

SOVIET PULP AND PAPER INDUSTRY: FACTORS EXPLAINING ITS AREAL EXPANSION

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Seloste

NEUVOSTOLIITON MASSA- JA PAPERITEOLLISUUDEN ALUEELLISTA LAAJENEMISTA
SELITTÄVÄT TEKIJÄT

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Planners of the Soviet pulp and paper industry are constantly faced with the problem: which investment policy guarantees the best location structure? Should one invest in existing localities or expand to new areas, especially in heavily forested parts of Siberia? A location theory for the pulp and paper industry, based on three factors (markets, wood raw materials, relative costs) has been suggested by the Soviet authors Antonov and Trusova. In the present study this theory is – for the first time – given empirical contents and feasible areas for future growth of the industry are tentatively determined. One of the main findings of the study is the detecting of considerable unutilized wood reserves in the European USSR. This supports those Soviet views advocating a European-oriented location in investment strategy for the industry, as market and cost factors are unfavourable to Siberian location.

1. INTRODUCTION

The purpose of this study is primarily to develop a theory which will permit forecasting of future location decisions in the Soviet pulp and paper industry. The present location of industry for the Tsarist period and for the Soviet period up to 1965 has been treated from Western authors by A. Rodgers and B. Barr, and several Soviet researchers, i.e. Glotov, Antonov, Trusova, and Solomko, up to the mid-1970s.

The location of pulp and paper industry has in general been explained by means of two factors, raw material sources and markets. This is the approach taken by Bjöörn (1971) for Western Europe and Rodgers and Barr (1971, 60) for the Soviet Union by taking the channels of transportation into account as well.

One evident shortcoming of this simple theory is that it does not explain why large areas with abundant timber resources in

Siberia and the Far East have no pulp and paper industry. Thus the present areal structure of the industry cannot be adequately explained solely by raw material and market factors.

Also, the aim of this study – the forecasting of future location decisions – requires further theoretical elaboration. This is a study of the probable areal expansion of the Soviet pulp and paper industry in the future. The following analysis is based on three assumptions:

- areal expansion is an outcome of investment decisions
- investment decisions are based on certain concepts of future costs and returns (in the Soviet system, too)
- consequently, a location factor reflecting costs is included in the theory.

The theme of this paper is developed as follows: after a short description of the principles of Soviet industrial investment alloca-

tion, i.e. industrial location, and a historical outline of the areal expansion of the pulp and paper industry, the main location factors (markets, raw materials, relative costs) deemed relevant for future location decisions, are analyzed empirically. The empirical analysis of markets and raw materials is based primarily on Soviet publications and is accordingly developed further than in previous studies (Barr 1971, Glotov 1977):

- areal markets of the pulp and paper industry are differentiated by users and product groups,
- raw material analysis is focused on reserves so far unutilized, which make up the potential for areal expansion of the industry.

2. AREAL EXPANSION AND LOCATION DECISION AS PART OF THE INVESTMENT PROCESS

Areal expansion is a result of a location decision, which is always an investment decision. In the market economy areal expansion is commonly thought to be motivated by the search for more profit through production growth in new localities. In the Soviet industry the decision parameter is not more profit but the fulfillment of production plans, i.e. quantitative growth. Thus it can be supposed that areal expansion in the Soviet industry will materialize when planned production growth is not achieved in old locations. After the production target is set the problem of choosing the best of the various location alternatives still remains.

The problem of industrial location is approached from three different aspects in the Soviet Union:

- location criterion for finding optimal location,
- location principles,
- location factors.

The location criterion means the way of determining the economically optimal location. In the Soviet system the commonly accepted criterion is Weberian cost minimization. This criterion was adopted in the 1920s, then abandoned in the early 1930s, and reintroduced in the 1950s. (For a history of Soviet

Areas where expansions are likely to occur are determined. A location theory for the Soviet pulp and paper industry is formulated and some of its implications for the future discussed.

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industrial localization theory see Kotov 1980).

Another question is how cost minimization can be operationalized in the planned economy system, where the price mechanism does not reflect real costs and where time factor and interest rate are not incorporated in cost calculations. These problems, which have been discussed by several Western (Nove 1977, 17) and Soviet economists (e.g. Glotov 1973, 60, Pavlov 1976, Shatalin 1980, 68, 70-71) are beyond the subject matter of this study. Apart from the operationalization problem, cost minimization remains the general economic criterion for industrial location in the Soviet Union.

Location principles are a special trait of the Soviet approach to areal allocation of investments. The main location principles are (Khrushchov 1979, 85):

- accelerated industrial development of backward areas, especially those inhabited by non-Russian nationalities,
- intensified exploitation of the natural resources of eastern regions,
- strengthening of the country's defense potential.

It is evident that these principles do not necessarily meet the cost minimization re-

quirement. Thus no operational guidelines to investment decisions can be deduced directly from these principles. One can agree with Huzinec (1977, 261) that much of Soviet location theory is actually concerned with regional economic development (rather than location decisions as such).

However, location principles are an integral part of the Soviet investment allocation policy, which has and still guides much of the industrialization in the north, east and other peripheral areas. In the period of large-scale industrialization from the 1930s to the 1950s

3. CHANGES IN THE AREAL STRUCTURE OF THE INDUSTRY

3.1. Tsarist Russia

The manufacture of paper in Russia began in 1565 and it remained a handicraft up to the 19th century. The first paper machine was started up in 1816 and by the end of the century machines had replaced manual production. Pulp also replaced rags as the raw material. Paper production entered a period of rapid growth and it increased from 35,500 to 226,000 tons in 1861-1914.

On the eve of the First World War 60 % of the production took place in the vicinity of St. Petersburg and in White Russia, with the remainder concentrated almost entirely on central and southern Russia. Northern areas and the Ural region accounted for an extremely small proportion.

There were many reasons for the concentration of production in the environs of St. Petersburg. The city had a large timber export harbor and logging was extensive in the adjacent districts around the capital; raw material supplies were therefore secure. Moreover, the pulp, chemicals and machines required by the paper industry were also brought in through the St. Petersburg harbor. Marketing factors were also significant in the location of industry in St. Petersburg (Rodgers 1955, 92). In general, the location of industry in this period can be regarded as market-oriented. Two mills - Sokol in the Vologda region and Lobva in the Urals - can be considered raw-material-oriented. More

cost minimization was disregarded in favor of various location principles.

An economic geographic analysis of industrial location is usually based on location factors, which are converted into production inputs and costs to determine minimum cost location. This approach is also applicable to Soviet circumstances, where cost minimization is stated as the prime location criterion. Another question is whether exact empirical calculations can be made from the available Soviet material.

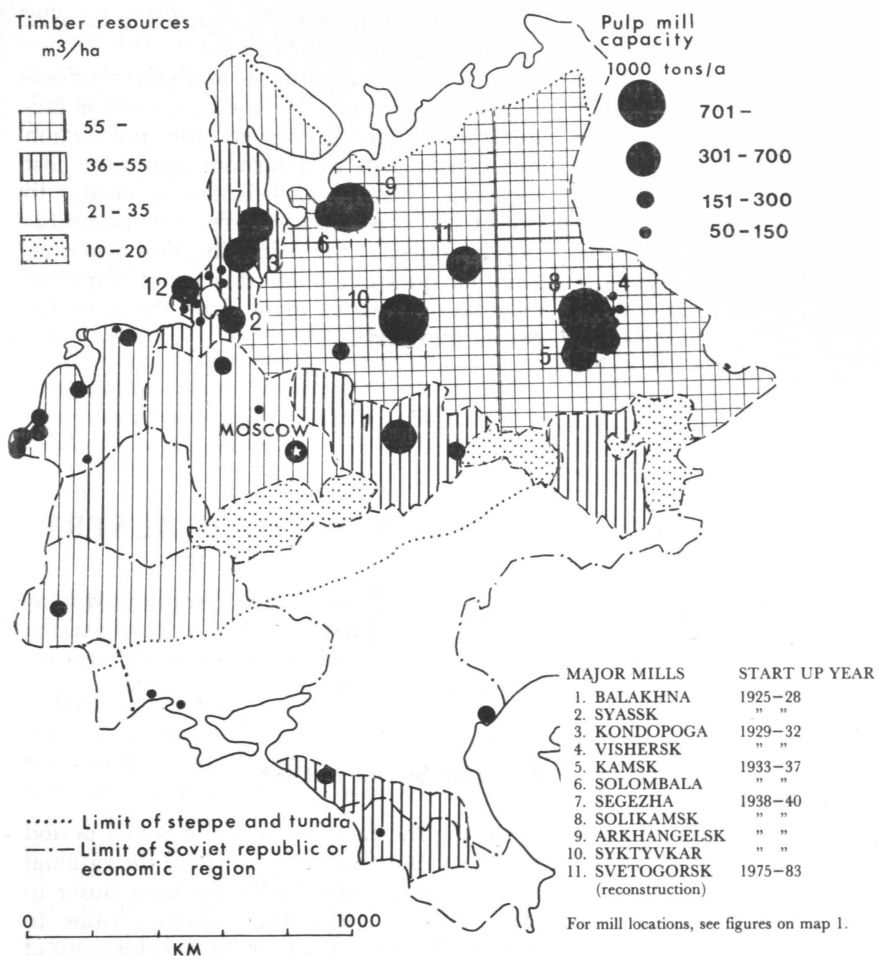
than half of Russia's paper mills were destroyed in the First World War (Uchastkina 1973, 16). Pre-war production levels were re-established in 1925.

3.2. The Soviet period

During the early years of the Soviet period Lenin's view, according to which the rational location of industry called for sites closer to raw material and energy sources, came to prevail. Thus the plan for the development of the forest industry for 1924-41 stated that in the main, forest industry had to be concentrated in the northern, north-western, Vyatka-Vetlyuz and Ural regions. Furthermore, the resources of Siberia and the Far East were to be utilized, primarily with the export trade in mind (Talevich 1927, 44). At the same time the concept of combined production of paper, lumber and plywood at integrated mills, in the manner of Sweden and other Western countries, was proposed (Faas 1927, 6).

These ideas were brought closer to realization in the five-year plan approved in 1929 and in the conference on the reconstruction of the forest industry held in 1932, at which the following was decided concerning the course of future development:

- the forest industry was to be developed in heavily forested areas



Map 1. Timber resources and pulp mills in the European Soviet Union.

Kartta 1. Euroopan SNTL:n puuvarat ja massatehtaat.

- new mills were to be integrated. They would comprise several units and have a common source of raw material, energy supply and utilization and they would make use of all wood raw material, including wood residues (Glotov 1977, 11).

The move to locations closer to raw-material sources had already begun in 1925-28, when the complexes at Balakhna and Syassk were built. In 1929-32, during the first five-year plan, the complexes at Kondopoga and Visher, in Soviet Karelia and in the Urals, respectively, were completed. During the second five-year plan the Kama and Solombala complexes were completed in the Urals and in the vicinity of Archangel. In 1938-40 integrated mills were also started up at Segezha

in Soviet Karelia, Solikamsk in the Urals and at Archangel (Veinova 1958, 72-93). For mill locations, see map 1.

During this period there was a rapid shift in the paper industry to the forested areas of northern Russia and the Urals. In 1937 one-fourth of production took place in these regions (Rodgers 1955, 95). At the beginning of the 1930s bold plans were also made for investments in regions east of the Urals. It was estimated that timber resources would in the future allow an annual production of 7 million tons of pulp in Siberia and the Far East (Altgauzen, Shkondin 1932, 43). According to even a conservative estimate, Siberia was to be producing 150,000 tons (Stoyanov 1932, 24). Opinions to the effect

that Western Siberia alone could be producing 400,000 tons of paper annually were also voiced at this time (Laksberg 1933, 271). However, these projections did not materialize in the 1930s.

During this period Siberia and the Far East accounted for 13-18 % of the total investment volume. However, industrialization was not broadly based, and concentrated on fuel and raw-material intensive sectors (coal and ores, logging, the sawmill industry). Production involving a greater value added - for example the engineering, chemical and paper industry - was not developed at this time (Ekonomicheskie problemy razvitiya Sibiri 1974, 34).

Production of course dropped during the Second World War, but areas taken during the war - Karelia, East Prussia (the present Kalinigrad oblast) and southern Sakhalin - provided considerable additional capacity. In 1940-50 pulp production rose from 0.9 million to 1.5 million tons and production of paper and board increased by approximately the same amount (cf. Glotov 1977, 36-37). These production volumes were inadequate with respect to the achievement of consumption targets.

A new phase in development began in 1960 with the publication of the decision of the Central Committee of the Soviet Communist Party and the Council of Ministers of the USSR concerning "measures to eliminate the lag in the pulp and paper industry." The decision led to the construction of two large paper machine factories in Petrozavodsk and Izhevsk and to expansion of existing facilities in Leningrad and Dnepropetrovsk and also to an extensive program of investment to increase pulp and paper capacity.

Plans for expansion were in line with the move toward sources of raw materials previously outlined. The first great wave of investment was in the five-year period 1961-65 during which the following major projects got under way: Kotlas and Syktyvkar in the European part, Bratsk in Siberia and Amursk in the Far East (Uchastkina 1973, 18). A strong bias in favor of the raw-material orientation was typical of this period.

The next great wave of investment was during the 9th five-year plan in 1971-75, when progress in the utilization of the forest resources of Siberia and the Far East con-

tinued. During this period the Krasnoyarsk and Selenga mills started up and work on Ust-Ilimsk began.

During the 10th five-year plan, 1976-80, growth in the production of pulp and paper was achieved primarily by expanding or rebuilding existing facilities. The pulp mill at Ust-Ilimsk, the major Siberian project, started up.

3.3. The present areal structure

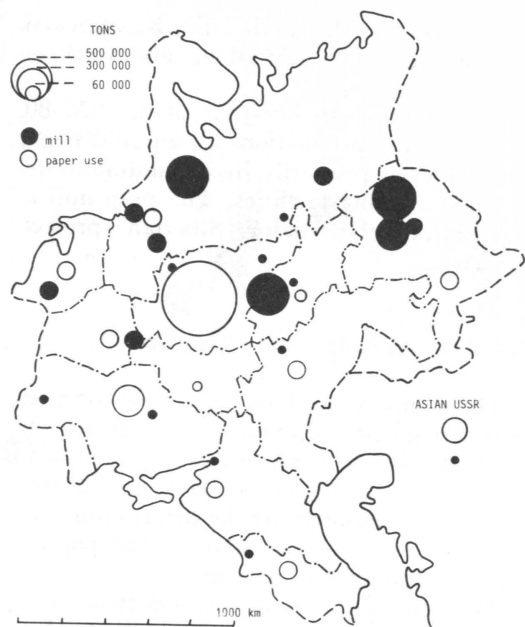
The standard analysis of the present areal structure of the pulp and paper industry can be made on the basis of raw materials and markets as location factors. Here we can consider forest resources as the determining element for raw-material sources and population distribution for markets.

An examination of the location structure is facilitated by the fact that the main markets and raw material sources are separated by some distance from each other, the densest areas of population being south of the taiga zone. This means that the pattern of location can be perceived merely by examining the maps.

Map 1 depicts the location of pulp mills in relation to forest resources in the European Soviet Union. This indicates that the production of pulp, which is a semifinished product, is largely raw-material-oriented; this is further supported by the location of mills in Siberia and the Far East. The raw-material orientation is also shown by the fact that in 1975 71 % of all production of pulp occurred in so-called heavily-forested regions. (Glotov 1977, 36), i.e. basically the taiga zone.

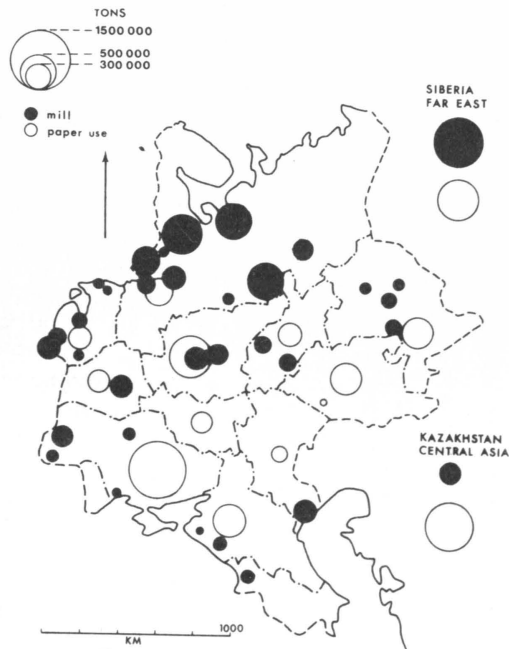
The mills located outside the heavily forested areas are mainly in the Baltic region. Zhidachov in the Ukraine is raw-material-oriented because it gets its timber from the Carpathians. The two mills in the Caucasus can also be regarded as raw - material - oriented. The mills located in unforested areas - Astrakhan, Kherson and Izmail - were originally intended to operate with reed, but were later converted to use mainly wood or waste paper. Astrakhan alone uses reed. (Solomko 1977, 128, Barr 1971, 63). Thus the location of these mills may be considered the result of planning errors.

The location of paper and board produc-



Map 2. Production and use of printing and writing papers in the Soviet Union.

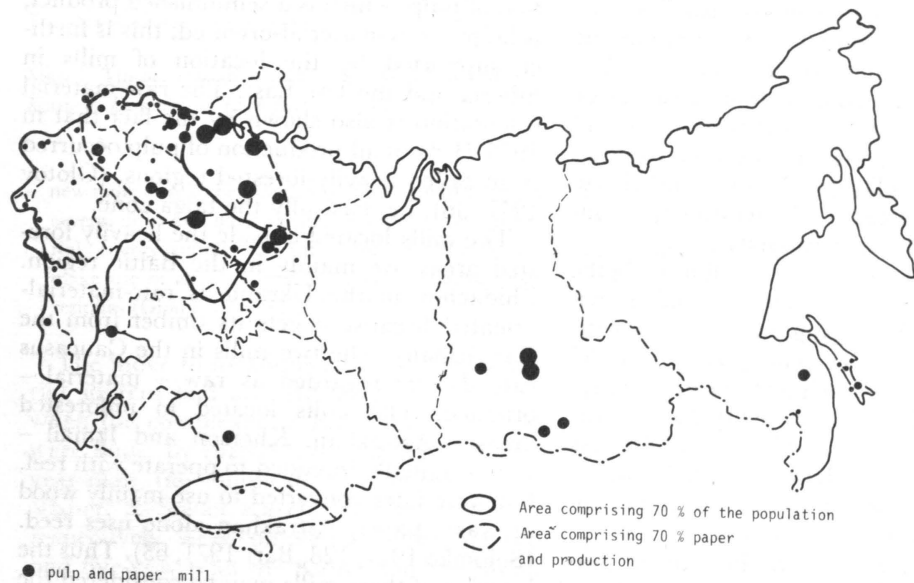
Kartta 2. Kirjoitus- ja painopapereiden tuotanto ja käyttö SNTL:ssä.



Map 3. Production and use of industrial papers. Kartta 3. Teollisuuspapereiden tuotanto ja käyttö.

tion is indicated by maps 2 and 3. A cursory comparison with map 1 shows that paper production is definitely more market-oriented than pulp production. In 1975 only 51 % of

the paper and board production took place in the heavily-forested areas (Glotov 1977, 37), and thus 49 % can be considered market-oriented.



Map 4. Location of the Soviet pulp and paper industry and its main markets.

Kartta 4. SNTL:n massa- ja paperiteollisuuden ja sen päämarkkinoiden sijainti.

Map 4 was drawn up in order to provide a general picture of the market orientation of paper and board production. It includes both the areas in which 70 % of the country's population lives and the area where 70 % of the paper and board production takes place. These areas overlap each other extensively, and thus it can be said that most paper and board production in the Soviet Union is market-oriented. Even the raw-material-oriented mills of northern Russia and the Urals are located near the primary market areas.

This is indeed to be expected, for the prevailing view of mill location calls for efforts to minimize costs. As a result, pulp production – which involves a considerable loss in weight – takes place near the sources of raw materials, whereas paper and board production is more market-oriented.

The special feature of the location of the Soviet pulp and paper industry is the extreme raw-material orientation behind certain location decisions. This refers to the large mills built in Siberia (Bratsk, Ust-Ilimsk, Krasnoyarsk, etc.), which produce primarily for domestic consumption but also for export. The unique feature of these mills is that they are located 3500–6000 kilometers from the major markets, something that is unknown in other large forestry areas (North America, Brazil, the Nordic countries). The Siberian paper industry cannot be regarded as completely raw-material-oriented, for the more than 25 million people in the region itself require local production.

3.4. Summary

The expansion of the paper industry of Russia and the Soviet Union can be divided into a few distinct phases depending on the prevailing orientation in the location of mills.

1st period, to 1913. The location of industry in the Tsarist era can be considered mainly market-oriented.

2nd period, 1925–39. This phase spans the time between the making of the first development plan for the paper industry and the outbreak of war. A definite bias in favor of the raw-material orientation in the concentration of investment in the forested areas of northern Russia and the Urals was typical of the period.

3rd period, 1940–59. This phase was an exception in the history of the paper industry, for due to external factors, the acquisition of territory, there was a shift in industrial priority to the periphery, away from the main sources of raw material and toward a market orientation. This can be regarded as an interim phase, for little new capacity was built.

4th period, 1960–80. During this period the raw-material orientation again came to the fore and unlike the 1925–39 period, expansion reached Siberia for the first time as well. Toward the end of the period there was a decline in eastward expansion as the bulk of investment was on rebuilding and expanding existing plants.

4. EMPIRICAL ANALYSIS OF LOCATION FACTORS

In the following, the factors deemed essential for future location decisions in the pulp and paper industry – markets, raw material sources, relative costs – are analysed empirically. The material concerning markets, timber resources and their use as well as cost data, is collected from various published Soviet sources. Data on the capacities of paper and pulp mills are from Soviet sources and Finnish data banks.

4.1. Definition of markets

In order to determine the degree of market orientation of the pulp and paper industry the location of markets¹ has to be defined. Mar-

¹ In this context the term market, as customary in locational studies, is used. Although there is no working market mechanism in the Soviet Union the term "market" is widely used also by Soviet economists (viz. Ekonomicheskaye entsiklopediya 1979, 526).

kets in this context mean the areal consumption of pulp and paper. No such data are available so areal consumption has to be estimated.

Consumption estimates made in the West e.g. by the FAO are based on the concept of derived demand. In most paper grades the areal demand is a function of national income. There is a marked though not always linear correlation between the gross national product and the paper consumption in a certain region (cf. Sundelin 1970, 77).

An approach like this to the Soviet paper markets would require data on the population distribution and areal differences in per capita incomes. One way of tackling the problem would be to multiply the per capita income by the population and knowing the income elasticity of paper, calculate the paper demand potential. The required data on the Soviet Union are not available so that another approach has to be chosen.

As a rule, the product coming out of the pulp and paper mill is not ready for consumption. It has to be processed further into printed matter, packages, etc. Thus the prime users of pulp and paper are not consumers but intermediaries, of which a list is given below:

Product	User
Pulp	paper mill
printing paper	printing houses
writing paper	organizations, offices, population
industrial papers:	
- liner and fluting	agriculture, food industry
- sack kraft, sacks	manufacturing, commerce, cement, sugar, fodder, fertilizer industry, food industry
- technical papers	manufacturing
- sanitary tissue	households, hospitals, etc.

Pulp is a semifinished good, of which 80 % in the Soviet Union is processed at integrated mills. The rest, over 1 million tons a year, is market pulp, which is delivered to domestic mills and exported. Most of the market pulp (almost 0.9 million tons, calculated according to Glotov 1977, 36-37) is produced in Siberian and Far Eastern mills.

4.1.1. Location of markets

The analysis of paper markets can be started with the grouping of paper grades into two categories also used by FAO: writing and printing papers including newsprint, and industrial papers.

About 30 % of the Soviet paper and board¹ production consists of printing and writing grades (vz. Narodnoye khozyaistvo SSSR za 60 let, 1977, 238). The prime users of these grades are printing houses defined here as markets. Their location is very centralized; 60 % of all Soviet printed matter is produced in Moscow, where publishing in Russian is concentrated. The second largest city, Leningrad, accounts for only 1,5 % of the total (calculated from Pechat SSSR 1976). One motive for decentralizing printing arises from the demand for publications in national languages in non-Russian republics and areas. Thus, the second biggest producer of printed material is Kiev, the Ukrainian capital, which is the third largest city in the country. The Ukraine accounts for 10 % of total printing paper use, which is considerably less than its share of the population, 17 %.

In the Baltic republics the shares of printing and population are almost the same, 2,8 % but in the Caucasian republics the share of population far exceeds that of the printed matter, 3,2 %, calculated in terms of the quantity of paper used.

On map 2 there are mills producing printing and writing papers as well as their markets, i.e. printing houses in the European part of the country. The Asian part accounts for only 2 % of all printing papers in only one mill there (Krasnoyarsk).

The bulk at the so-called industrial papers, which accounts for over 2/3 of the whole Soviet output is used for packaging and technological purposes. Paper going directly to consumers, such as sanitary tissue or wrapping paper, accounts for a small share of the total. The largest users of packaging papers and sacks are the food, cement and fertilizer industries, but other industries also use paper-based packaging materials. The metal and engineering industries are an exception;

¹ In the Soviet Union a clear distinction is made between "paper" and "board" but in the West no clear boundary is drawn. That is why the term paper also usually covers "board" in the Western practice.

they use very little packaging material of this kind.

No data is available on the respective shares of these users in the total consumption. That is why the population distribution is chosen as an indicator of areal markets for industrial papers on map 3. It is made on the assumption that there are no areal variations in the per capita consumption of paper. However, this assumption is not wholly realistic. The areal per capita income shows a clear positive correlation with the level of industrialization (cf. Telepko 1971). Thus it can be assumed that paper consumption is higher in industrialized than in agricultural areas of the Soviet Union. The exact relationship between areal income level and paper consumption in Soviet circumstances is not known, though, and it will not be assessed in this connection either. The areal units used on the map (economic regions) are so big that part of the differences are evened out.

The areal consumption of industrial papers is determined by multiplying the population by the annual per capita consumption, which was 26 kg in 1976.

When comparing maps 2 and 3 it is evident that the production of printing papers is more centralized than that of the industrial grades. Almost all printing papers are produced in the European part of the country whereas in industrial grades important quantities (up to 20 %) of industrial papers come from Siberia and the Far East.

Also, printing paper consumption seems to be more centralized than that of the industrial grades. This is primarily due to the way the respective markets were defined. If the population distribution had represented the markets, the areal pattern of consumption would have been identical on both maps.

As data on the use of paper by printing houses were available areally, the markets for printing papers were defined accordingly. Their use is highly concentrated in Moscow.

A large part of the industrial paper is processed for packaging. This is partly made in the same paper mill, partly in factories specializing in packaging products.

If the markets are defined analogously with printing paper markets, sack and packaging factories have to be chosen as users of corresponding paper grades. This approach was not chosen here, because

- in cases where packaging production is integrated in the paper mill the producer and the user would be the same, as for instance the Segezha mill. This is not the case with printing papers, the production of which is not normally integrated into printing
- in contrast to printed matter it is difficult or impossible to obtain sufficient empirical data on Soviet packaging production.

The users of industrial papers constitute a heterogenous group compared with the users of printing papers. Thus the best operational way of estimating markets for industrial papers seems to be the population distribution (map 3).

4.2. Raw materials

For its raw materials the pulp and paper industry is essentially dependent on fibres obtained from wood which is made into pulp and pulp to paper. Waste paper is also an important raw material. Also other materials such as kaolin are used as fillers and coaters in paper making. In most paper grades their percentage is so small that they are without significance for location decisions.

The major raw material source in the Soviet context is pulpwood. There are differences between wood species regarding suitability for pulping. The best suited are softwoods, excluding larch (*Larix sibirica*). The development of kraft pulping has also made the growing use of hardwood possible. In the Soviet Union the share of hardwoods (mainly birch, *Betula* spp, and aspen, *Populus tremula*) was 10 % in all pulpwood used in 1975 and the target for 1980 was 14 % (see Attikov 1976, 13).

The most abundant wood species of the Soviet Union, the larch, is still a problem from the pulping point of view. It cannot be hauled over long distances economically, as it sinks when floated. Moreover, pulping of larch together with other wood species is difficult because larch contains large amounts of water soluble elements.

The second major source of raw material is waste paper. The Soviet paper industry used 1.8 million tons of it annually in the late 1970s, which corresponded to 15 % of all paper produced (Solomko 1977, 130, Kasparov 1979, 20).

Reed-based paper mills (Izmail, Kherson, Kzyl-Orda, Astrakhan) have also been built, but due to difficulties in reef procurement they have shifted to pulpwood (Barr 1971, 56, Solomko 1977, 128).

In the following analysis the availability of the major raw material source, pulpwood, is assessed by economic region. The analysis also requires a description of the peculiarities of forest management in the Soviet Union, especially concerning harvesting and surveying methods which affect the availability of pulpwood.

In earlier phases of areal expansion up to the late 1970s investments in the pulp and paper industry have been greatly channeled to the densely forested taiga zone (European north and also Siberia). When studying the future raw material base from the areal expansion point of view, mere mapping of timber resources, as presented by many authors, is not adequate. One must also know the intensity of timber utilization and the annual increment of the growing stock as well as other potential raw material sources (wastewood residues). This kind of analysis will also be followed here.

In the following the results of an analysis of the future supply of pulpwood in the Soviet Union is attempted. The analysis is based on a careful screening of published Soviet data (statistical yearbook, monographs, forestry journals). This is the first time an analysis of the raw material base of the Soviet pulp and paper industry has been attempted on the level of economic regions. Corresponding data, which cover either the whole European part of the country or certain areas only, have been published in the Soviet Union (Anuchin 1978, 1980, Lyamin 1978, Solomonov 1978). Barr (1970, 1979) has analyzed the raw material base of the whole forest industry sector without special attention to the pulp and paper industry.

4.2.1. Reserves for increased pulpwood utilization

There are several sources of greater pulpwood supply:

- annual increment exceeds the annual logging volumes
- unutilized mill residues
- wood reserves freed from fuelwood use
- intensification of silviculture
- wood freed from other uses

It is evident that these reserves cannot be taken into use very rapidly or simultaneously. According to the experience gathered in many Western countries, the economically feasible order of utilization can be as follows:

- sawmill residues (softwood)
- annual increment in excess of annual softwood cut
- plywood mill residues (mainly hardwood)
- annual increment in excess of annual hardwood cut
- fuelwood freed for industrial use (mainly hardwood)
- logging residues
- sawdust
- intensified silviculture

In the Soviet Union the economical order of these measures may deviate from the above for institutional reasons. In the following analysis it is supposed that the annual increment in excess of annual cut, mill residues and, possibly, reserves freed from fuelwood use, can be regarded as economically feasible pulpwood reserves within a reasonable period of time (under Soviet conditions). As for logging residues and sawdust, it is reasonable to suppose that there are still too many technical and economical constraints on their large-scale utilization as raw materials. Consequently these items are not included in the following analysis. Intensified silviculture is not considered a rapid way to increase available pulpwood and consequently it is not included in the analysis.

4.2.2. Special features of the utilization of forests and its planning

In the utilization of forests the principle of continuity and rationality prevails in the Soviet Union. However, methods applied in the Soviet Union differ from those in the Nordic countries in estimations of both growing stock and allowable cut. Moreover, administrative considerations and environmental protection requirements impose limitations on the industrial use of wood.

4.2.3. Forest surveys and allowable cut

Forest utilization and allowable cut in the Soviet Union are based on forest surveys (in Russian *taksatsia lesa, lesoustroistvo*). However, the extent of the forested areas and deficiencies in methods lead to unreliable results. Also, international comparison of results as well as interpretation is difficult, be-

cause the methods used differ from those in for example the Nordic countries.

There is a continuous debate in the Soviet professional literature and press about the forest survey methods and their reliability. In one year surveys are made of a 45 million hectare area which comprised 4 % of the forested area and 25 million hectares in Siberia and the Far East (Sinitsyn 1978).

The classification of forests according to wood species is a possible source of error. In some cases the area of coniferous forest is overestimated, for the total may include areas in which the percentage of conifers is only 40 % (cf. Grave 1978).

The method used to estimate growing stock in the Soviet Union yields smaller results than that used for example in the Nordic countries. The average annual growth in growing stock is obtained when the volume of final felling per hectare is divided by the age of the stand in years. This method fails to take into account the annual mortality, which might be as much as one-fourth of the total growth. In the Nordic countries measurements are made several times in the course of rotation, which reflects more accurately the real growth.

Furthermore, the method for computing the allowable cut differs considerably from that applied in for example the Nordic countries. In fact, agreement has still not been reached in the Soviet Union regarding the best method, for actually five methods are in use. As a result, the annual allowable cut in 1951-73 was revised three times by reducing the total from 1,752 million to 620 million m³ (Glotov 1977, 73). In computing the allowable cut in the Soviet Union only the mature stands are taken into account. In this way the allowable cut remains much smaller than that in similar conditions in the Nordic countries¹, where it is based on total growth (provided the age class distribution is even).

Since the allowable cut in the Soviet Union does not include growth in young stands, which by means of thinnings could be used as pulpwood, reserves important to the pulp and paper industry are left outside the estimate.

¹ In lightly forested areas such as the Ukraine, White Russia and the black earth zone of the RSFSR, where mature forests account for only 3-7 %, the letter of this rule cannot be observed.

4.2.4. Institutional framework

Not all the forested area of the Soviet Union is by any means included within the sphere of timber procurement. Some of the forested area belongs to administrative sectors outside the forest industry and is reserved for their own use (*zakreplennye lesa*); some is also reserved for the collective farms. Timber for use by the forest industry is not in general available from these forests. These account for 6,3 % of the total forest area and 3,8 % of the coniferous forests. The percentage is larger in the European part of the country and varies greatly by region. In the Ukraine and Latvia it is as much as 38 % (Vorobyov et al. 1979, 56).

The remaining forests are under the administration of forestry and forest industry organizations (mainly *Minlesbumprom*). They are divided according to wood production into three groups:

- 1) Conservation and recreation forests. These include urban green belts, forests bordering watercourses and roads, shelter belts, forests bordering the tundra etc. In these forests thinning is permitted but not clear cutting.
- 2) Forests where thinning is carried out but not extensive clear cutting. These forests are multi-purpose areas.
- 3) Forests used exclusively for timber production, where clear cutting dominates (Cf. Sinitsyn 1976, 48-49, 54).

The existence of forests belonging to organizations outside forestry and the forest industry and the large percentage of forests reserved for recreation or otherwise protected curtail the volume of timber available for industrial use. Admittedly, normal harvesting does take place in these forests, with the exception of those reserved for recreation or otherwise protected but forest management is on a smaller scale in collective farm forests than in forests under the administration of forestry organizations. The difference between allowable cut and actual cuts in group 1 forests is substantial, for large scale clear cutting is not carried out in them.

4.2.5. Harvesting methods

Harvesting methods have bearing both on the yield of timber species at a given moment and on continued development of the stock.

Moreover, the above-mentioned forest groups each require their own special harvesting methods. When the thinning method is not suitable, for example due to a lack of harvesting equipment in these forests, the yield remains below the potential and the natural mortality increases.

The most important harvesting methods in the Soviet Union are final cutting (glavnye rubki) or clear cutting (sploshnye rubki). These accounted for 82 % of the harvested area in 1976. In the taiga zone selective clear cutting (uslovno-sploshnye rubki) is also practiced; with this method the less valuable wood, in general hardwoods and larch, is left. This method accounted for 13 % of the harvested area in 1976.

Thinning accounted for 5 % of the total area harvested and 2 % of the timber volume accumulated (Vorobyov et al. 1979, 130, 165).

Consequently, the difference between actual logging volumes and the allowable cut, which under Scandinavian circumstances indicates the unutilized roundwood reserves, is not applicable to Soviet circumstances. Annual increment is a more reliable indicator than the allowable cut when assessing potential raw material reserves. In the following analysis the annual increment is collated with annual logging volumes. The latter are based on data from 1977.

4.2.6. Timber resources

Timber is the most important raw material for the pulp and paper industry and has the greatest effect on the location of industry. The forest area of the Soviet Union is 770 million ha and the total volume of the growing stock is 83 billion m³.¹ Larch accounts for 37 %, other conifers (*Pinus sylvestris*, *Picea abies*, *Pinus cembra*, *Abies sibirica*) for 48 % and hardwoods (mainly *Betula* spp., *Populus* spp.) for 15 %. Forests cover 38 % of the country's area, but are distributed unevenly. Most of the timber (83 %) is located in regions east of the Urals while the steppe and desert zone is virtually treeless. The location of forest reserves is disadvantageous with respect to the regional demand for wood products. The annual log-

¹ All quantities of roundwood given here in m³ mean solid volume. Soviet sources do not indicate whether they are with or without bark.

ging volumes were about 360–380 million m³ in the late 1970s, of which the share of Siberia and the Far East was one third. For a more detailed analysis of Soviet timber resources and wood supply see Glotov 1970, Tsymek 1975, Vorobyov et al. 1979, Timofeyev 1980, Sutton 1975, Barr 1970, 1979.

When studying the potential for areal expansion in the pulp and paper industry, still unutilized timber reserves, i.e. logging potential, are relevant. As explained earlier, the allowable cut is not a good indicator of this in Soviet circumstances because it does not express the increment in immature stocks. Here, the logging potential is calculated as the difference between the annual increment and the annual cut by regions.

Data area a constant problem in studying the Soviet economy. The data problem has been solved as suggested by Barr (1979), by piecing together information from various sources, including statistical handbooks. Logging potential (surplus of deficit) by economic regions of the European part of the country are presented on table 1. Annual increment of the growing stock has been calculated according to Sinitsyn 1977 and Vorobyov et al. 1979. The annual cut is from Timofeyev (1980).

In the European part of the country the annual increment exceeds the annual cut by 4 to 5 million m³ in softwood and by 50–60 million m³ in hardwoods.

Similar figures are also proposed by Soviet authors. Lyamin (1978, 4) states that the annual cut of softwoods can be increased by 5 million m³ in the area in question. According to Anuchin (1978), 40–45 million m³ of the annual allowable cut of hardwoods remain unutilized.

The most promising areas for increased cutting seem to be the central economic region, White Russia, Northern Ukraine, the Baltic republics and northern parts of the Volga economic region.

Important parts of the reserves are to be found in immature forests requiring thinning, which yield small diameter wood suitable for pulping. Another reserve comprises forests of the groups 1 and 2. in which industrial cuttings are restricted. With suitable technology cuttings from these forests could undoubtedly be increased without damage to their other functions (recreation).

Table 1. Annual additional wood raw material potential by economic regions in the European USSR in 1977, millions m³.

Taulukko 1. Vuotuinen puuraaka-aineen käytön lisäysmahdollisuus SNTL:n talousalueittain (Euroopan puoli) v. 1977.

	Softwoods	Hardwoods	Total
<i>North-West</i>			
Increment of growing stock	76,0	27,0	103,0
Cut	83,0	8,0	91,0
Surplus/deficit	-7,0	19,0	12,0
Saw and plywood mill residues	2,3	0,5	2,8
	-4,7	19,5	14,8
<i>Urals</i>			
Increment of growing stock	35,0	27,0	62,0
Cut	46,0	11,0	57,0
Surplus/deficit	-11,0	16,0	5,0
Saw and plywood mill residues	1,4	0,4	1,8
	-9,6	16,4	6,8
<i>Volga-Vyatka</i>			
Increment of growing stock	11,0	17,0	28,0
Cut	11,0	16,0	27,0
Surplus/deficit	0,0	1,0	1,0
Saw and plywood mill residues	1,0	0,2	1,2
	1,0	1,2	2,2
<i>Centre</i>			
Increment of growing stock	16,5	24,0	40,5
Cut	8,0	19,0	27,0
Surplus/deficit	8,5	5,0	13,5
Saw and plywood mill residues	1,2	0,3	1,5
	9,7	5,3	15,0
<i>North Caucasus, Caucasus</i>			
Increment of growing stock	3,0	10,0	13,0
Cut	1,0	3,0	4,0
Surplus/deficit	2,0	7,0	9,0
Saw and plywood mill residues	0,3	0,3	0,6
	2,3	7,3	9,6
<i>Ukraine, White Russia, Baltic</i>			
Increment of growing stock	..	..	58,0 ¹⁾
Cut	..	..	41,4
Surplus/deficit	..	..	16,6
Saw and plywood mill residues	1,9	0,4	2,3
	..	..	18,9

1) estimate
.. no data available

The figures presented are of an indicative nature because

- data on annual increment of the growing stock are approximate
- annual cut by wood species is an estimate based on data from the early 1970s
- when determining the logging surplus the annual increment is not sufficient; the age distribution of the growing stock must also be taken into consideration, which is not the case here.

4.2.7. Wood residues as raw material

Sawmill, plywood mill and logging residues can be used for pulping or fuel when chipped. In the Soviet Union 65 million m³ of saw mill and plywood mill residues are produced annually. Of this 30 million m³ is suitable for chipping (0.4 million m³ is plywood waste). The rest is sawdust and other waste, which is not used as raw material in Soviet pulp mills (viz Korzov 1978, 7). Less

than 30 % of the residues, 8 million m³, was chipped and used as raw material. Consequently the annual unutilized reserves are over 21 million m³.

It is not realistic to suppose that all of these reserves could be drawn into industrial use. The administrative structure of the Soviet sawmill industry is one important factor complicating the procurement of wood residues. In the late 1970s about 40 % of the sawn wood was produced at the mills of the Ministry of Forestry and Forest Industries (then Minlesprom, since 1980 included in Minlesbumprom). All the sawmill residues (8 million m³) used for pulping came from these mills. They produced a total of 12 million m³ of such residues. Consequently, unutilized reserves amount to 4 million m³ annually.

Another category are mills whose production is also planned centrally although they do not belong to the above-mentioned ministry. These produced 45 million m³ of sawn wood, which represents 13.5 million m³ of chipable waste wood (cf. Shatilov, Afanasyev 1978, 4), so far unutilized for pulping. The remaining sawmills, producing about 15 million m³ annually, belong to various industries, organizations and collective farms. They are in general small, poorly equipped mills and can hardly serve as a pulp wood reserve in the foreseeable future.

The other potential waste wood reserve are logging residues. In the Soviet Union chipping has not yet measured up to plan. Academician N.P. Anuchin (1980) states that 40 mill. m³ of logging residues is produced annually, of which 40 %, i.e. 16 mill. m³, can be utilized economically.

To sum up, residues from the mechanical wood industry and logging combined yield an annual wood reserve of which more than 30 mill. m³ can be used economically. Of this the percentage of conifers can be estimated at 80–85 %. On the basis of the regional breakdown of cutting and sawing, it can be estimated that some 22 mill. m³ of this volume is from the European part of the country.

Much bolder estimates of the waste wood reserve have been presented. According to N. Anuchin, the mechanical forest industry produces 70 mill. m³ of waste wood and 40 mill. m³ of logging waste annually, of which 56 mill. m³ could be put to economical use. (Anuchin 1980).

4.2.8. Pulpwood reserves

The pulpwood reserves on which the growth of the pulp and paper industry can be based consist of underutilized timber resources and unutilized saw and plywood mill residues.

In the European Soviet Union the economically accessible annual wood reserves amount to at least 67 million m³. This figure does not include logging residues, nor wood reserves freed from fuel use. The distribution of these reserves by economic regions is presented on table 1.

Unutilized forest resources account for over 80 % of the reserve and wood residues for slightly under 20 %. Over 80 % of the reserves consist of hardwoods (mainly *Betula* spp., *Populus tremula*), but there is a lack of data in some areas and therefore an accurate figure cannot be given.

In all economic regions there are abundant unutilized hardwood reserves (mainly birch and aspen) whereas a serious deficit in softwoods, especially in saw logs, is felt almost everywhere in regions where the wood-processing industry is most developed: the North-Western, Volga-Vyatka and Ural economic regions. Annual available mill residues are estimated at 10 million m³.

The reserves analysed here contain a large proportion of hardwoods, small diameter wood and waste, which makes them suitable for chipping and thus a raw material base for the pulp, particle board and fiber board industries. In the late 1970s the Soviet pulp industry used 40 million m³ and the particle and fiber board industries appr. 10 million m³ (including small amounts of sawdust, cf. Delimov 1978, 40). The hydrolyze industry also uses certain amounts of low quality wood. The pulp and paper industry accounts for an estimated 75 % of total pulpwood use. If this share is to remain constant in the near future the available reserves for pulping in the European part of the country alone must amount to about 50 million m³ (mainly hardwood) annually. This exceeds total wood use by the pulp industry.

4.3. Relative costs

In the cost minimization approach, which is the main element in Soviet localization

doctrine, all relevant location factors are converted into production inputs and reflected in costs. Is it then feasible to choose a separate cost variable as a location factor for the pulp and paper industry, as suggested e.g. by Antonov and Trusova (1976) and Glotov (1977)? The answer is yes, if a cost element can be found which

- is sufficiently independent of the other factors, markets and raw material sources
- shows marked areal variation

The possible cost elements to be considered are total costs or production costs and investment costs. Production costs do not fulfil the first requirement because they include raw materials and transportation to end users (markets). Investment costs do not have these shortcomings. They consist mainly of outlays on machinery, equipment, materials and their transportation to building site as well as assembly and construction work. (Investment costs can be seen as a synthetic indicator reflecting e.g. harsh climatic and topographic conditions (high construction and manpower costs) and long distances (transportation costs). Investment costs incorporate production inputs that are subject to short-term variations such as material and manpower costs, but also deep-seated structures such as harsh natural conditions or long distances. Consequently investment costs also show areal variation. Thus relative invest-

ment costs can be regarded as a location factor.

4.3.1. Empirical material

Published data on areal cost differences in the Soviet Union are scant, but certain general conclusions can be made. It is self evident that investment costs are considerably higher than the national average in the zone of harsh climatic conditions, such as Siberia. A cold climate and permafrost raise building costs and can shorten the working season. Higher wages also have to be paid.

Certain data concerning cost differences in the pulp and paper industry have been published. According to Makoshin (1977, 19) a mill producing 500,000 tons a year of bleached saw-pulp costs 25 % more in Siberia than in the European part of the country and 35 % more if investments in infrastructure are taken into consideration. The actual cost difference is even bigger as construction of a Siberian mill tends to be 20–40 % longer than in the European part of the country. This delay is not sufficiently reflected in cost calculations (cf. Mansurova 1976). Siberian pulp and paper mills are large, relatively new, and this explains why the running production costs are not essentially above the national average (cf. Slepov 1974, 58–59). However, distances up to 4 000–5 000 km from the mills to the main consumption areas raise the real cost of Siberian pulp and paper much above the average.

5. TOWARD A LOCATION THEORY OF THE SOVIET PULP AND PAPER INDUSTRY

For the foregoing analysis three factors deemed relevant for explaining the location of the Soviet pulp and paper industry were analyzed empirically. Soviet sources also mention several other location factors such as energy, labour and water resources (cf. Antonov, Trusova 1976). Why were they omitted?

Energy is not considered a critical location factor by many specialists as big pulp and paper mills can be more or less self-sufficient

in energy (cf. Sominski 1980, 99). Labor and water supply are linked to a considerable extent with either markets or forest resources. Since markets can be determined according to settlement, market-oriented enterprises also have a dependable supply of labor. Labor can become a critical factor in the eastern and northern forest areas where labor shortages can arise both in the timber procurement stage and at the mills.

The production process requires large vol-

umes of water. In the core area of the paper industry, the coniferous forest zone, the river network is rather dense and evaporation is insignificant due to the short, cool summers. Here water supply can be regarded as secure. Further south, in the mixed forest and forest steppe zone where a continental climate prevails, water shortage may prove a critical factor. Also, competition with other forms of water use and water protection regulations become a problem in more southern, densely populated regions. Technological development is advancing toward lower water consumption (closed circulation) and dependence on an abundant supply of water is declining (Solomko 1977, 135).

No one of these factors is sufficiently important in itself to act as an independent factor in location. The energy factor can be expressed by means of costs; labor and water supply – at least in the framework of larger regional units – are difficult to distinguish from markets and raw material sources.

If the *cost variable* is chosen as the third regional factor, which reflects regional fluctuations in either investment or production costs, certain advantages are gained. Investment costs are a combination of many factors: the regional availability of production inputs, the regional availability of labor, the transport factor, natural and climatic conditions. Moreover, this factor is not dependent on the two previous factors, the location of raw materials and markets.

The theory can be formulated as follows:

The regional expansion of industry is the result of location decisions which are decisions to invest. These decisions aim at a given economic result, which under Soviet conditions calls for a location that minimizes costs. A location of this kind is a result of the effect of the location factors: the most important of these for the Soviet pulp and paper industry are *markets*, i.e. the location of users, *raw material sources* and the *regional differences in investment costs*.

The inclusion of the cost factor is a contribution of this article compared to that of Barr (1971). Investment costs are a factor that is rarely brought out explicitly in Western localization studies. This may be due for instance to the research problem chosen, in which the regional differences in investment costs are not relevant or correlate strongly with another cost variable that has been taken into account.

Since the theory formulated in this study seeks to predict future investment decisions, it can be tested with empirical material in the course of the next couple of decades. The new theory conforms to the more cost-conscious thinking which became prevalent in Soviet investment policy in the 1970s. Emphasis on the efficiency requirement in the channelling of investments also apparently means the beginning of a new phase in the history of the expansion of the country's pulp and paper industry. It was stated earlier that a definite period of raw material orientation began in 1960, when abundant new capacity was created in e.g. Siberia. It is possible that Barr's simple theory – based on raw material sources and markets – has been sufficient during a period when expansion with no regard for costs was typical.

A new period apparently began at the end of the 1970s when the emphasis shifted from increasing production by regional expansion to increase achieved through greater efficiency. This view has become dominant, as the proceedings of the 25th CPSU congress reveals: "Material and financial resources must be directed primarily to the modernization and renewal of functioning plants, where existent production capacity can be expanded with minimal investment costs" (Materialy XXV s'ezda, 1976, 46). The emphasis on economic approach has increased in the five-year period 1981–85. The new phase requires a new theory, which was attempted above.

6. DISCUSSION

The basic premise of this study is that raw material sources and markets are inadequate to predict future location decisions in the Soviet pulp and paper industry; regional cost differences, for which investment costs have been chosen to explain, must also be used as a variable. The pronounced raw-material orientation that began at the end of the 1920s and continued until the 1970s is apparently diminishing. What is an apparently more market-orientated policy is replacing it, although the new approach takes more direct account of regional cost differences.

The theory formulated contains a clear stand on the debate that has gone on for years about the regional expansion of the Soviet pulp and paper industry. This debate can be divided into two parts:

- 1) The traditional raw-material-oriented position emphasizes the necessity of eastward expansion in the coniferous forest zone. This conforms with the above-mentioned principle presented by Lenin and party resolutions on the development of the economic potential of the eastern regions (Materialy XXV s'ezda KPSS 1976, 223); thus there is also a strong ideological background for the raw-material orientation. This thinking was realized in the 1960s when expansion continued in northern Russia (the Syktyvkar integrated complex) and began in Siberia. Figures showing that a paper-pulp industry producing 30–40 million tons annually could be built on the forest reserves of eastern Siberia alone were typical of this period (cf. Vasiliev, Zheludkov 1965, 389).

The position of the traditional thinking is still strong in the discussion dealing with the pulp and paper industry. An example of this is the work published by Glotov in 1977 in which he proposes that expansion of the pulp industry can happen only in regions where there are abundant reserves of raw materials, water, and energy, primarily in Siberia and the Far East. He has specified those economic regions and oblasts which would be likely locations for new mills (cf. Glotov 1977, 177, 185).

Similar view are brought out by I. N. Voyevoda (1980, 56–57) in his work on the Siberian forest industry: the development of the Siberian forest industry has strategic importance. Because of the future growth rate in the sector, particularly in the pulp and paper industry, the location of large production units

in Siberia cannot be replaced by any other alternative without loss.

- 2) A second trend in the discussion lacks this one-sided concentration on timber resources. It stresses a more exact analysis of raw material resources and the significance of the cost factor.

The advantages of the utilization of the raw material reserves of the European Soviet Union over those of Siberia are underscored in articles by Academician N. P. Anuchin (1973, 1978, 1980) and by e.g. M. A. Attikov (1976, 7).

This study also definitely supports the point of view favoring the European part of the country. In addition to market and cost factors, the analysis of raw material reserves also shows that expansion of production capacity is feasible and profitable in the European-Ural region.

By taking into consideration those "additional" raw material areas located near markets and by eliminating those in which the investment costs become "unreasonable", one can conclude that for the time being, the expansion of the Soviet paper industry toward the east and north seems to be over. Future growth in production will be based on the expansion of existing mill capacity and on the more intensive use of forest reserves and other sources of raw materials now in use (the development of thinning, more extensive use of hardwoods and waste wood, more effective collection of waste paper, etc.). This trend is supported by regional differences in investment costs in favor of the European part of the country and the apparent reluctance to begin construction of new, large integrated complexes, which suggests reduction of the optimum mill size and additional prospects for the European part of the country as an investment area. These factors and the location of the main markets support the channelling of paper industry investments mainly to the European part of the country. This is contrary to the official aim of developing the country's eastern natural resources and industry, but it is compatible with the desire to minimize costs and achieve economies.

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SELOSTE

NEUVOSTOLIITON MASSA- JA PAPERITEOLLISUUDEN ALUEELLISTA LAAJENEMISTA SELITTÄVÄT TEKIJÄT

Eräs Neuvostoliiton massa- ja paperiteollisuuden kehittämisiongelmiä on oikeiden sijaintipäätösten tekeminen: pitäisikö tuotantoa kehittää olemassa olevissa laitoksissa jo vakiintuneilla alueilla vai laajentua Siperian metsärikkaille alueille? Tätä kysymystä voi lähestyä neuvostotutkijoiden V. K. Antonov ja L. I. Trusova esittämän teorian avulla, jonka mukaan massa- ja paperiteollisuuden sijainti riippuu pääasiassa kolmesta tekijästä: markkinat, puuraaka-ainelähteet ja kustannusten alueelliset erot.

Tässä artikkelissa teoriaa sovelletaan empiiriseen aiheeseen. Tutkimuksen tulokset viittaavat siihen, että Neuvostoliiton Euroopan puoleisessa osassa on vielä käyttämättömiä puureservejä. Koska markkina- ja kustannustekijät eivät suosi Siperiaan tapahtuvaa laajenemista, antaa tämä tutkimus tukea niille kannanotoille Neuvostoliitossa, jotka puoltavat maan Euroopan puoleisen osan suosimista teollisuuden kapasiteettia laajennettaessa.