or Southern Finland, or mean basic prices in which the regional variations complicate a study of changes in the price level.

From the price was deducted the export fee payable by sawnwood exporters in 1951—52 and 1957—58.

The *development of sales* was worked out from the sales reports of the FSOA. These reports illustrate the 1—2 week progress of sales for delivery in a certain calendar year. It was possible to calculate from these reports — in many cases by interpolation — the development of sales in periods of 1, 2, 3 etc. months before and after the price change. The amount sold in each month was converted to correspond to a 30-day cycle.

It should be noted that data on actual sales were obtainable only from members of the FSCO (Finnish Sawmill Control Organisation), but these accounted for c. 95 per cent of total sawnwood exports by Finland. Not all exporters notify the FSCO of their sales at the right time; small shippers especially are often late in providing the information. The result is that the sales statistics of the FSOA are slightly (by a couple of weeks) behind the real development of the sales. This caused hardly any appreciable error in the present study which was concerned with sales ratios in different periods.

Sales to the USSR are entered in the statistics "artificially" at the time the bilateral trade agreement is concluded. Hence they were omitted.

The 1957 development of sales vis-à-vis price variations was studied in periods of 1—24 months. For 1952 the material was obtained only in periods of 1—23 months.

The "elasticity coefficients" obtained are given in Table 3, the development of prices and quantities sold around the two dates are illustrated in Figures 2 and 3.

Ervasti (1959) observed a fairly pronounced seasonal fluctuation in the sawnwood sales of Finland in 1951—58, contrary to the present author's (1954) finding for 1947—53. This phenomenon must be remembered in considering the results reported here. Its effect, however, probably does not disturb comparison of the development of sales within a short period (0—1 month) and within a period of 12 months before and after the price change has taken place.

The results are surprising in a way. Firstly, sales increased fairly vigorously after the price drop of 1952, i.e. the price elasticity of supply was negative. The same holds good for the price increase of 1957 (September 15) in a short time (one month). The price elasticity of a period of well over a year begins to be apparent and is fairly high for 1 $^1/_2$—2 years.

The results do not warrant definite conclusions of the price elasticity of sawn-

Table 3. Price elasticity of sawnwood exports, estimated from the major price changes of 1952 and 1957.

Taulukko 3. Sahatavaran viennin hintajousto vuosien 1952 ja 1957 suurten hinnan muutosten perusteella laskettuna.

Time since the price change, months *Aika hinnan muutoksesta lukien, kk*	Price drop May 14, 1952 *Hinnan lasku 14. 5. 1952* e_s	Price rise September 15, 1957 *Hinnan nousu 15. 9. 1957* e_s
1	— 2.27	— 0.83
2	— 7.76	+ 0.01
3	— 12.08	+ 0.30
4	— 15.04	— 0.20
5	— 12.63	+ 0.11
6	— 12.46	+ 0.06
7	— 11.35	— 0.18
8	— 9.87	— 0.43
9	— 9.99	— 0.58
10	— 9.88	— 0.81
11	— 8.65	— 0.75
12	— 7.36	— 0.55
13	— 6.09	— 0.22
14	— 4.64	+ 0.16
15	— 3.19	+ 0.36
16	— 2.15	+ 0.43
17	— 1.69	+ 0.80
18	— 1.04	+ 0.97
19	— 1.39	+ 0.97
20	— 1.38	+ 0.96
21	— 1.58	+ 1.17
22	— 1.64	+ 1.28
23	— 1.71	+ 1.15
24	..	+ 1.14

wood supply, especially as exports were to some extent influenced in the early 1950s by the gradual decontrol of sawnwood imports and utilisation in the U.K. It seems likely, however, that price changes do not always lead to anything like the expected reaction. Furthermore, when it is possible to speak of logical price elasticity it appears only a relatively long time after the price change. So long after the "primary" price change, "secondary" changes (not very great in the case in point) will already have occurred and will complicate examination of the elasticity of supply on the basis of the primary price change.

These "unexpected" results lend support, however, to some conclusions drawn earlier in the present investigation (Chapters 3—4). The price drop of 1952 signified the turning point of a very vigorous upswing, the "Korean boom". The great increase in demand which occurred in 1950—51 — first and foremost for

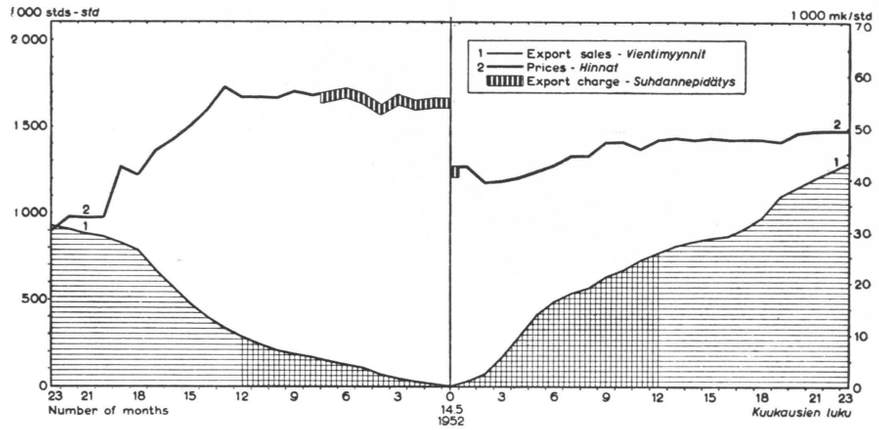

Fig. 2. Finnish export sales (1) and prices (2) of sawn softwood around the steep price fall in May 14, 1952. The sales diagram refers to periods of 0—1, 0—2, . . . 0—23 months before (to the left) and after (to the right) the price fall; the price diagram refers to the price level prevailing at the end of each period.

Kuva 2. Suomen havusahatavaran vientimyyntien (1) ja vientihintojen (2) kehitys 14. 5. 1952 tapahtuneen jyrkän hinnanlaskun molemmin puolin. Myyntikäyrä on summakäyrä, joka osoittaa myyntien suuruuden 0—1, 0—2, . . . 0—23 kk:n pituisina jaksoina ennen (vasemmalle) ja jälkeen (oikealle) hinnanmuutoksen.

the accumulation of small stocks and of strategic stockpiles — raised prices and speeded up production. When these demand-stimulating factors ceased to function, and strategic stockpiles were cut, a price drop was inevitable. Producers, however, were obliged to sell the sawnwood already produced or for the production for which the raw material had already been purchased. The price drop of May 1952, technically started by a big Finnish company but in actual fact resulting from restrained demand, was as it were the starting signal for sales work in the new situation, activity which had long been quiet in anticipation of the new price. The buyers waited, however, for the stabilisation of the new price level before the purchasing activity proper got under way. The case is a good example of the *small downward price elasticity of sawnwood supply*. It is also an example of the *long adaptation time* in these markets, especially if the price change occurs early in the spring. Long-term price elasticity is greater than short-term elasticity (cf. SCHNEIDER 1960, p. 308).

On the other hand, the development of sales after the price rise of 1957 supports the earlier conclusion that supply is relatively elastic "upwards" and that elasticity is positive, i.e. "correct in direction". By contrast, the price drop of 1952 was followed by an increase in sales.

It must be emphasised that the price rise of 1957 was not "normal", i.e. it was not an international phenomenon due to increased demand but was solely

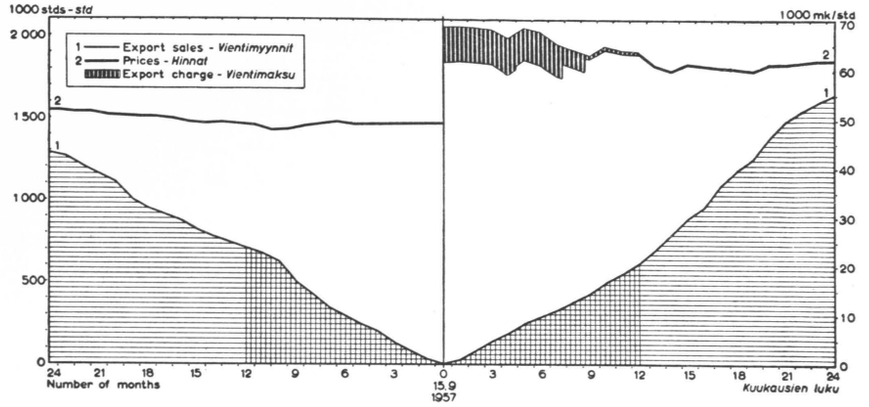

Fig. 3. Finnish export sales (1) and prices (2) of sawn softwood around the price rise in connection of the devaluation in September 15, 1957. See explanation in Fig. 2.

Kuva 3. Suomen havusahatavaran vientimyyntien (1) ja vientihintojen (2) kehitys devalvaation (15. 9. 1957) aiheuttaman hinnannousun molemmin puolin. Ks. kuvan 2 selitystä.

of "Finnish" origin. The aim of the devaluation of the Finnmark was to increase the competitiveness of Finnish producers and at the same time to increase Finland's share in the demand of the buyer countries. Although it is to be compared from the producers' point of view with a price increase, it had certain special features such as the speculation preceding it on the part of both producers and buyers and the attempt by buyers to reduce the devaluation profits by lowering prices.

The result indicates that price effects must be studied in a wider context. Accordingly, an attempt was made to determine the elasticity coefficient also by applying *regression analysis*. This required the construction of a statistical model which would explain as completely as possible the variations in the supply for export and in which price would appear as one of the variables.

Regression analysis was performed on the basis of the yearly series (1950—59). This series was selected primarily because the elasticity of supply, as was observed above, responds relatively slowly to price changes and in general any period shorter than a year usually fails to give a satisfactory solution. Secondly, the best statistics available on the variables that enter into the question are obtainable in annual series. The selection of the relatively short period of 1950—59 was prompted above all by the fact that the control of sawnwood imports was abolished in Great Britain in 1950. Free imports and price formation could be expected to be more effective than before in regulating supply.[1]

[1] In 1951, however, there was still some (c. 20 per cent) importing by the Timber Control, and in 1952 sawnwood imports were governed by a quota confirmed by the Government until sawnwood import controls were completely abolished (in November). Licencing on the use of building timber was abolished at the end of 1953.

The model took the following logarithmically linear form:

$$\log q = a + b\log p + c\log r_1 + d\log r_2 + \ldots \quad (5)$$

where

q = export sales of sawnwood
p = price
r_1, r_2 ... = relevant variables other than price
a, b, c ... = parameters whose values are computed from empirical material.

Several different variables (r) and combinations of variables were used experimentally. Apart from price, the following factors could be expected to influence the supply of — and demand for — sawnwood:

1. the national income of the buyer countries;
2. the building activity of the buyer countries, especially the production of residential housing;
3. the industrial production of the buyer countries;
4. sawnwood stocks in both buyer and exporter countries;
5. sawnwood production costs (primarily wages and raw material);
6. domestic sales (use).

Some investigations that have been published support the view that the above factors have a prominent role. FAO (1953, pp. 96—97) uses mainly the "gross product" variable for its demand prognoses, but also the price ratio of sawnwood and other materials. STREYFFERT (1957, pp. 45—47) studied the development of the utilisation of timber e.g. in ratio to the development of the national income and industrial production. The present author mentioned the significance of residential house production and stocks in a study of sawnwood imports by Great Britain (1953, pp. 22, 83—86).

Factors 1—3 can be expected to show some degree of mutual correlation.

Attention is drawn to the variables which, production costs excepted, are variables of "demand" although the object is to study the price elasticity of supply. Most of the reasons for this were mentioned in Chapter 1.[1]

The coefficients of the regression models were calculated by the method of TÖRNQVIST (1958). Its special advantage is that one variable at a time can be added to the model, providing a clear picture of the gradual emergence of the model against the diminishing residual variance.

It was not possible to construct a satisfactory model representing Finland's

[1] GREGORY (1960) has avoided this drawback by applying the recursive model introduced by WOLD and JUREEN (1953). In his model demand is treated in one equation, supply in another, and price in a third, each of them containing a separate set of variables. The lack of the sufficient statistical information on the supply side (e.g. production, stocks, raw-timber prices) prevents the application of this method in the present investigation.

sawnwood exports by using variables representing the national income in real terms of the principal buyer countries and the export price deflated by the index of forest work wages (to illustrate sawnwood production costs). The "purest" and most reliable series of variables was obtained by limiting the sales aspect to one leading buyer country. The country chosen was the U.K. whose average share in Finland's sawnwood exports in 1950—59 was 38.3 per cent.

After experimenting with combinations of several different variables, the following model was considered to be the best solution:

$$\log q_{UK} = 0.029 + 0.044\, t + 0.934 \log R - 0.545 \log V_{t-1} + 1.031 \log p$$

where

q_{UK} = Finland's sales of sawn softwood to the U.K.
t = time factor for the explanation of trend (1950 = 0, 1951 = 1 etc.)
R = building activity in the U.K. (number of houses started each year)
V_{t-1} = stocks of imported sawn softwood in the U.K. at the end of the previous year
p = export price deflated by the Finnish forest workers' wage index.

Variables R and V were obtained from the Monthly Digest of Statistics. They and variable p were first converted to indices (1950 = 1).

The computation resulted in the multiple correlation coefficient $r = 0.958$, which means that the variables "explain" 92 per cent of the variance of the logarithms of the Finnish export sales of sawnwood to the U.K. Regression coefficients with their standard errors were as follows:

$b_t = 0.044 \pm 0.006$
$b_R = 0.934 \pm 0.239$
$b_V = -0.545 \pm 0.109$
$b_p = 1.031 \pm 0.324$

All coefficients exceed their double standard errors and can thus be considered significant. As shown in Fig. 4, the mathematical regression curve fits quite well the curve computed from actual data.

The variations in supply for export (export sales) are included as four known variables, of which the price is one. The positive elasticity coefficient of price implies that supply increases with the increase in price and vice versa. Of the other variables, especially R (building activity) and V (stocks) are of great significance.

Of the other variables which could be used in addition to those now adopted to explain sawnwood supplies, domestic use deserves emphasis. It had to be omitted because there are no sufficiently reliable statistics on it or on building

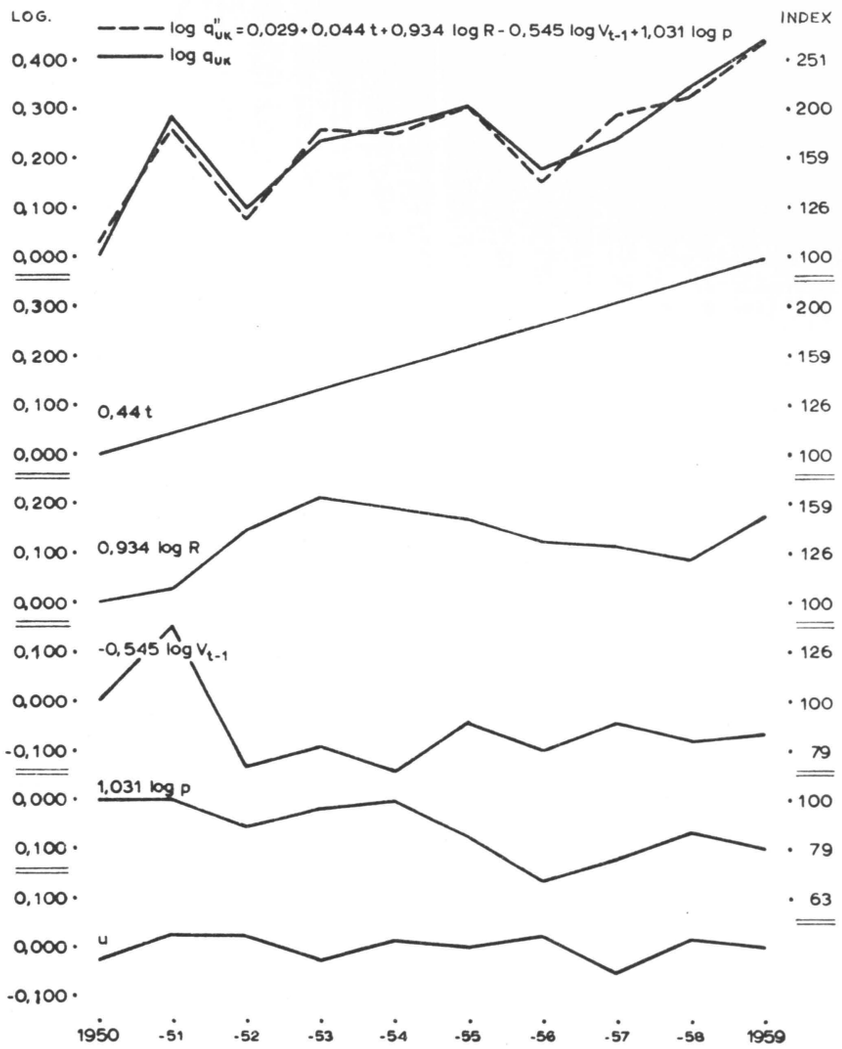

Fig. 4. Graphic comparison of observed data (Finnish sawnwood sales to the U.K. in 1950—59, solid line) and the computed regression equation (dotted line).

Kuva 4. Suomen havusahatavaran vienti Britanniaan v. 1950—59. Teoreettisen mallin perusteella lasketun (katkoviiva) ja todellisten havaintojen perusteella piirretyn (yhtenäinen viiva) diagramman vertailu.

activity. The substitution of other materials for sawnwood probably also occurred in the 1950s.

The reliability of regression analysis in the post-war period is weakened by the shortness of the time series. As every new variable diminishes the number

of the degrees of freedom by one, the residual variance (s^2), which is obtained by dividing the residual sum of squares of the model by the number of the degrees of freedom (= number of observation years — number of parameters), soon grows in a period of 10 years when several variables are used. It was not possible to include more variables in the model. Consequently the results obtained should be checked, say, at the end of the 1960s when sufficiently long time series are available.

7. Summary of the main results

The results can be summarised as follows:

1. Producers cannot in the short- and medium-term view use the price parameter to increase total utilisation in the *sawnwood market*. It is determined by other factors. Demand holds a primary position in price formation. It is consequently more correct to speak of the price elasticity of supply than of demand.
2. The capacity reserve of the sawmill industry permits great variations in output at the mill level and thus great elasticity in the supply of sawnwood. Seasoning, however, is a retarding factor.
3. A characteristic of the structure of the sawmill industry's costs is the high proportion of raw timber costs, especially the stumpage price. The supply of raw timber can easily be adapted even to large variations in demand. Empirical studies conducted in Sweden and Norway indicate, moreover, that the price elasticity of roundwood supply is rather great. In Finland, it is probably even greater on the whole than in the other Scandinavian countries. The elasticity is perhaps different at different price levels and greater downward than upward.
4. The long process of sawnwood production and the resultant relatively long lead-time of deliveries result in a long adaptation time of supply. The seasonal rhythm typical of the production and marketing process, moreover, varies the supply response to price fluctuations in different seasons.
5. The expansion and contraction of sawnwood exports and often concurrently of other products frequently cause via the effect of exports on income similar fluctuations in the domestic sales of sawnwood, and this weakens the price elasticity of exports in some degree.
6. Relatively great sawnwood stocks at the different levels of production and trade provide opportunities for speculation which complicate the empirical calculation of elasticity.

7. As the business cycles since World War II have been of short duration, a few years only, the disturbing effect of stocks and speculation on price elasticity was probably greater in the 1950s than in the inter-war years.
8. The conclusion reached is that the "instantaneous elasticity" upward of sawnwood supply might well be great, but speculation with stocks at the different levels of production often makes it "incalculable". These disturbing factors often cause insuperable difficulties for the empirical determination of especially short-term elasticity. The price elasticity of a medium-long and long period can be expected to be relatively great upwards. The downward elasticity of a period of medium length is probably small. The elasticity of a prolonged period may be influenced by the substitution of other materials for sawnwood.
9. The empirical calculations performed support the main conclusions mentioned in 8.

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SUOMENKIELINEN SELOSTE:

SAHATAVARAN VIENTITARJONNAN HINTAJOUSTO

Tutkimuksen tarkoituksena on valaista viime aikojen markkinatutkimuksessa yhä enemmän huomiota osakseen saaneen hintajouston ongelmaa sahatavaran vientitarjonnan osalta. Luvussa 1 käsitellään lähemmin, miksi tässä tapauksessa on hedelmällisempää tutkia tarjonnan kuin kysynnän hintajoustoa.

Tutkimuksen pääosan muodostaa sahatavaran vientitarjonnan hintajouston perusteiden ja luonteen käsittely (luvuissa 2—5). Lopuksi esitetään (luvussa 6) empiirinen laskuesimerkki lähinnä saatujen tulosten tarkistamiseksi.

Tutkimuksen tulokset voidaan tiivistää seuraaviin päätelmiin.

1. Tuottajat eivät *sahatavaramarkkinoilla* voi hintaparametria käyttäen lisätä mainittavasti kokonaiskäyttöä lyhyellä tähtäimellä, vaan tämän määräävät muut tekijät. Hinnanmuodostuksessa kysyntä on primäärisessä asemassa, joten on oikeampaa puhua tarjonnan kuin kysynnän hintajoustosta.

2. Sahateollisuudelle ominainen kapasiteettireservi tekee mahdolliseksi suuret tuotoksen vaihtelut tehdasportaassa ja sallii siten suuren jouston sahatavaran tarjonnassa (taulukko 1) Hidastavana tekijänä saattaa kuitenkin olla kuivausvaihe.

3. Sahateollisuuden kustannusten rakenteelle on ominaista raakapuukustannusten ja nimenomaan raakapuun kantohinnan suuri osuus (taulukko 2). Raakapuun tarjonnan on luonnostaan helppo sopeutua suuriinkin kysynnän vaihteluihin. Eräät empiiriset Ruotsissa ja Norjassa suoritetut tutkimukset viittaavat lisäksi siihen, että raakapuun tarjonnan hintajousto on huomattavan suuri. Suomessa tämä jousto on todennäköisesti keskimäärin vielä suurempi kuin Skandinavian maissa. Jousto lienee kuitenkin erilainen erilaisilla hintatasoilla (eri suhdannevaiheissa) ja lisäksi alaspäin suurempi kuin ylöspäin.

4. Sahatavaran tuotannon pitkä tuotantoprosessi aiheuttaa sen, että tarjonnan sopeutumisaika on pitkä. Tuotanto- ja markkinointiprosessille ominainen kausirytmi aiheuttaa lisäksi sen, että tarjonnan mahdollisuudet reagoida hinnan vaihteluihin ovat erilaiset eri vuodenaikoina.

5. Sahatavaran viennin ja usein samanaikaisesti tapahtuva muiden tuotteiden viennin paisuminen ja supistuminen aiheuttaa viennin tulovaikutusten kautta usein samansuuntaisia vaihteluja sahatavaran kotimaisessa myynnissä (kuva 1), mikä jossain määrin heikentää viennin hintajoustoa.

6. Keskimäärin suhteellisen suuret sahatavaran varastot tuotannon ja kaupan eri portaissa tarjoavat mahdollisuuksia spekulaatiolle, joka häiritsee jouston empiiristä laskentaa.

7. Kun toisen maailmansodan jälkeen talouselämän »suhdanneaallot» ovat muodostuneet lyhytaikaisiksi, vain muutaman vuoden kestäviksi, on varastojen ja spekuloinnin hintajoustoa häiritsevä vaikutus 1950-luvulla todennäköisesti suurempi kuin sotien välisenä kautena.

8. Edellä esitetyn perusteella päädytään siihen, että sahatavaran tarjonnan välitön jousto ylöspäin voisi kyllä olla suuri, mutta spekulointi tuotannon eri portaissa pidetyillä varastoilla tekee sen usein »laskemattomaksi». Nämä häiriötekijät aiheuttavat usein ylivoimaisia vai-

keuksia etenkin lyhyen ajan jouston empiiriselle määrittämiselle. On odotettavissa, että keskipitkän ja pitkän ajan hintajousto on ylöspäin suhteellisen suuri (kohtalainen). Jousto alaspäin on kuitenkin todennäköisesti pienempi kuin ylöspäin. Yli-pitkän ajan joustoon voi vaikuttaa sahatavaran korvaaminen käytössä muilla materiaaleilla.

9. Empiirinen jouston tarkastelu joka ensinnä kohdistui Suomen havusahatavaran vientimyynnin kehitykseen vuoden 1952 jyrkän hinnanlaskun ja devalvaation v. 1957 aiheuttaman markkamääräisen hinnannousun molemmin puolin (taulukko 3, kuvat 2 ja 3) antoi tukea kohdassa 8 mainituille päätelmille. Regressioanalyysi joustokertoimen määrittämiseksi suoritettiin vuosisarjojen pohjalla vuosijaksoon 1950—59 kohdistuvana. Tulos nähdään kuvasta 4.