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COINTEGRATION OF THE ROUNDWOOD MARKETS AROUND THE BALTIC SEA

An empirical analysis of Roundwood markets in Finland, Estonia, Germany and Lithuania*

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ABSTRACT: In this study the level of market integration between roundwood markets in the Baltic Sea region countries is studied. Five roundwood assortments in Finland, Estonia, Lithuania and Germany are investigated on the basis of monthly price data from the years 1994-2001. Johansen's method is used in analysing the degree of market integration between the countries. If cointegration is found, then also the exogeneity of prices is studied.

The results indicate that pulpwood markets are integrated to some extent, but only pine pulpwood markets were fully integrated. Birch pulpwood market have one cointegrating relation and spruce pulpwood two relations indicating partly integrated markets. The sawlog markets show no integration. This means that price development in each country is not necessarily linked with the price developments in the other countries analysed. The analysis shows no evidence of weak exogeneity in any of the assortment and country specific markets.

These results suggest that the Baltic Sea region is not a single market for roundwood. However, further studies using different data are needed to understand the relations and price development in the roundwood market of the Baltic Sea region.
Key words: Roundwood markets, roundwood prices, market integration, cointegration analysis, Baltic Sea countries

Marko MÄKI-HAKOLA. 2002. ITÄMEREN ALUEEN RAAKAPUU-MARKKINOIDEN YHTEISINTEGROITUVUUS. Suomen, Viron, Saksan ja Liettuan raakapuumarkkinoiden empiirinen analyysi. Pellervon taloudellisen tutkimuslaitoksen työpapereita n:o. 55. 49 p. ISBN 952-5299-53-8, ISSN 1455-4623.

TIIVISTELMÄ: Tutkimuksessa tarkastellaan raakapuumarkkinoiden integroituneisuutta Itämeren altaan alueella. Tutkimuksessa analysoidaan viiden puutavaralajin markkinoita vuosina 1994-2001 Suomessa, Virossa, Liettuassa sekä Saksassa. Aineiston muodostavat kunkin puutavaralajin kuukausihinnat tarkastelluissa maissa. Markkinoiden yhteneväisyyttä tutkitaan Johansenin yhteisintegroituvuus menetelmällä. Mikäli yhteisintegraatio vektoreita löytyy, niin myös heikon eksogeenisuuden olemassaoloa eri maiden markkinoiden välillä testataan.

Tulokset osoittavat että markkinat ovat vain joltain osin integroituneet. Mäntykuitumarkkinat näyttäisivät olevan täysin integroituneet. Kuusikuidulle löytyy kaksi vektoria ja koivukuidulle yksi yhteisintegroituvuusvektori. Nämä tulokset kertovat jonkinasteisesta, mutta ei täydellisestä yhtenevyydestä. Mänty- tai kuusitukkimarkkinoilla ei löydy ainuttakaan vektoria ja voidaankin puhua erillisistä tukkipuumarkkinoista. Yksittäisissä maissa mänty- tai kuusitukin hintakehitys ei siis ole havaittavassa yhteydessä muiden tarkasteltujen maiden hintakehitykseen. Tulosten mukaan mikään tutkimuksessa mukana olleista maista ei näytä olevan heikosti eksogeeninen minkään puutavaralajin suhteen eli mikään maa ei osoittautunut selkeäksi hintamuutosten lähdealueeksi Itämeren alueen puumarkkinoilla.

Kaikkiaan tulosten mukaan Itämeren alueen maat eivät muodostaneet jaksolla 1994-2001 yhtenäistä raakapuumarkkina-aluetta.
Avainsanat: Raakapuumarkkinat, raakapuuhinnat, markkinoiden yhtenevyys, yhteisintegraatio, Itämeren maat

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Yhteenveto – Itämeren alueen puumarkkinoiden alueellisuus

Tutkimuksen tarkoituksena on selvittää kuinka yhtenevät Itämeren reunavaltioiden puumarkkinat ovat keskenään. Puumarkkinoiden integroituneisuutta tutkitaan puun hinta-aikasarjojen avulla. Mikäli yksittäisten maiden raakapuun hintakehitys seuraa tarkasti muiden maiden hintakehitystä, markkinoita voidaan pitää yhtenä suurena puumarkkina-alueena, missä hinnat vaihtelevat varsin yhtenevästi. Raakapuumarkkinoiden integroituneisuutta on tutkittu aiemmin, mutta Itämeren maiden väliset yhteydet ovat tähän asti jääneet vähemmälle huomiolle. Tämän tutkimuksen tavoite onkin tuoda lisätietoa näistä yhteyksistä.

Aineisto

Tutkimusaineistona käytettiin raakapuun kuukausihintoja Suomessa, Virossa, Liettuassa sekä Saksassa. Tutkimuksessa selvitettiin viiden raakapuutavaralajin hintojen yhteisintegroituneisuutta ajanjaksolla tammikuu 1994 – kesäkuu 2001. Tutkittavat puutavaralajit olivat koivukuitu, kuusikuitu, mäntykuitu sekä kuusi- ja mäntytukki Saksassa hinnat ovat tilastoitu painotettuna indeksinä, joka sisältää suuren määrän erilaisia laatu- ja määräluokkia. Empiiristä tutkimusta varten myös Suomen, Viron sekä Liettuan hankintahinnat muutettiin ensin Saksan markka-arvoisiksi ja tästä edelleen indekseiksi.

Menetelmä

Markkinoiden yhteneväisyyden tutkimuksessa käytettiin Johansenin yhteisintegroituvuusmenetelmää. Johansenin menetelmässä tutkitaan epästationaaristen aikasarjojen pitkän aikavälin yhteyttä toisiinsa. Tuloksena saatava yhteisintegroituvuusvektorien määrä kuvaa yhteneväisyyden astetta. Markkinoiden voidaan ajatella olevan täydellisesti integroituneita, mikäli vektoreita löytyy yksi vähemmän kuin tutkimuksessa on maita mukana. Tällöin ainakin yhden hinnan lain heikon muodon voidaan ajatella pätevän markkinoilla. Mikäli vektoreita ei löydy, voidaan markkinoita pitää erillisinä.

Tutkimuksessa testattiin myös eri maiden puutavaralajikohtaisten hintojen heikkoa eksogeenisuutta. Maan puutavaralajihinta on heikosti eksogeeninen, mikäli sen voidaan katsoa aiheuttavan stokastisia trendejä, mitkä sitten heijastuvat muiden maiden markkinoille. Muun muassa fyysisesti suurien markkinoiden on ajateltu olevan heikosti eksogeenisia pienempiin verrattuna. Tutkimuksessa on siksi oletettu, että Suomi olisi heikosti eksogeeninen muihin, ainakin Baltian, maihin verrattuna.

Tulokset

Mänty- ja kuusikuidun analyyseissä sekä kuusitukin analyysissä selvitettiin kaikkien neljän maan välistä integroituneisuutta. Koivukuitu sekä mäntytukki puutatavaralajien kohdalla analyysit tehtiin ilman Saksaa. Saksa ei ollut mukana koivukuituanalyysissä hintatietojen puuttumisen vuoksi. Mäntytukkianalyysissä Saksa ei ollut mukana aikasarjan stationaarisuuden vuoksi.

Mäntykuitu markkinoille löytyi kolme vektoria ja tämän mukaan markkinat olisivat täysin integroituneet. Tukkipuumarkkinoille ei löytynyt ainuttakaan vektoria ja siksi voidaankin puhua erillisistä tukkipuumarkkinoista. Kuusikuidulle löytyi kaksi vektoria ja koivukuidulle vastaavasti yksi yhteisintegroituvuusvektori.

Oletus Suomen heikosta eksogeenisuudesta ei saanut tukea analyysistä. Tulosten mukaan mikään tutkimuksessa mukana olleista maista ei ole heikosti eksogeeninen.

Johtopäätökset

Syitä kuitupuumarkkinoiden integroituneisuuteen voi olla monia. Yksi saattaa olla paperiteollisuuden puuttuminen Virosta sekä Liettuasta. Kuitupuu onkin tärkeä vientiartikkeli. Tämä on johtanut siihen että kuitupuun hinta Baltian maissa on suuresti riippuvainen ulkomaisesta kysynnästä. Huomionarvoista on, että kuitupuumarkkinoilla toimivat yritykset ovat suuria verrattuna tukkipuumarkkinoilla toimiviin yrityksiin. Tukkipuumarkkinat ovat kaikissa maissa kilpailullisia markkinoiden rakenteesta päätellen ja tukkipuun kotimainen käyttö on suurta. Tukkipuumarkkinoiden eriytymisen syinä voivat olla esimerkiksi tukkipuun laatuerot sekä raakapuun kauppatapojen erilaisuudet eri maissa.

Tutkimuksen tuloksia tulee tarkastella tietyllä varovaisuudella. Tutkimusajanjakso oli suhteellisen lyhyt. Yhteisintegraatio analyysin luotettavuus kasvaa kun ajanjakso on pitempi ja havaintoja on enemmän. Monet Itämeren maista ovat niin kutsuttuja siirtymätalousmaita. Talouden kehitys on ollut nopeaa ja tämä on puolestaan saattanut johtaa hieman erillisiin hintakehityksiin. Kiinnostavaa olisikin tutkia, onko integroituneisuus lisääntynyt ajanjakson aikana. Tämä ei kuitenkaan ajanjakson lyhyyden vuoksi ollut mahdollista tässä työssä ja käytetyillä menetelmillä.

1 Introduction

Do we have a common Baltic Sea roundwood market? A commonly presented argument has been that roundwood markets in Europe, at least in the northern Europe, would be integrating due to a number of reasons.

The Baltic Sea region forms an interesting trade region of many countries with large and fairly similar forest resources. Forest industry in Finland and Sweden is already well known. Finland and Sweden took a big step towards common European market by joining the European Union (EU) in 1995. Now Poland and the Baltic countries; Estonia, Lithuania and Latvia are planning to do the same. Therefore, most of their economic policies are adjusted towards the EU membership. These so called countries in transition are former socialist countries that were characterised by an one-party political system and centrally planned economy till the late eighties[1]. Increasing European economic integration together with internationalisation of forest companies may lead to further integration on roundwood markets.

Econometric studies analysing the roundwood market integration have been made earlier, but these have studied relationships between the markets in the Western countries like for example Finland, Sweden and Austria[2] or Norwegian prices compared to European prices[3]. Some studies have been made on national roundwood markets. For example Toppinen and Toivonen[4] have studied the Finnish roundwood market cointegration.

However, roundwood markets between the Baltic Sea countries have not yet been in focus in econometric research. Thus, the relationships and linkages in roundwood markets between the Baltic Sea countries; Russia, Estonia, Latvia, Lithuania, Poland, Germany, Denmark, Sweden and Finland are not fully known. To fill this lack of information, this study focuses on the common development of roundwood markets between these countries.

The purpose of this study is to describe the characteristics of domestic roundwood markets in the different Baltic Sea countries and to investigate if the roundwood price development varies between these countries, i.e. if the roundwood markets in different countries are integrated with each other. If roundwood markets are fully integrated, then it is feasible to say that the countries have common roundwood markets.

[1] Csoka, 1998: p. 10
[2] Toivonen et al., 2000
[3] Nyrund, 1999
[4] Toppinen & Toivonen, 1997

Some of the countries in the Baltic Sea region are countries in transition and developing towards free market economy whereas others have always been in market economy. The development from socialistic economy to market economy takes time. It is feasible to assume that the market integration has increased during the study period. However, it is also reasonable to assume that roundwood markets around the Baltic Sea area may not yet be fully integrated. Therefore this study explores the degree of market integration on the Baltic Sea region. Market integration is analysed using the concept of cointegration. Roundwood prices may vary widely in different countries, but time series of roundwood assortments may share a same stochastic trend. In that case time series are cointegrated. In practice, the market integration among four Baltic Sea countries namely Finland, Estonia, Lithuania and Germany, will be tested.

There are two broad industries that demand roundwood in the markets, the pulp and paper industry and the sawmill and wood based board industries (wood products industry). The pulp and paper industry is generally characterised by larger and more global companies than the wood products industry. Pulpwood is also more homogenous than sawlogs and may therefore be used by different buyers. Therefore the pulpwood markets may be assumed to be more integrated than the sawlog markets. This assumption is supported by the findings of earlier studies.

The data in this study consist of monthly roundwood price series between 1994 - 2001 in these countries. Different roundwood assortments in this study are pine, spruce and birch pulpwood, pine and spruce sawlogs. Literature, statistical data, interviews and expert opinions are also used in this study.

The study method in statistical empirical analyses is Johansen's multivariate cointegration analysis[5]. Johansen's method has been widely used also in non-forest product markets around the world and this study follows the same path as most of the previous studies.

The paper is organised as follows: In the next section the subject, market integration will be presented. After that roundwood markets in the countries within the empirical study will be presented. The time series data is described and presented in section 4. The test method is presented in detail in the following chapter. After that the results from the empirical study will be presented and analysed. This study ends with a discussion and some concluding remarks. Finally, the list of references and appendixes are located in the last section of this study.

[5] Johansen, 1988, 1995; Johansen & Juselius, 1990

2 Market integration

It is often thought that many goods are traded in well-internationalised markets, i.e. markets have low trade barriers, homogenous products and that the end products are sold in the competitive world markets[6]. If markets in different countries are competitive and well functioning, then prices in these countries should be the same when the transportation costs are excluded (the Law of One Price) .

However, there may be temporary price differences even between neighbouring countries or regions. These differences may offer arbitrage possibilities in the short run but not on a long run. Traders can quickly transport tradable goods from low price countries to high price countries and in that way earn profits. This eventually leads to the new equilibrium, where prices differ only by the amount of transport costs[7]. The resulting competitive equilibrium is referred to as a "long-run equilibrium". The process of establishing market equilibrium is described by the short-run behaviour of the system, and referred to as the "short run dynamics". When market equilibrium is reached, the markets are integrated and the price of homogenous tradable good is the same in different countries. This situation is called as the strong form of the law of one price, i.e. [8]

$$X_{at} = X_{bt} * E_t \qquad (1)$$

Where X_{at} and X_{bt} represent commodity prices in the two markets at time t and E_t represents the exchange rate between the two currencies. When transaction costs exist and they are assumed to be constant throughout the period, then the weaker form of LOP is written as:

$$X_{at} = \alpha + X_{bt} * E_t \qquad (2)$$

Where α represents the transaction costs. This situation leads to co-movement between prices in different countries with integrated markets and therefore roundwood prices in the two countries are the same at each moment of time. There is no possibility to arbitrage. This co-movement is referred as cointegration. The strong and the weak form of LOP is described for example by Buongiorno and Uusivuori(1992).

If roundwood markets in different countries are integrated, then possible market shocks should spread to all countries. For example massive storm damages may increase roundwood supply in some country and roundwood prices in well functioning

[6] Nyrund, 1999: p. 5
[7] Silvapulle & Jayasuriya, 1994: p. 370
[8] Nyrund,1999: p. 5

competitive international roundwood market may decrease as a result. When there is no integration between the countries, the markets are autarkic. The other extreme is when roundwood market is a homogenous common market and price in different countries or regions is the same at each moment of time. In reality, it may be that the actual market situation mostly lies somewhere between these two cases. It must be remembered that the LOP can be expected to hold perfectly only in markets where goods are perfectly homogenous.

Traditionally the market integration has been studied using correlation and single-equation regression analysis. The lack in these models is that the interrelationship between two price series might not be found despite that the time series might have the same kind of trend. Because economic time series are often non-stationary[9], also the time series characteristics like unit root and cointegration have to be studied[10]. With this objective the Johansens' multivariate cointegration model is superior when compared to previous methods. Johansens' method will be closely described in chapter 5.

[9] Expected value and variance are changing during the period
[10] Toppinen & Toivonen, 1997: p. 4

3 Roundwood markets in the Baltic Sea countries

3.1 General

Roundwood markets in each individual country may be shortly described as follows. Each country has two parts in their roundwood markets: domestic markets and international markets. The domestic markets may differ a lot between countries. For example, roundwood sellers and buyers may be more or less organised, roundwood selling may take place in various ways, forest resources are not alike or the economical situations are not similar.

The international market may become more important when the world globalises. Forest enterprises become larger and multinational. When the trade restraints are removed or diminished, transaction costs become lower and it might be more profitable to trade roundwood with other countries. In that way all countries are a part of international roundwood markets.

Trade between countries is expected whenever imbalances exist in the geographic distribution of resources and needs. Trade should diminish price differences between the different markets involved in the trade relations if the international commodity arbitrage is efficient[11].

Essential in understanding the international roundwood market of the Baltic Sea region is to know the domestic roundwood markets in different countries. For example market imperfections may change market efficiency. Therefore this chapter is dedicated to explain and describe the roundwood markets in the countries studied in this study. Here, the basic facts of roundwood market and type of domestic roundwood trade will be shortly presented. A more detailed description of the Baltic Sea countries is presented in Appendix 1.

Not only strictly economical variables affect roundwood markets. Also for example geographic or climate factors may have a major impact on the international roundwood markets. One example of this is the windstorms in December 1999. Because of those storms volumes equal to many years' harvest were felled during one day. Totally 193 million m³ forest were wind-thrown in Europe. France suffered the worst damages, but damages in many Baltic Sea countries were enormous. In Germany wind-thrown volumes (30 million m³) in December 1999 were 76,9 % of the annual removals in 1998. In Sweden wind-thrown volumes were 5 million m³ (8,6%). In Denmark volumes were 3,5 million m³ (159,1 %), in Poland 2 million m³ (8,6%) and in Lithuania 0,4

[11] Thorsen, 1996: p.2

million m³ (8,2 %). Also Latvia and Estonia suffered minor damages.[12] This kind of storm damage leads to a surprising increase in roundwood supply.

A short summary of the roundwood markets in the countries relevant for this empirical study; Finland, Estonia, Lithuania and Germany, is presented below. A more detailed description of all Baltic Sea countries can be found in Appendix 1. Table 1 describes basic economic variables in all Baltic Sea countries.

Table 1. *Main economic and forestry statistics of the Baltic Sea Countries.*

	Finland	Estonia	Lithuania	Germany	Latvia	Russia	Poland	Sweden	Denmark
Population mill.	5,2	1,4	3,7	82,2	2,4	147,2	38,7	8,9	5,3
Area 1000 ha	30459	4227	6258	34927	6205	1688851	30442	41162	4243
Forest area** 1000 ha (% of total area)	21935 72 %	2060 49%	1994 32 %	10740 31 %	2923 47 %	851400 50 %	9047 30 %	27134 66 %	455 10 %
GDP USD/capita (2000)	22156	3470	3009	21898	2964	1699	4159	25641	30393
GDP annual growth % (90-99)	2	-0,3	-3,9	1	-3,7	-5,9	4,4	1,2	2
Inflation (2000)	3,4	4	1	2	2,7	20,8	10,1	1	2,9
Balance of trade 2000 mill. USD	11923	-1109	-1647	51784	-1320	55711	-17289	14308	4410*

Sources: Finnish statistical yearbook of forestry, 2001 & www.stat.fi. *1999, **all forests (forest available for wood supply and forests with some legal, economic or environmental restrictions.)

3.2 Finland

Finland is one of the most important countries exporting forest industry products in the world with its 20,1 million hectares forestland. There are four major types of roundwood suppliers in Finland: 1) Private forest owners, 2) The National board of forestry (the state), 3) Supply from abroad and 4) Supply from forest companies own forests.[13] The most important is the supply from privately owned forests: 54 % of all forestry land is privately owned[14]. The demand side of roundwood market is fairly concentrated. There are three leading forest groups in Finland; StoraEnso, UPM-Kymmene and Metsäliitto-Yhtymä which buy and use pulpwood. In addition to these companies, there are some tens of medium-sized and hundreds of small sawmills buying and using sawlogs.

There are mainly two types of wood sales in Finland. The first is stumpage sales. In the stumpage sales the seller gives the buyer the right to fell trees. The price paid to the seller is the so-called stumpage price, and it is paid according to the volume of felled

[12] United Nations, 2000b: p. 24-28
[13] Tilli, 1997: p. 16
[14] Finnish Statistical Yearbook of Forestry, 2001: p. 44-45

wood. The second way of selling roundwood is to sell at the delivered price. This means that the seller agrees to deliver the roundwood to an agreed place. Nowadays, stumpage sales are the more common type, and over 80 % of domestic sales are done in this way[15]. The roundwood seller usually sales directly to a forest company. In many cases the forest owner association however works as a middleman between the roundwood trade parties.

3.3 Estonia

Estonian history as an independent country begins again in 1991 after the Second World War. The independency after the Soviet period led to a privatisation of Estonian forest sector. In 1999 the share of fellings from private forests were about 55 %[16]. Estonia's forest sector's production has grown rapidly during recent years. The main Estonian roundwood buyer is the sawmill industry, and it is believed to have nearly reached the maximum capacity[17].

Roundwood supply consists of supply from state and private forests. Estonian roundwood buyer, the modern wood processing industry, is made up of hundreds of companies. Most of them are small or medium size firms. Despite them, also intermediate agents are buying and selling sawlogs. Domestic demand for sawlogs is high and the sawlog prices have constantly increased. Increased roundwood demand is also leading to rising sawlog imports.[18]

The domestic pulp- and paper industry has a low processing capacity in Estonia, and pulpwood is therefore an important export commodity. It is usually bought by large foreign companies. An important factor determining pulpwood price in Estonia is the export demand by large foreign companies, such as those in Nordic countries.[19]

Roundwood is sold from Estonian state owned forests through delivery sales, stumpage sales and auctions. Roundwood prices in state owned forests are negotiated for 3 to 6 months at the time. The usual roundwood trade form in privately owned forests are delivery sales. However, the stumpage sales are becoming more common when the forestry and forest management are developing. The majority of private forest owners sell directly to buyers, without any intermediate agents. The roundwood is also purchased by buying whole forest holdings. The reason to this kind of roundwood sales

[15] Metsäteollisuus ry, 2000: p. 36
[16] Aastaraamat mets, 2000: p. 57
[17] Baltic Timber journal, 2/2001
[18] Kaubi, 2002: Personal comment
[19] Kaubi, 2002: Personal comment

is that when the forest holding is obtained in restitution, it may be sold without any taxes. The share of taxes is quite large in other sales systems.[20]

3.4 Lithuania

The development of the Lithuanian forest sector has been rapid after the independence in 1991. The state owned all the forests in the beginning, but now it is foreseen that 35-45 % of the total forest area will be privately owned in the future, as the result of ongoing land reform. Privatisation is leading to constantly increasing share of private fellings. In 1999 they were 26% of the total fellings[21].

The sawmill industry is the major domestic roundwood buyer in Lithuania. Most of the Lithuanian sawmills are quite small and thus the concentration of the roundwood buyers is low[22]. Also, there is little cooperation between forest owners in Lithuania today. There are several cooperatives, but they are struggling to attract members and they are functioning more or less as companies trying to sell their services. The prices and quantity of the demanded pulpwood depend on the market situation. Nowadays the demand for pulpwood is highly dependent on foreign forest industries.[23]

At the moment and probably also in the future the Lithuanian state is the major single domestic roundwood supplier in Lithuania. Roundwood sales in the state forests are based upon the Rules for Roundwood Trade, approved by the Ministry of Environment. The key point in those rules is that wood is sold in auctions, and the sale happens as delivery sales. Auctions are held at the end of every year and concern next coming year. It may happen that because of the market situation, the results from the auctions are not valid for the whole year. Then there is a possibility to renegotiate the auction results or possibly other companies may participate in the trade. Stumpage sales are not common in state owned forests. Private forest owners can sell their wood in that way which is suitable for them. This means that both stumpage and delivery sales are used in the sales of private owners[24].

[20] Kaubi, 2002: Personal comment
[21] Lithuanian Statistical yearbook of forestry, 2001
[22] Indufor & ECO, 2000: Country case study Lithuania p. 26-27
[23] Zinkevičius, 2002: Interview
[24] Zinkevičius, 2002: Interview

3.5 Germany

In Germany there is approximately 10,7 million hectares of forest land (10,1 available for wood supply)[25]. One third of this is owned by the states, one fifth by municipalities or communities, and almost half by private forest owners. The ownership structure in Germany varies between the states quite a lot. Almost half of all domestic roundwood comes originate state owned forests, and less than one third from privately owned forests[26]. In other words, the privately owned forests are used in wood production less intensively than the state forests, which is the opposite to the situation in Finland or in Estonia.

The sawmill industry is the most important roundwood buyer in Germany. However, it is noteworthy that 60 % of paper and paperboard industries' raw material were waste paper in 1999[27].

Germany is divided in many states and roundwood trade in the individual states differ greatly. In southern Germany pulpwood prices are partly negotiated between individual buyer and supplier for some time periods. But these negotiations do not necessarily bind the prices. Sawlog prices are usually separately negotiated in each individual case. In Northern Germany all buyers set their own prices and common negotiations are therefore rare.

The sawlog market is clearly more important than pulpwood market. Private forest owners sell their roundwood usually at delivery sales and directly to forest industry or to intermediary agents. Thus, the supplier side of the market is not concentrated. It is typical for Germany that middlemen take care of roundwood trade. Middlemen buy roundwood from the forest owners and then distribute different roundwood assortments to different buyers. During the recent years forest companies have started to buy these intermediary agents[28]. Stumpage sales are not in use in Germany.

Sawlog supply exceeded demand in Germany during the past years, mainly due to the large storms in late 1999. Thus, there has not been scarcity of roundwood.

The demand side of the roundwood market is not concentrated. There are some larger companies but their total market share is quite low. Large enterprises have established in capital-intensive areas such as the paper industry. Delivery sales are the most common roundwood sales type in state forests, but roundwood is also sold in auctions. Though, roundwood trade systems and markets vary a lot in different states and

[25] Finnish Statistical Yearbook of Forestry, 2000: p.330
[26] Mäki & Toivonen, 1998: p. 32-33
[27] Finnish Statistical Yearbook of Forestry, 2001: p. 337-338
[28] Lagerwall, 2002: Interview 24.1.2002

therefore, it is difficult to draw a general conclusion about roundwood trade form in Germany. However, the traded quantities have increased during the past years.[29]

3.6 The summary of countries of the empirical study

The most important variables concerning roundwood trade and markets in the countries of the empirical study are summarised in Table 2.

[29] Lagerwall, 2002: Interview 24.1.2002

Table 2. *Summary of roundwood markets within the countries included in the empirical study.**

	Finland	**Lithuania**	**Estonia**	**Germany**
Forest resources				
Tree species	Pine 64,7%, Spruce 24 %, Birch 9 %	Pine 35%, Spruce 24%, Birch 21%	Pine 34%, Spruce 17,5%, Birch 31%	Spruce 32%, Pine 28%, Hardwood 34%
Age class structure	Even	Uneven (young)	Uneven (middle-age)	Even
Forest sector				
Private forests	54 %	23 % (Increasing to 52 %)	20-25% (increasing to 35-45 %)	46 %
Size of private forest holdings (ha)	20-30	2,5	8-12	8
Most significant round-wood using forest industry	Pulp-paper industry	Sawmill	Sawmill	Sawmill
Most important roundwood supplier	Private 86 %	State 74 %	Private 55 %	State 44%
Most important forest industry product trade partners	Germany, UK	Germany	Finland, Sweden **	France, Finland, Sweden
Roundwood trade				
Price formation	Mainly directly between buying company and selling forest owner. Also forest owner associations assist quite commonly in the sale.	State organises auctions of delivery sales from state forests. Private forest owners may sell directly to individual companies.	State sales directly to companies or to intermediary agents. Private forest owners sell mainly directly to companies, but also felling rights in auctions.	May happen directly bet-ween buying company and selling forest owner. There are also many intermediary agents between forest owners and forest companies.
Annual industrial roundwood fellings (million m³), share of sawlogs	55,3 49%	4,9 65%	6 41%	35 67%
Roundwood exports, million m³ (% of the total fellings)	0,9 2%	1,2 23%	3,8 64%	4 (11%)
Roundwood imports (million m³)	11,4	0,06	0,3	2,7
Roundwood trade balance Main import/export country	Net importer 84 % from Russia in 2000	Net exporter 52% to Sweden in 2000	Net exporter 46% to Sweden in 1999	Roundwood trade quite balanced
Type of roundwood trade	Delivery & stumpage sales	Auctions, Delivery & stumpage sales	Auctions, Delivery & stumpage sales	Mainly delivery sales. Some auctions.

*For more information see Appendix 1. **includes also roundwood

4 Data

4.1 Unit root test

In this chapter, the time series data and the study method will be described. The time series are roundwood prices in four Baltic Sea countries. As mentioned earlier, the aim of this study is to investigate if the roundwood market in the different countries are integrated. Johansen's multivariate cointegration analysis will be performed in the analysis. The characteristics of Johansen's method set some limitation concerning the data. The most important is the non-stationarity of the time series data. Therefore this chapter begins with the test of non-stationarity, unit root test.

Cointegration means a long-run co-movement between time series. Cointegrated time series have a common equilibrium to which their fluctuations revert. This means that cointegrated time series do not move independently, but they have common stochastic trends.

Cointegration assumes non-stationary data series with a common trend, which in turn means that they are integrated of the same order. This assumption of the time-series properties must be tested before the analysis can be carried out. To test this, the Augmented-Dickey-Fuller (ADF) unit root test is carried out. If a unit root is found, then a stochastic series follow a random walk and do not probably revert back to some previous level. Thus, ADF tests for *I(1)* against *I(0)*. Non-stationary data series are integrated *(I(d))* of order *d*, and therefore imply that if d=0, the data series are stationary.Time series are said to be integrated of order '*d*' *(I(d)*), if the series need to be differenced '*d'* times to produce a stationary time series.

$$\text{ADF test}^{30}\text{: } \Delta X_t = \alpha_0 + \alpha_1 T + \delta X_{t-1} + \sum_{i=1}^{k} \beta_i \Delta X_{t-i} + u_t \qquad (3)$$

The null hypothesis is that there is a unit root: $\delta = 0$. If the null hypothesis is not rejected, then the process is non-stationary and follows random walk. Δ is the first difference operator, X is the time series variable, T is time trend α and β are the coefficients, k is the number of lags and u is the error term. The constant or trend may be excluded from ADF the model.

Cointegration necessitates that the variables are integrated of the same order, and if all variables are stationary in the first difference, then the ADF-test gives the results that variables are *I(1).* In this case or in a case that variables are integrated of the same order, it is reasonable to go on in testing the cointegration.

[30] Hendry & Doornik,1996: p. 211

4.2 Time series data

4.2.1 Description of the time series data

In this study cointegration analysis is performed with four countries, Finland, Estonia, Lithuania and Germany, and five roundwood assortments. In four analyses all four countries were studied and in analysis for birch pulpwood prices in three countries were analysed. The data in this chapter are monthly time series data for pine, spruce and birch pulpwood, pine and spruce sawlogs. The study period is January 1994 – June 2001. Thus the data consists of nineteen time series and 90 observations in each series.

All prices were first converted to DEM/m³. Then they were transformed to indices. Prices series were transformed into DEM by using monthly exchange rates off all currencies. Exchange rates were obtained from the Bank of Finland and from the Bank of Lithuania. In this study the nominal prices are used. Price relations are reflected through exchange rates and therefore a deflation of nominal prices is not needed. Here, the time series data for Finland, Estonia, Lithuania and Germany are presented.

All tests and analyses were carried out with the computer programs PcGive and PcFiml. All tests are performed with logarithmic variables of indices.

Finland

For Finland there were two possible time series data to use, monthly stumpage prices or monthly delivery prices. In this study monthly delivery prices over bark in private forests are used, because roundwood prices in other countries are also mainly delivery prices. The data was obtained from METINFO, the on-line statistics database of the Finnish Forest Research Institute.

Estonia

Estonian data consist of monthly roadside prices over bark in state forests. Data was obtained from Estonian state forest management agency (RMK) and FAO[31].

Lithuania

Lithuanian data are monthly roadside prices over bark. Prices represent prices for roundwood from state owned forests. Data is obtained from Lithuanian Centre of Forest Economics (MEC).

[31] United Nations, 1997, 1999a & 2000c

Germany

Prices from Germany were obtained in index form[32] and they are "over all" prices in state owned forests. This means that the index contains a great number of different regions, wood-qualities and kinds of units that have been aggregated by the German statistical office (Statistishes Bundesamt) by using special weighting-factors.

4.2.2 Development of roundwood prices

Here prices of different roundwood assortments in the studied countries are compared visually by using the graphs in Figure 1. The graphs represent price development in index form. The base month (100) is January 1994. A price index does not tell anything of the price level in the studied countries, but the developments in different countries. Generally, in the early nineties the price level in Estonia and Lithuania was considerably lower than the price level in Finland and Germany. For example, pine sawlogs delivery prices in January 1994 were 68 DEM/m³ in Finland, 59 DEM/m³ in Estonia, 34 DEM/m³ in Lithuania and 139 DEM/m³ in the State of Bavaria, Germany. In June 2001 prices were 93 DEM/m³ in Finland, 74 DEM/m³ in Estonia, 76 DEM/m³ in Lithuania and 94 DEM/m³ in the State of Bavaria, Germany. Thus, price levels in different countries have converged to each other towards the end of the study period.

Prices in Lithuania have increased most strongly, relatively speaking. This applies especially to sawlog prices, which have doubled during the study period (nominal prices). It is conspicuous that pulpwood price development in Estonia and Lithuania seems to follow about the same kind of cycles. Pine sawlog prices in Germany have fluctuated relatively little and no increase has happened.

[32] Statistisches Bundesamt, several years

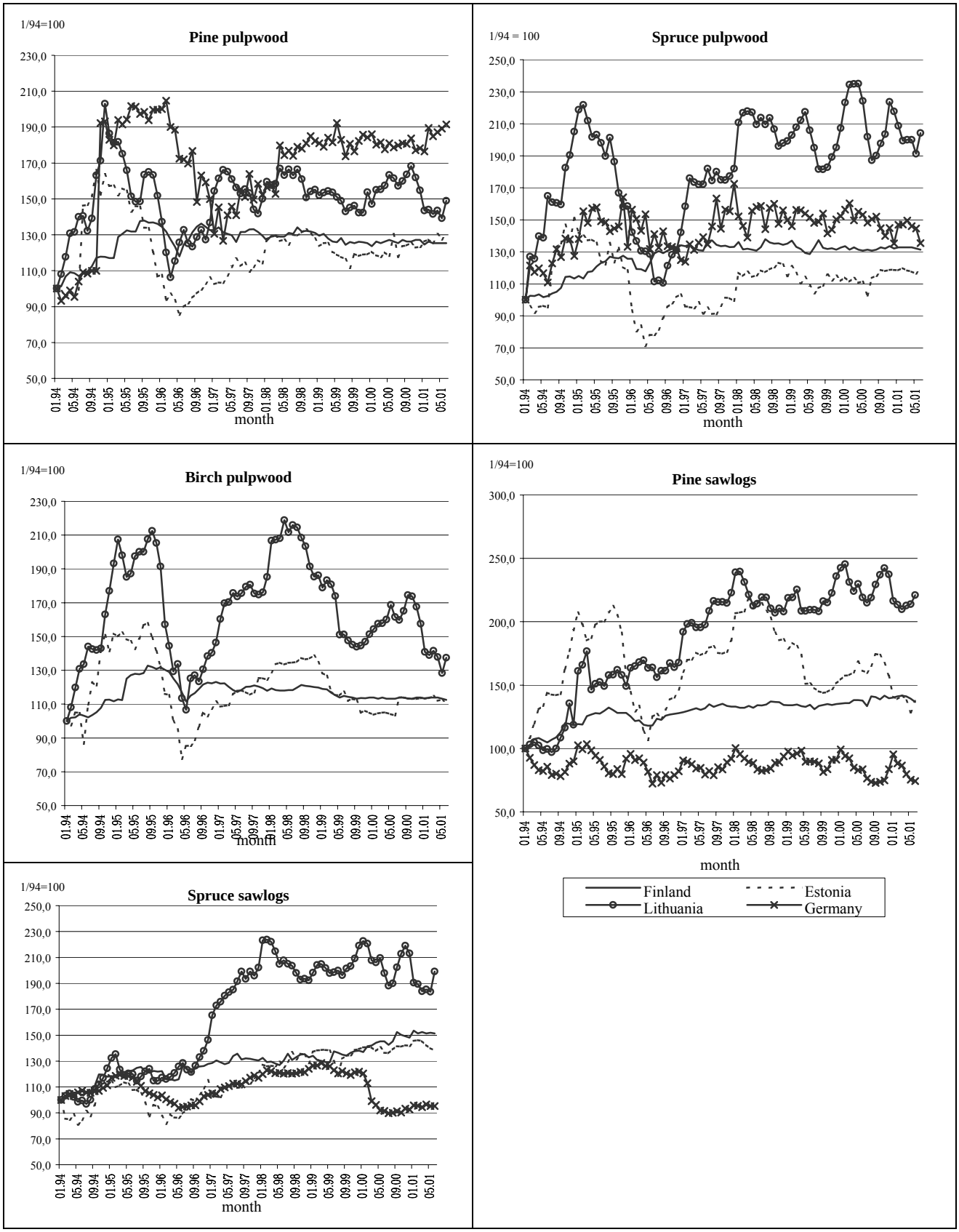

Figure 1. *Time series of roundwood prices for the period January 1994- June 2001. Graphs present price developments as indices for each country (January 1994 = 100). The nominal prices were first converted to German currency (DEM) and then transformed to indices.*

4.3 The unit root test results

The presence of unit roots was tested with Augmented Dickey-Fuller (ADF) test. The results are summarised in Table 4. The numbers in Table 4 are the t-values for δ in equation (3). Time series data for all pulpwood assortments and spruce sawlogs seem to have a unit root, i.e. these are non-stationary in levels, and stationary in first differences in every country.

For pine sawlogs, the German data are stationary even on one percent level. Thus the null hypothesis of non-stationarity is rejected with certainty for pine sawlogs in Germany. The results hold regardless of the number of lags. For pine sawlogs data in the three other countries the hypothesis of non-stationary was accepted. The ADF statistics (Table 4) were obtained from a model with two lags, trend and a constant. Because of the ADF test results, Germany was left outside the pine sawlog cointegration analysis. The ADF test results are supported when the time series data in Figure 1 is studied. The graph for pine sawlogs in Germany represents a typical stationary data with constant error and expected value.

Table 4. *ADF-test for roundwood price by different countries. H_0: Time series are non-stationary.*

Augmented Dickey-Fuller test by countries				
Level	Finland	Estonia	Lithuania	Germany
Spruce pulpwood	-2,30	-2,64	-2,78	-2,58
Pine pulpwood	-2,66	-2,46	-3,35	-2,93
Birch pulpwood	-2,85	-2,42	-2,43	-
Spruce sawlogs	-3,02	-2,12	-1,60	-2,05
Pine sawlogs	-2,60	-2,43	-2,46	-4,70**
1st differences				
Spruce pulpwood	-6,21**	-3,8*	-4,73**	-7,05**
Pine pulpwood	-5,08**	-3,62*	-5,68**	-5,85**
Birch pulpwood	-4,96**	-3,56**	-4,03**	-
Spruce sawlogs	-6,42**	-4,83**	-4,94**	-3,66**
Pine sawlogs	-5,51**	-4,03*	-6,34**	-10,8**

Critical values for accepting H_0 : 5%=-3,46 1%=-4,07. ** rejection of H_0 at 1% level, * rejection of H_0 at 5% level.

5 Cointegration analysis

5.1 Model Estimation

Cointegration will be tested by using a maximum likelihood based unrestricted, statistical p-dimensional VAR (Vector Auto Regression)[33] model. Johansens's method is based on the following VAR process[34]:

$$X_t = A_1 X_{t-1} + ,..,+ A_k X_{t-k} + \mu + \Phi D_t + \varepsilon_t, (t=1,\ldots,T) \qquad (4)$$

Where $A_1, A_2, \ldots, A_k$ are p x p matrices of estimation coefficients. X_t is a (p x 1) column vector that denotes the t'th (1,..,T) observation on a set of p variables (the number of countries in this study), μ is a p-dimensional vector of constants, D_t represents a set of non-stochastic variables (seasonal dummies), Φ represents (p x 1) vector of non-stochastic variables, k is the optimal lag length and $\varepsilon_t \sim$ IID(0,Ω)[35] is the (p *x 1*) error vector. Errors might be correlated with each other but they are assumed to be uncorrelated with their own lagged variables and the right-hand side variables.

This kind of VAR models will be formulated for each roundwood assortment. The structure of the model can be studied by misspecification tests. This means that residual characteristics are studied by testing for autocorrelation, heteroskedasticity and normality[36]. The autocorrelation is tested with the F-form of the Lagrange Multiplier (LM) test. This test is performed through the auxiliary regression of the residuals on the original variables and lagged residuals. The null hypothesis of no autocorrelation, is rejected if the test statistics is too high.

Heteroskedasticity is tested with the F-form of the LM test. Here it tests the joint significance of lagged squared residuals in the regression of squared residuals on constant and lagged squared residuals. The null hypothesis is no heteroscedasticity. The normality of the residuals is tested by the Doornik-Hansen test. It tests if the skewness and kurtosis of the residuals correspond to those of a normal distribution.[37] Thus, the model formulation and the question of how many lags (k) to use are solved by testing different number of lags with help of these misspecification tests. The model may be explained with a simple example with two countries (p = 2):

[33] Autoregression means that value of the time series depends on the previous values of the same series
[34] Johansen, 1988 & 1995, Johansen & Juselius 1990.
[35] Independently and identically distributed with mean 0 and variance Ω
[36] Autocorrelation function tells how much correlation there is between neighbouring data points in the time series data, i.e. if the error terms are independent. Heteroskedasticity tells if the error term have a constant variability.
[37] Doornik & Hendry, 1997: p.278

If there are two markets (countries), and the relationship may be written as: $x_t = \alpha + \beta y_t + \varepsilon_t$. x and y are non-stationary market price data, α and β are the coefficients. If the linear combination, $\varepsilon_t = x_t - \alpha - \beta y_t$, of the error term ε is stationary, then x_t and y_t are cointegrated.

5.2 Cointegration

Cointegration and error correction are closely related, because every cointegrated time series has an error correction representation. Error correction has been defined by many authors as a way of capturing adjustments in a dependent variable, which depended not on the level of some explanatory variable, but on the extent to which an explanatory variable deviated from an equilibrium relationship with the dependent variable.[38] The basic Johansen model in the error correction form may be written as:

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + ,..,+ \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-k} + \mu + \Phi D_t + \varepsilon_t, \quad (t=1,\ldots,T), \qquad (5)$$

where $\Pi = -(I - A_1 - A_2 - ... - A_k)$ (I is an identity matrix)

$\Gamma_i = -I + A_1 + A_2 + ... + A_i, \quad i=1,2,..,k-1$

Johansen's method assumes a reduced rank r of the long-run impact matrix Π. Thus, if all components of X_t are $I(1)$, then the rank of Π must be $r \leq p-1$, where r is the number of independent stationary linear combinations (rank) that can be formed by the p-variables, when cointegrating vectors exist. If Π has a full rank p, then all elements in X_t are stationary and each variable is a single cointegrating vector. Therefore no conclusion on price relations can be made if all elements are stationary. If the rank of Π is zero, the model reduces to VAR in 1st differences and it contains no long-run information. Thus, $(p - r)$ implies the amount of stochastic trends. If for example p = 4, the complete market integration requires that the rank is 3. If the rank would be lower than three then the law of one price does not hold in all four countries simultaneously.

When the rank is known, the structural problems of the model may be solved. From the (p x p) dimensional matrix a reduced (r x p) dimension matrix $\alpha\beta' = \Pi$ may be derived. α measures the short-run effect, i.e. the speed of adjustment to equilibrium. This means that, α "guides" to equilibrium in the long-run relationship, $\beta' X_t$. β measures the long run effects, i.e. it is the cointegrating vector. If not, then $\beta' X_t$ is the deviation from the long-run equilibrium. In other words, α measures the impact that

[38] Banerjee et al., 1993: p. 50

each cointegration relation (β) has on ΔX_t. $\beta' X_t$ represents the cointegrating relations and the estimate of β can be solved by eigenvalue test. It may be summarised that the columns of the matrix β are the cointegration vectors representing the stationary linear combinations of variables X_t. The respective columns of matrix α give the weights with which the error correction terms enter each equation indicating the speed of adjustment to equilibrium.[39]

Thus, the degree of market integration is tested by estimating the rank of the price systems. This will be done with maximum likelihood ratio tests. Two different likelihood ratio tests may be used. One possibility is a trace test (λ-trace). It tests how many stationary equilibrium vectors there are in the cointegration space and indicates the degree of market integration. Another possible test is the maximum eigenvalue (*λ-max*) test. For trace test the null hypothesis is no cointegration and the alternative hypothesis is that there are $0 \leq r < p$ cointegrating vectors. The null hypothesis for *λ-max* is no cointegration and the alternative hypothesis is that there are *r* cointegrating vectors, when *r = p-1* These tests are formulated in Johansen and Juselius(1990):

$$\lambda\text{-trace} = -T \sum_{i=r+1}^{p} \log(1-\lambda_i), \quad r = 0,1,\ldots,p-1, \tag{6}$$

where λ_i are the eigenvalues from smallest to largest. The testing is performed sequentially until the null hypothesis is the first not rejected. The *r* is selected as the last significant statistics.

$$\lambda\text{-max} = -T \log(1-\lambda_{r+1}) \tag{7}$$

Critical values have been tabulated for example by Johansen & Juselius (1990).

5.3 Weak exogeneity

A variable is called weakly exogenous if it does not adjust to deviations from any equilibrium relation in the short run in any other variable. The adjustment to equilibrium happens through changes in the other variables but not in the weakly exogenous one. By studying the weak exogeneity it is possible to identify which prices are behind the stochastic trends in the cointegrated roundwood markets. It is usually thought that larger market may be exogenous against smaller markets. Therefore the preliminary assumption is that the Finnish roundwood prices are weakly exogenous.

[39] Nagubadi et al., 2001: p. 74

This means that the long-run development in roundwood prices is assumed to be given by the development in Finnish prices.

Weak exogeneity is tested by restricting the coefficient of the short-run matrix α. An α-vector is restricted to be α =Aθ, where θ is the vector of earlier estimated coefficients and A is the estimated test matrix. If the α is zero in some row of the matrix and the restriction cannot be rejected, then variable in that equation is weakly exogenous. The model may be formulated for example as follows[40].

Suppose that there is a VAR of three equations, $x_t = (x_1, x_2, x_3)'$, α_0 and β_0 are (3 x 3). Then it could be tested that none of the cointegrating vectors enters the first equation. Here is assumed that rank is 2, α and β are (3 x 2). Therefore α matrix is restricted and expressed as $\alpha_r = A\theta$, where

$$A = \begin{pmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 1 \end{pmatrix} \quad , \quad \theta = \begin{pmatrix} \theta_{11} & \theta_{12} \\ \theta_{21} & \theta_{22} \end{pmatrix} \quad \text{and} \quad A\theta = \begin{pmatrix} 0 & 0 \\ \theta_{11} & \theta_{12} \\ \theta_{21} & \theta_{22} \end{pmatrix}. \qquad (8)$$

The choice of A implies a selected rank ≤ 2. If this restriction is rejected, Δx_1 is not weakly exogenous for α and β.

[40] Doornik & Hendry, 1997: p.226-228

6 Results

6.1 Model estimation

The time series data were non-stationary and it was justifiable to proceed cointegration testing. The next phase in the analysis was to formulate VAR models for each roundwood assortment. By sequential omission of the number of lags and with help of residual misspecification tests (appendix 2) the most appropriate models were formulated. The most appropriate model for spruce and birch pulpwood was a model with three lags. Models for sawlogs and pine pulpwood contain four lags.

These specification removed most of the residual autocorrelation and heteroscedasticity from the models. However, there remains some autocorrelation and heteroscedasticity in the models, and therefore the results must be taken with some caution.

6.2 Cointegration analysis

The results of the cointegration analysis are presented in Table 5. Since there are four countries in the models for pine- and spruce pulpwood and spruce sawlogs, acceptance of full market cointegration requires three cointegrating vectors and one stochastic trend (r = 4 – 1). Thus, the rank of three would mean that one stochastic shock spreads to all countries. In the models for birch pulpwood and pine sawlogs the full market integration requires two cointegrating vectors.

The maximum eigenvalue test and the trace test results in Table 4 indicate that pine pulpwood markets are fully integrated, Since the rank is 3. Spruce pulpwood has two cointegrating vectors and birch pulpwood one cointegrating vector. Pine and spruce sawlogs have no cointegrating vectors.

The spruce and particularly birch pulpwood markets are only partially integrated around the Baltic Sea region. The requirement for full integration to hold was $r = p - 1$. Sawlog markets in the countries analysed may be described as fairly independent from each other.

Table 5. *The cointegration test results. The table represents Eigenvalues, trace test and the maximum eigenvalue statistics.*

Cointegration tests				
Ho:	r = 0	r ≤ 1	r ≤ 2	r ≤ 3
Spruce pulpwood				
Eigenvalues	0,36	0,27	0,12	0,11
λ-max	38,42**	26,56*	10,81	9,92
95 %	31,5	25,5	19,0	12,3
Trace test value	85,7**	47,28*	20,73	9,92
95 %	63	42,4	25,3	12,3
Pine pulpwood				
Eigenvalues	0,38	0,29	0,26	0,11
λ-max	42,14**	29,72*	26,13**	9,9
95 %	31,5	25,5	19,0	12,3
Trace test value	108**	65,8**	36,11**	9,9
95 %	63	42,4	25,3	12,3
Birch pulpwood				
Eigenvalues	0,26	0,12	0,09	
λ-max	26,46*	10,6	8,01	
95 %	25,5	19,0	12,3	
Trace test value	45,01*	18,56	8,01	
95 %	42,4	25,3	12,3	
Spruce sawlogs				
Eigenvalues	0,20	0,12	0,08	0,05
λ-max	20,32	11,49	7,413	4,60
95 %	31,5	25,5	19,0	12,3
Trace test value	43,82	23,5	12,01	4,60
95 %	63	42,4	25,3	12,3
Pine sawlogs				
Eigenvalues	0,23	0,12	0,08	
λ-max	22,73	10,66	6,82	
95 %	25,5	19,0	12,3	
Trace test value	40,2	17,48	6,82	
95 %	42,4	25,3	12,3	

**indicates rejection of null hypothesis at 1 % level. * at 5 % level

6.3 Weak exogeneity

Tests for weak exogeneity were performed for roundwood assortments that imposed cointegration. The estimated ranks were one for birch pulpwood, two for spruce pulpwood and three for pine pulpwood. The results of the weak exogeneity test are presented in Table 6. The results of the likelihood ratio test show that none of the countries would be a clear source of price fluctuations on the Baltic Sea region roundwood markets.

Table 6. Weak exogeneity tests under estimated cointegration rank r. The first value presents the chi² value and the value inside the square bracket is the p-value.

Ho:αi=0	**Finland**	**Estonia**	**Lithuania**	**Germany**
Birch pulpwood r=1	χ^2[2]10,00 [0,007]**	χ^2[2]17,7 [0,00]**	χ^2[2]17,0[0,00]**	
Spruce pulpwood r=2	χ^2[4]13,35[0,0098]**	χ^2 [4]25,9[0,00]**	χ^2[4]21,0[0,00]**	χ^2[4]25,3 [0,00]**
Pine pulpwood r=3	χ^2[3]11.1 [0,011]*	χ^2[3]17,18[0,00]**	χ^2[3]21,1 [0,00]**	X^2[3]14,1[0,003]**

** indicates rejection of weak exogeneity at the 1% level and * the 5% level

7 Discussion

In this study the market integration between roundwood prices in the Baltic Sea region was studied. Five separate roundwood assortments, pine, birch and spruce pulpwood, pine and spruce sawlogs, in Finland, Estonia, Lithuania and Germany were studied on the basis of monthly data for 1994 - 2001.

The results from the cointegration analysis indicated that the pulpwood markets were integrated to some extent. However, the degree of market integration differed for different pulpwood assortments. Only the pine pulpwood markets seem to be fully integrated. Birch pulpwood market had one cointegrating relation and spruce pulpwood two relations, which indicate some but not full market integration. Every observed cointegration relation implies one long-run relation between the countries within the system. The coniferous sawlogs markets showed no integration and therefore they may be considered as separate national markets. Overall, the Baltic Sea region does not make up a single roundwood market, and particularly this regards sawlogs spruce and pine markets. However, analysis of pine sawlog markets did not cover Germany, and the analysis of birch pulpwood markets did not include Germany either due to insufficient data.

The tests showed no evidence of weak exogeneity. The lack of exogeneity means that prices in all studied countries are endogenous and significant for the system. This result is not in accordance with the assumption that the physically larger markets would be exogenous to the smaller ones.

Noteworthy is that most of the roundwood exports from Estonia and Lithuanian are directed to Sweden. Therefore, it would be interesting to study if Swedish prices are exogenous against the Baltic prices. Unfortunately roundwood prices in Sweden are published quarterly. Therefore it was not possible to include Swedish prices in this study. However, if the analysis would be made using annual data then it would be possible to include Sweden. Unfortunately, the method used in this study would require longer time series than what is available yet. Therefore other kinds of methods should be used.

The almost complete non-existence of pulp and paper industry in the Baltic States leads to relatively large pulpwood exports. This makes the degree of the internationalisation on pulpwood markets much higher than that on the sawlogs markets.

The importance of Russian roundwood is evident when birch pulpwood is considered in Finland. The absolute majority of Finland's birch pulpwood imports originates from Russia. Therefore the birch roundwood trade with other countries is only marginal and

the markets are in all probability not integrated. I assume that the rank one in birch pulpwood analysis indicates the integration of Estonian and Lithuanian markets. The time series data in Figure 1 supports this conclusion.

The pulpwood price may also depend on price of waste paper. As described in chapter 3 waste paper is important raw material in especially in Germany. The relationship between waste paper prices and spruce pulpwood prices may possibly be one reason for the rejection of market integration in the spruce pulpwood markets in Germany. Pulpwood price may depend more on waste paper prices than foreign pulpwood prices. This relation could be studied in future.

The rigidity of regional roundwood demand and supply may also lead to that adjustment to price changes may happen slowly. Therefore annual time series might lead to different results and possibly more cointegration could be found. However, it is not possible to obtain as long yearly time series from the Baltic States that this kind of study would be possible.

It would be logical to assume that the market integration increases when the markets in the countries in transition develop further. One reason to not fully integrated markets may be the conditions inside the countries during the transition process. For example, the possible presence of so called grey sector or black market in some of studied countries may have hindered the smooth development and adjustment of markets.

The results of this study must be taken with some caution. The study period is relatively short, and therefore, for example some shocks may have distorted the results.

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APPENDIX 1. Description of the forest sector and roundwood markets in the Baltic Sea countries.

1 Finland

1.1 Forest resources

Finland is one of the most important forest industry product exporting countries in the world. Finland has 20,1 million hectares forest land, which is 66 % of the total land surface area in Finland. 61,6 % are privately owned, 24,6 % are state owned forests. 8,9 % of the forests are owned by forest companies and 5,3 % by other groups.[41] Private forest owners make the most important roundwood supplier. 86 % of all fellings were done in private owned forests in 2000.[42] There are over 400000 privately owned forest holdings in Finland. Private forest holdings are usually 20-30 hectares in size. State owned forests are mainly situated in Eastern and Northern Finland and they are managed by the Finnish Forest and Park Service. Some small areas of the state forests are also managed by the Finnish Forest Research Institute and The Ministry of Defence[43].

Pine is the dominant tree species in 64,7 % of Finnish forests, spruce is dominant in 24 % and birch in 9 % of forests. Age structure of forests is divided quite evenly between different age classes. Most trees are in the age class 21-40 year (21,8 %). 20,6 % of all trees are more than one hundred years old. 6,1 % of Finnish forests are classified as nature conservation areas. Total annual increment of growing stock in Finland is 79,4 million m^3.[44]

1.2 Roundwood markets

Forest industry uses 90 % of the total domestic roundwood supply.[45] The total turnover of the Finnish forest industry was over FIM 200 billion in 1999. There are three leading forest groups in Finland; StoraEnso, UPM-Kymmene and Metsäliitto-Yhtymä. Therefore, the demand side of domestic roundwood market is strongly organised . More than a half, FIM 110 billion, of 1999's turnover were result from international business[46].

[41] Finnish Statistical Yearbook of Forestry, 2001: p. 44-45
[42] Finnish Statistical Yearbook of Forestry, 2001: p. 146
[43] Ministry of Agriculture and Forestry, 2001
[44] Finnish Statistical Yearbook of Forestry, 2001: p. 48-65
[45] Tilli, 1997: p. 13-14
[46] Metsäteollisuus Ry, 2000: p. 7

There have been differences in roundwood demand for the different tree species. Traditionally the demand for pine logs has been the highest and the demand for hardwood the lowest. Demand for different species varies mainly because of the differences in foreign demand for Finnish export products.[47]

In Finland there are four major types of roundwood suppliers: 1) Private forest owners, 2) The National Board of Forestry, 3) Supply from abroad and 4) Supply from forest companies' own forests.[48]

Commercial cuttings were 55,3 million m³ in Finland in 2000. 27,3 million m³ were logs and 28 million m³ were pulpwood. The total industrial use of roundwood was 68,83 million m³ in 1999. 17 % of this was imported from abroad.[49] Reasons for roundwood import are various. For example, it may not be possible to produce enough roundwood in Finland: The annual need for birch pulpwood is 10-12 million m³ and domestically it is possible to produce only half of it.

There are mainly two wood sales systems in Finland. One is stumpage sales. In the stumpage sales the seller gives the buyer the right to fell trees. The price paid to the seller is the so-called stumpage price. The other way of selling roundwood is to sell at the delivered price. This means that the seller agrees to deliver the roundwood to an agreed place. Nowadays, stumpage sales are more common and 80 % of domestic sales are done in this way[50].

Earlier the roundwood trade was based on two agreements. The first was a general agreement, which contained general methods and objectives for the roundwood trade. The second was a price recommendation agreement, which concerned individual cases of roundwood trade. These agreements have not been valid after 1992. The European Union deemed those kinds of agreements to be against antitrust legislation. [51] After a couple of years a new form of price formation arose in 1994. Since 1994 parties of roundwood trade were able to negotiate over roundwood prices in individual cases. These negotiations were based on price development and expectations of future roundwood prices. During the years 1995 and 1996, regional negotiation mechanisms were used between roundwood trade parties. In 1997, competition authorities approved a legislation that allowed negotiations of the price level between individual buying enterprises and selling forest owners. The forestry council of the Central Union of Agricultural Producers chose those forest owners who represented all other private

[47] Pajuoja, 2000: p. 5
[48] Tilli, 1997: p. 16
[49] Finnish statistical yearbook of forestry, 2000: p. 249
[50] Metsäteollisuus ry, 2000: p. 36
[51] Kiviniemi, 1997: p. 338

forest owners in negotiations with forest enterprises. The aim of negotiations considering roundwood price expectations was to reach a mutual understanding of market situation and price expectations for coming seasons[52]. A mutual understanding was found in 1997, but not in 1998. Competition authorities forbid negotiations in 1999. Nowadays, the roundwood seller usually sales directly to a forest company. In some cases the forest owner association works as a middleman between the roundwood trade parties.

The main market area of Finnish forest industry products is the EU. 69 % of all exported forest industry products were sold in EU countries in 1999. The most important trade country was Germany (19 % of exported value). The foreign trade of Finnish forest industry is export oriented and in 1999 import value was only 7 % of the corresponding export value. Paper products are the most important export commodity group. The most important import products are converted paper and paperboard products[53].

The mean transportation distance of Finnish roundwood was 118 km with transportation costs 34,2 Fim/m³ (0,25 FIM/m³km) in 2000[54]. If roundwood was transported to mill by road the distance was 101 and costs 30,9 FIM/ m³ (0,31 FIM/ m³km). Rail transportation sequence was 294 km and 49,3 FIM/m³ (0,17 FIM/ m³km). Water transportation distance was 255 km and unit costs for water transportation were 40,2 FIM/ m³ (0,16 FIM/ m³km).[55]

2 Estonia

2.1 Forest resources

The independency after the Soviet period in 1991, led to a privatisation of forest sector in Estonia. Privatisation or land-reform has two phases. In the first phase the forest ownership were restored to the situation, which prevailed in 1940 when forests were expropriated. The forest ownership rights were restored to former forest owners or their inheritors. In the second phase the forests with no owner after restitution process are privatised. Difference between restitution and privatisation is that restitution process is free and in privatisation the forest must be bought from the state[56].

[52] Hakkarainen, 1999: p. 58-59
[53] Finnish statistical yearbook of forestry, 2000: p. 273-275
[54] 1 € = 5,94573 FIM
[55] Finnish statistical yearbook of forestry, 2001: p. 186
[56] Jögiste, 2001

The total Forest area in Estonia is approximately 2,1 million hectares. It is foreseen that privately owned forests cover 52 % of the forest area in the future. The privatisation process is expected to increase the total amount of private forest owners to 80000-100000 with average forest holding size of 8-12 ha[57]. At the beginning of 2000 about half of the land reform was executed. The restitution process is nearly completed, but the privatisation process will be completed in the future. The number of forest owners is approximately 50000[58]. In 1999 the share of private fellings were about 55 %[59].

The Estonian Ministry of the Environment is responsible for the forestry in Estonia. Under it the department of forestry shapes and accomplishes the forest policy, develops forestry laws and participates international co-operations. Locally the officials of the County Environmental services are dealing with the problems of forest owners. They advice forest owners and control the planned activities in forests. All planned forestry activities must be announced to Environmental services. If planned work is not lawful, the Environmental service has the right to forbid that work. Under the jurisdiction of the Ministry of Environment works also the State Forest Management Agency. It takes care of the management of state forests and is a state business enterprise. It is located in Tallinn, but has local offices around Estonia[60].

The small size of the forest holdings is a big problem for private forest owners in Estonia. It is not possible to produce continual and long-term benefit. There is also a lack of well functioning co-operatives who could arrange the management of privately owned forests.[61] Estonian Private Forest Union represents private owners interests on political level. The objectives of Private Forest Union are, for example, to help forest owners in practical forest work, to help in roundwood trade, to develop sustainable forestry and to advice forest owners in various tasks[62]. Private Forest Union has 25 local organisations, but only 1 % of forest owners have joined to the organisations and therefore the co-operation between the private forest owners is poorly developed.[63] The foundation Private Forest Centre was established in 1999. The Private Forest Centre is founded by state, but private forest owners have the control over the Centre.

Estonia became a WTO member in 1999 and is actively negotiating of getting the EU membership during the first round. Estonia introduced its new currency kroon in June

[57] Karppinen, 1998: p.167
[58] Aun, 2001
[59] Aastaraamat mets, 2000: p. 57
[60] Jögiste, 2001
[61] Aun, 2001
[62] Jögiste, 2001
[63] Aun, 2001

1992. Estonia uses currency board system. Estonian currency, kroon were pegged to the DEM with rate 1 DEM =8 EEK[64]

34,3 % of the forest area is covered by pine stands, spruce stands account for 17,5 and birch stands for 30,7 % of the total forest area. The age distribution in Estonian forests is quite uneven, the share of both young and mature forests is low. Forests are dominated by trees of ages between 40 and 80 years. Annual increment in Estonian forests is 11,6 million m³[65].

2.2 Roundwood market

Total domestic roundwood production in Estonia was 6 million m³ in 1998. 5,4 million m³ of this was industrial roundwood. Industrial roundwood was divided into pulpwood (3,1 million m³), logs (2,2 million m³) and other industrial roundwood (0,3 million m³)[66]. In 1999 64 % of domestic roundwood was exported. Roundwood exports to Sweden made up 46 % of the total Estonian roundwood export value[67].

Estonia's forest sector has grown rapidly during the recent years. Estonian roundwood buyer, the sawmill industry is made up of hundreds of companies. Most of them are small or medium size firms. Nevertheless, companies with yearly production capacity of more than 50000 m³ of sawn materials consume 70 % of sawlogs. The major products are coniferous sawn wood and panels. Over a half of the panels and sawn wood produced are exported. Sawmilling has nearly reached the maximum capacity and all bigger sawmills are hoping for the sawlog import, mainly from Russia and Latvia[68].

Pulpwood is an important export commodity, because domestic pulp and paper industry have a low processing capacity. Pulpwood is usually bought by large companies and a majority of sawlogs are usually bought by those medium size procurement companies. Also intermediate agents who are trying to earn profits are buying sawlogs. Roundwood supply consists of the supply from state and private forests[69]. The most important export countries for Estonia are Finland, Sweden, Germany, UK and Netherlands. Imports are mainly from Russia and Latvia[70]

Many kinds of roundwood trade systems are used in Estonian state owned forests: These are auctions, delivery sales and stumpage sales. The usual roundwood trade

[64] OECD, 2000: p. 30, 60
[65] Aastaraamat Mets, 2000: p. 4, 22-29
[66] United Nations, 2000a
[67] Aastaraamat Mets, 2000: p.114
[68] Baltic Timber journal, 2/2001
[69] Kaubi, 2002: Personal comment
[70] United Nations, 1999b: p. 22-25

forms in private owned forests are delivery sales. Roundwood is also purchased by buying whole forest holdings. The reason for this kind of roundwood sales is that forest holdings obtained in restitution may be sold without any taxes. The share of taxes is quite big in other sales systems. However, the stumpage sales are becoming more common when the forestry and forest management is developing[71]. Despite that Private Forest Centre organises roundwood sale auctions, where the felling rights are sold. The majority of private forest owners sell directly to buyers, without any intermediate agents.

Pulpwood price in Estonia depends on how much the Scandinavian forest companies are willing to pay for pulpwood. Domestic demand for sawlogs is high and the sawlog prices have constantly increased. Roundwood prices in state owned forests are negotiated for 3 to 6 months at a time. The factors that affect domestic sawlog prices are the sawlog price at harbour, i.e. what the foreign companies are willing to pay, the price and quantity of foreign roundwood that has been imported to Estonia. Also, the local public price offers and the quantity and quality of supplied domestic roundwood affect the sawlog prices. New sawmills have made increased domestic fellings possible, but increased roundwood demand leads also to rising sawlog import quantities.[72]

3 Lithuania

3.1 Forest resources

Also Lithuanian history as an independent country begins in 1991. The development of the Lithuanian economy has been rapid. Lithuania introduced its own currency litas, in June 1993. In 1994 Lithuania started to use currency board system. Lithuanian litas was pegged to the US dollars ($1 = 4 Litas). Already in 1992 the Baltic States made a Baltic Free-Trade agreement (BAFTA) for industrial products. In 1992 and 1993 the Baltic States concluded free trade agreements with Norway, Sweden and Finland. When Finland and Sweden joined EU, these agreements continued under the provision of Baltic-EU free trade agreements. In 1995 all three Baltic countries formally applied for EU membership[73]. Lithuania became a WTO member in 2001.

Forests are an important nature resource in Lithuania. Forests cover one third of Lithuanian land area. The structure of forest ownership has been changed after the independence. In 1991 almost 100 % of the forests was state owned. In the future, after completion of the land reform in the forest sector it is foreseen that 35-45 % of the total

[71] Kaubi, 2002: Personal comment
[72] Kaubi, 2002: Personal comment
[73] OECD, 2000: p. 30, 62, 184-194

forest area will be privately owned. According to the Law of Restitution forest ownership rights are restored to former forest owners or their inheritors[74]. Currently, 23 % of forests are privately owned. Privatisation is leading to constantly increasing share of private fellings. In 1999 they were 26% of total fellings[75].

At the moment, two thirds of the productive forest area are the state owned and therefore, state is the major domestic roundwood supplier in Lithuania. The most state forests are managed by 42 state forest enterprises (93%) and four national parks (4%). Forest enterprises and national parks are divided into 458 forest districts, which are divided into 1511 forest guard sectors. Three percent of the state forests are managed by municipalities, Ministry of Defence and other public institutions[76]. The problem with the privately owned forestry is the small size of the forest holdings. The average size, 2,5 ha, makes it difficult to use advanced forest management methods in Lithuania.

35 % of forests are covered with pine. Spruce covers 24 % and birch 21 % of the total forest area. The distribution of age classes in forests is as follows: 24% of forests are young stands, 40 % middle aged, 18 % are premature forests. Mature forests cover about 18 % of the total forest area. 11,5 % of Lithuanian land area is protected and about half of this area is classified as forests. The total annual increment in Lithuania is 11,6 million m³.[77]

3.2 Roundwood market

During the soviet period, Lithuania was a net importer of roundwood. About 2 million m³ roundwood or wood products were annually imported from the Russian Federation.[78] After the independence the situation has become the opposite. Now, Lithuania is a net exporter: roundwood exports were 23 % of the total domestic fellings, i.e.1,2 million³ and imports 0,06 million m³ in 2000. 52 % of exports was directed to Sweden[79].

Total domestic roundwood production in Lithuania was 4,9 million m³ in 1998. 3,7 million m³ of this was industrial roundwood. Industrial roundwood was divided into pulpwood (1,2 million m³), logs (2,4 million m³) and other industrial roundwood (0,04 million m³)[80].
Lithuanian wood-processing companies have formed two associations, Mede and Lietuvos Mediena. The professional association “Lietuvos Mediena” has 60 forest

[74] Gaizutis, 1998: p.112-119
[75] Lithuanian Statistical yearbook of forestry, 2001
[76] Lithuanian Statistical yearbook of forestry, 2000: p. 25-26, 33-41
[77] Lithuanian Statistical yearbook of forestry, 2001
[78] Gaizutis, 1998: p. 114-119
[79] Lithuanian Statistical yearbook of forestry, 2001
[80] United Nations, 2000a

industry companies as members, the biggest sawmill companies among them. Lietuvos Medienas objectives are to develop the national wood industry and to represent the interest of its members in the various national and international organisations and institutions. Most of Lithuanian sawmills are quite small and the concentration of roundwood buyers is low[81]. There is very little cooperation between forest owners in Lithuania. There are several cooperatives, but they are struggling to attract members and they are functioning more or less as companies trying to sell their services[82]. The problem with cooperatives is that people understand those as kolkhozes, which reminds from the Soviet period. Forest Owners Association of Lithuania (FOAL) represents private forest owner's interests in Government and other institutions. It was founded in 1993 and it is active in enlarging its number of members. Forest owner's co-operatives work more at the individual level: for example, they prepare forest management plans for the private forest holdings. The Forest Law is the main legal instrument in Lithuania. It controls the forest policy and management strategy[83].

After retaining the independence the structure of Lithuanian forest industry has changed dramatically. During the first years the production decreased. Not only because of the privatisation but also because of the decrease in the raw material supply from Russia. After 1994 the forest industry started to show positive trend and the growth rate of primary forest industry was exceeding that of other industries in the country. The major part of roundwood is used by sawmill industry. Wood pulp production ceased in the 1990s and the production of paper and paperboard declined by 90 % during the decade. However now investments on pulp and paper industry have started to develop again. The prices and volume of demanded pulpwood depends on the market situation and nowadays they are highly dependent on foreign forest industries. An especially difficult year for Lithuanian economy was 1999, when total GDP dropped by 3,9 %. Yet, forest industry continued steady growth even then. Germany is the most important export country for Lithuanian forest industry products. The biggest volumes of forest industry products are imported from Russia. Most of the roundwood exports are directed to Sweden.[84] Sales of roundwood to local forest industry were partly influenced by the shutdown of the most state-run sawmills.[85]

Roundwood transportation occurs mainly by road. In 2000, 81% of the roundwood from state forests was transported by trucks. Railway transports were 19 % of the total transports[86]. Roughly estimated average transport cost in Lithuania is 20 LTL/m³ (≈5,6 €/m³) and average distance 80 km.

[81] Indufor & ECO, 2000: Country case study Lithuania p. 26-27
[82] Zinkevičius. 2002: Interview
[83] Indufor & Eco, 2000: Country case study Lithuania. p. 38
[84] Lithuanian Statistical yearbook of forestry, 2000: p. 90-91
[85] Mec Naujineos, 2001: p. 4
[86] Lithuanian Statistical yearbook of forestry, 2001

Two roundwood sale systems used after Lithuanian independence are the same than in Finland, namely stumpage and delivery sales. In Lithuania the delivery sales are more common than stumpage sales. Delivery sales in state forests were 3,2 million m³ in 1999, stumpage sales were only 0,57 million m³ at the same time[87].

Roundwood sales in state forests are based upon the Rules for Roundwood Trade, approved by the Ministry of Environment. The key point in those rules is that the wood is sold in auctions and the sale takes place as delivery sales. Auctions are held at the end of every year and concern the following year. It may happen that the results of the auctions are not valid for a longer period, because of the market situation. Then it is possible to renegotiate the results, or other companies may participate in the trade. Stumpage sales are not common in state owned forests. Private forest owners can sell their wood in a way that is suitable for them and they may sell directly to domestic sawmill companies. Both stumpage and delivery sales are used in the sales of private owners.[88]

4 Germany

4.1 Forest Resources

In Germany there is approximately 10,7 million hectares forest land (10,1 available for wood supply)[89]. One third of this is owned by the states, one fifth by municipalities or communities, and almost a half by private forest owners. There are about 450000[90] private forest owners with an average forest holding size of only less than 8 hectares. Forests that are owned by different municipalities are relatively large, 170 ha on average. Almost half of all the domestic roundwood comes from state owned forests and only less than one third from privately owned forests[91]. The ownership structure in Germany varies in different states. German forest industry does not own forestland[92].

Because of small forest holding sizes, private and also municipal forest owners have founded a lot of various associations that are organizing different kind of silvicultural and forest management activities. There are approximately 5400 different forestry co-operatives in Germany with 446000 forest owning members that possess altogether 3 million hectares forest. That corresponds to a third of German forests[93].

[87] Lithuanian Statistical yearbook of forestry, 2000: p. 82
[88] Zinkevičius. 2002: Interview
[89] Finnish Statistical Yearbook of Forestry, 2000. p.330
[90] Bundesministerium für Verbr…, 2001
[91] Mäki & Toivonen, 1998: p. 32-33
[92] Toivonen, 1997: p. 9
[93] Bundesministerium für Verbr…, 2001

The Ministry of Food, Agriculture and Forestry is mainly responsible for the development and implementation of national forestry programs in Germany. Also international questions belong to the ministry. All of the federal states have their own, very influential forestry departments[94]. They manage the selling of state forests and control the compliance of the forest laws. The highest forest authority in the federal states is the forest ministry. The middle level authority (*Höhere Forstbehöre)* consists of regional forest organisations (*Forstdirektion, Forstwirtschaft).* This level usually takes care of roundwood sales and the management of state owned forests. The low level authorities are the local forest offices (*Staatliche Forstämter*), which manage the local roundwood trade and forestry. In some states, the state forest organisations manage only state forest. In those states the local forest office, which works under the jurisdiction of *Landwirtschaftskammer* is helping in management of private forests by providing financial and technical support[95].

Spruce forests make up 32 % of total forest area in Germany. Pine forests account for 28 % of the forests, other coniferous forests for 6 % and hardwood forests for 34 %[96]. Annual increment in Germany is 103 million m³. Age distribution in German forests is quite even: 37% of forests are under 40 years old, 33 % are 41-80 years old and 30 % over 80 years old[97].

4.2 Roundwood market

Total domestic roundwood production in Germany was 37 million m³ in 1999. 35 million m³ of this was industrial roundwood. Industrial roundwood was divided into pulpwood (10,2 million m³), logs (23,4 million m³) and other industrial roundwood (1,3 million m³).[98] Germany imported 2,7 million m³ foreign roundwood and exported 4 million m³ domestic roundwood to other countries. The sawmill industry is the most important sector in Germanys roundwood market. 63 % of all produced roundwood was sawlogs. However, noteworthy is that 60 % of paper and paperboard industries' raw material consists of waste paper[99]. EU countries are the main market for Germanys forest industry products. The biggest volumes are exported to France and imported from Sweden and Finland[100].

Germany is divided into many states and roundwood trade in individual states differ greatly. In southern Germany pulpwood prices are partly negotiated between individual

[94] Schraml & Winkel, 1999: p129-130
[95] Mäki & Toivonen, 1998: p. 33-34
[96] Schraml & Winkel, 1999: p.119-120
[97] United Nations, 2000d: p.172
[98] United Nations, 2000a
[99] Finnish Statistical Yearbook of Forestry, 2001: p. 337-338
[100] United Nations, 1998: p.2-3

buyers and suppliers for some time periods. However, these negotiations are not necessarily binding as to the prices. Sawlog prices are usually separately negotiated in each individual case. In Northern Germany all buyers have their own prices and common negotiations are therefore rare. Sawlog market is more important than pulpwood market. Almost all roundwood in Germany is sold on the open log market. Private forest owners usually sell their roundwood on delivery sales directly to forest industry or to intermediary agents. Thus, the supplier side of the market is not concentrated. It is typical for Germany that middlemen take care of roundwood trade. Middlemen buy roundwood from forest owners and then distribute different roundwood assortments to different buyers. During the recent years forest companies have started to buy these intermediary agents[101].

There has been an oversupply of roundwood during the past years. But now the domestic supply has almost reached its limits, especially in the markets for sawlogs. Pulpwood market has not developed with same the speed than sawlogs market and it might be possible to raise pulpwood fellings. The demand side of the roundwood market is not concentrated. There are some larger companies but their total market share is quite low. Large enterprises have established capital-intensive areas such as the paper industry. Delivery sales are the most common roundwood sales type, but roundwood is also sold in auctions. Though, roundwood trade systems and markets vary a lot in different states and therefore, it is difficult to draw a general conclusion of the roundwood trade form in Germany. However, the traded quantities have increased during the past years.[102]

The main roundwood transport form in Germany is by road. Over 90 % is transported in that way. The rest is transported by rail (5 %) or inland waterways (1%)[103]. Transport distances and costs are quite low in Germany, even though the weight limits of trucks are influencing the total costs.[104]

5 Other Baltic Sea countries

5.1 Overview

In this chapter the rest of the Baltic Sea countries are shortly presented. These countries are Russia, Latvia, Poland, Sweden and Denmark. The purpose of this chapter is to

[101] Lagerwall, 2002: Interview 24.1.2002
[102] Lagerwall, 2002: Interview 24.1.2002
[103] Federal ministry...2002: Internet
[104] Lagerwall, 2002: Interview 24.1.2002

provide information on roundwood markets in countries outside the empirical study so that the similarities and differences between the Baltic Sea countries will be understood. This chapter begins with a summary table of these countries.

Table 1. *Characteristics of the forest sectors in other Baltic Sea countries.*

	Latvia	**Russia**	**Poland**	**Denmark**	**Sweden**
Tree species	38 % Pine, 19 % Spruce % 29% birch	38 % larch, 15 % pine & 11% spruce	Pine & Larch 75 %	30% Spruce & 16% Beech	39 % Pine & 43 % Spruce
Important forest product trade partners	Sweden & Great Britain	Japan & Finland	Germany	Germany	Germany, Great-Britain and Finland
Annual domestic roundwood productio (mill m³)	14	111	24	1,5	58,7
Private forests	43%	-	17%	70%	51%
Roundwood trade balance	Net exporter	Net exporter	n.a.	Net importer	Net importer

n.a. = not available

5.2 Russia

After the collapse of the former Soviet Union, Russia became less active in the international forest market. Russia has a great forest industrial potential. It has the largest forest resources in the world. Russian Federation has 851 million hectares of forest. Development towards free market economy has not been painless. A deep recession in Russian followed after the Soviet period. Forest industry collapsed and forest resource utilisation crashed down.

Larch is the most abundant species in the Russian forests. 38 % of the total forest resources is larch. 15 % of forests consist of pine and 11 % are spruce forests. The share of birch is 14 % of the total forest resources. Other species account for 24 % of all forests. The annual growth of Russian forests is estimated to be about 1,1 billion m³. 17 % of Russian forests are protected because of environmental, scientific, historical or socio-cultural values.[105] Significant for Russian forests is that the large part of the forests are over one hundred years old. Russian roundwood production was 111 million m³ in 1999.About 29 million m³ of this was exported. Only 0,1 million m³ was imported to Russia in 1999.[106] The most important trade countries for Russian forest industry products are Japan and Finland[107].

[105] Backman, 1998: p. 8-13
[106] Finnish Statistical Yearbook of forestry, 2001: p. 326-343
[107] Burdin et al. 1998: p. 31

North-West region

Of all Russian areas, the North-West zone is located closest to the Baltic Sea and it has therefore importance in the Baltic Sea trade. Three regions (*Oblasts*), namely Leningrad, Novgorod and Pskov Oblasts belong to this zone. There are over 10 million hectares forestland in the North-West Russia. The total standing volume is 1210 million m³. 55 % of this is coniferous. The main roundwood export market for North-West Russia is Finland.[108]

Roundwood sales in state forests occur by selling or renting felling rights. Private entrepreneurs, forest companies or maybe some other coalitions buy these rights and thereby also the roundwood. These felling rights might be up to 49 years long. State authorities provide the prices and places to harvest. State authorities are also controlling felling methods and the compliance of the forest laws. Thus the supplier side is strictly state regulated. The demand side of Russian roundwood market is more competitive. Domestic sawmill industry together with foreign forest industry uses Russian roundwood. Foreign industries are important to the development of Russian forest industry. However, the problems in Russian roundwood market are manyfold. For example, the lack of infrastructure, long transport distances and old machinery are slowing down the development of Russian forest industry.[109]

5.3 Latvia

After the restoration of independence the development of Latvian Economy has been greatly based on the forests. The forest industry has been privatised rapidly. The forest ownership was restored to previous owners or their inheritors. In January 2001 the share of privately owned forests was 42,9 %. It has been estimated that the total amount of private forest owners will be 80 to 120 thousand. The average size of private forest holding is 8 ha. International roundwood trade in Latvia have totally changed direction. Earlier, almost all trade was directed to the east and now EU is the largest trade partner. The most important trade destinations are Sweden and Great Britain[110].

Latvia has totally 2,8 million hectares of forest. 38 % of this area is covered by pine, 19,4 % by spruce and 29,3 % by birch. Birch and pine forests are relatively old. But the age class structure of spruce forests is quite the contrary: The majority of spruce forests are relatively young. About 17 % of forests are under some kind of protection. Total annual increment is estimated to be 16,5 million m³[111]. Roundwood production in Latvia was 14 million m³ in 1999. Exported quantity was 4,2 and imported 0,1 million m³.

[108] Kohlström et al. 2000: p. 461-464
[109] Hongisto, 2002: Interview
[110] Latvia's Forest Sector, 2000: p.12,22
[111] Latvia's Forest Sector, 2000: p.12-15

Also in Latvia, like in Estonia and Lithuania, the sawmill industry is a major domestic roundwood user [112].

5.4 Poland

Poland was the first country in Central and Eastern Europe to start a radical transition from centrally planned economy to market oriented economy. In 1996 Poland became OECD member and in 1999 NATO member. Currently, Poland is negotiating over EU membership[113].

There is about 8,8 million hectares forest in Poland. 86 % of all forests are coniferous. Pine and larch account for 75 % of all forests.[114] Annual increment in Poland is 58 million m³.

The forests are mainly (83 %) owned by public authorities. Practically this means that the State Treasure owns them. Private forests account for 17 % of all forests. Privatisation has been going on also in Poland. The scale of privatisation is determined by forests nationalised earlier with a total area of 4,9 million ha[115]. The total quantity of produced roundwood was 24 million m³ in Poland in 1999. Roundwood imports were 0,5 million m³.[116] Poland's main foreign trading partner is EU and there particularly Germany. Poland imports roundwood mainly from countries of Central and Eastern Europe, for example from Lithuania and Belarus. Roundwood is exported mainly to EU.[117]

5.5 Sweden

The total productive forest area in Sweden is 22,7 million hectares. 51 % of this is privately owned, forest companies own 39 %. Only three percent of forests are state owned and seven percent have some other kind of owner. In 1999 there were 274000 forest holdings in Sweden. 92,4 % of these belong to private forest owners, which are organised to six forest owners associations. Together they build the Swedish Forest owner association (Skogsägarnas riksförbund). It has almost 90 members and manages 6 million hectares forest.[118] Tree species are distributed in Swedish forests so that 39 % is pine, 43 % spruce and 11 % birch. Annual increment is about 101 million m³. About six percent of Swedish forests are nature conservation areas.

[112] Finnish Statistical Yearbook of Forestry, 2001: p. 326-343
[113] Indufor & Eco, 2000: Country case study Poland
[114] ECE, Timber Committee, 2001
[115] United Nations, 2000b: p. 41
[116] Finnish Statistical Yearbook of Forestry, 2001: p. 326-343
[117] ECE, Timber Commitee, 2001
[118] Skogsstatistik årsbok, 2001: p. 40-44

The Ministry of Industry, Employment and Communication is responsible for forest policy in Sweden. The Swedish Forestry Administration counters to practical forestry questions.[119]

Sweden produced 58,7 million m³ roundwood in 1999. 1,6 million m³ of this was exported. 11,6 million m³ roundwood was imported to Sweden in 1999[120]. Roundwood trade in Sweden takes place in several ways. Most of the roundwood is sold at roadside, as delivery sales. Another sales type also in Sweden is stumpage sales. However, there are several different variations of these two sales types. Price negotiations were more concentrated earlier, but price negotiating systems ended in Sweden because of market competition legislation. Now, forest owner associations negotiate the prices with each individual roundwood buyer. In Sweden large forest companies dominate in roundwood markets[121]. There are three main price formation types in Swedish roundwood market. The first one is pricing by delivery list, i.e. trade price is based on a general price list. The second type is pricing by negotiation and the third is pricing by bidding. The last pricing type means that the price is formed after offers from several possible buyers.[122] The most important forest product trade countries for Sweden are Germany, Great Britain and Finland[123].

5.6 Denmark

The forest area in Denmark totals 0,46 million ha and about 70 % of this is privately owned. 30 % is under public administration. Norway spruce covers 30,3 % of the forests and 16,2 % is covered by beech. The rest of the forest area is divided between various hardwood and softwood species. About 10 % of public forests are protected. Annual net increment is 3,3 million m³. Characteristic for Danish forestry is the high number of small forest holdings. The average size of the holdings is about 22 hectares.[124] Roundwood production in Denmark was 1,5 million m³ in 1999. Exported

[119] The Swedish Forestry Administration, 2001
[120] Finnish Statistical Yearbook of Forestry, 2001: p. 326-343
[121] Skogsstatistik årsbok, 2001: p. 215-217
[122] Skutin, 2000: p. 25
[123] The Swedish Forestry Administration, 2001
[124] Dragsted, 1999: p. 45-56

quantity was 0,7 and imported 1,4 million m³ in 1999[125]. The most important trade partner of Danish forest product industry is Germany.

[125] Finnish Statistical Yearbook of Forestry, 2001: p. 326-343

APPENDIX 2. Misspecification tests for residuals from estimated VAR models of roundwood prices. Models contain two lags and constant.

Misspecification tests for residuals			
	Autocorrelation	Heteroscedasticity	Normality
Spruce pulpwood	$F_{AR}(6,62)$	$F_{ARCH}(6,56)$	$\chi^2(2)$
Finland	1,67[0,14]	0,38[0,88]	0,5[0,77]
Estonia	1,92[0,09]	0,84[0,54]	11,08[0,00]**
Lithuania	2,78[0,02]*	1,16[0,33]	4,37[0,11]
Germany	0,56[0,76]	0,81[0,56]	4,89[0,08]
System	$VF_{AR}(96,164)$ 2,14[0,00]**		$V\chi^2(8)$ 19,4[0,012]*
Pine pulpwood	$F_{AR}(6,67)$	$F_{ARCH}(6,61)$	$\chi^2(2)$
Finland	1,30[0,27]	1,74[0,13]	8,16[0,016]*
Estonia	1,42[0,21]	0,84[0,59]	44,8[0,00]**
Lithuania	0,88[0,51]	1,45[0,21]	0,08[0,96]
Germany	1,63[0,15]	0,51[0,80]	50,2[0,00]**
System	$VF_{AR}(96,184)$ 2,66[0,00]**		$V\chi^2(8)$ 103,4[0,00]**
Birch pulpwood	$F_{AR}(6,66)$	$F_{ARCH}(6,60)$	$\chi^2(2)$
Finland	1,30[0,27]	0,10[1,0]	52,11[0,00]**
Estonia	1,84[0,10]	1,12[0,36]	34,54[0,00]**
Lithuania	0,59[0,73]	1,7[0,14]	8,8[0,012]**
System	$VF_{AR}(54,155)$ 1,83[0,002]**		$V\chi^2(6)$ 107,75[0,00]**
Pine sawlogs	$F_{AR}(6,70)$	$F_{ARCH}(6,64)$	$\chi^2(2)$
Finland	1,9[0,09]	0,61[0,72]	8,04[0,02]*
Estonia	3,01[0,11]*	2,74[0,02]*	14,6[0,00]**
Lithuania	1,39[0,23]	3,22[0,00]**	11,5[0,00]**
System	$VF_{AR}(54,167)$ 1,88[0,01]**		$V\chi^2(6)$ 37,2[0,00]**
Spruce sawlogs	$F_{AR}(6,67)$	$F_{ARCH}(6,61)$	$\chi^2(2)$
Finland	0,85[0,53]	0,82[0,56]	7,6[0,02]*
Estonia	2,2[0,054]	1,60[0,16]	14,01[0,00]**
Lithuania	1,3[0,27]	0,70[0,65]	1,98[0,37]
Germany	1,60[0,16]	1,2[0,25]	25,7[0,00]**
System	$VF_{AR}(96,184)$ 1,16[0,19]		$V\chi^2(8)$ 44,7[0,00]**

The autocorrelation is tested by using the F-form of the Lagrange Multiplier (LM) test. This test performed through the auxiliary regression of the residuals on the original variables and lagged residuals. Null hypothesis is no autocorrelation, which is rejected if the test statistics is too high. Also the heteroskedasticity is tested by using the F-form the LM test. Here it tests the joint significance of lagged squared residuals in the regression of squared residuals on constant and lagged squared residuals. The null hypothesis is no heteroscedasticity. The normality of residuals are tested by using Doornik-Hansen test. It tests if the skewness and kurtosis of the residuals correspond to those of a normal distribution.