Dynamics of Roundwood Prices in Estonia, Finland and Lithuania

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Abstract

This study analyses the development of Estonian, Finnish and Lithuanian roundwood markets using nominal monthly time series of delivery prices of pine, spruce and birch sawlogs and pulpwood from the time period of January 1996 – July 2004. The question whether any long run relationships between the wood assortment and species prices in the three countries exist is studied using the Johansen's co-integration method. The Estonian and Lithuanian roundwood prices have approached the Finnish price levels, but long run equilibrium relationships were only found between spruce sawlogs in Estonia and Lithuania, and in Finland and Lithuania. These results indicate that the roundwood markets in the Baltic Sea Area are not yet integrated with the exception of spruce sawlogs. Thus, the regional roundwood supply and demand characteristics still play an important role in these countries.

Key words: Baltic Sea Area, roundwood markets, cointegration analysis, long run economic relationships

Introduction

Structure of wood and wood product markets in the North Eastern Europe is currently going through significant changes due to the large investments in sawmilling industry. Especially, the investments in sawmilling capacity have increased considerably in the Baltic States where, after declaring independence, the economies have undergone a significant structural change and showed a remarkable economic success. Partial privatization has been taken place also in the forestry sector. Along with the accession into the European Union in May 2004, economic integration in the Baltic Sea Area has deepened. It is therefore of interest to focus whether this increasing economic integration and the rising demand for roundwood have had an effect also on the price development in national roundwood markets.

Quantitatively, international trade of roundwood in the Baltic Sea Area has increased approximately 50 % between the years 1995 and 2001, and the trade occurs mainly within the Baltic Sea region and not outward of it. The Baltic Sea Area can therefore be considered as a relevant roundwood market area for the forest industry operating in the Northern Europe. Since most roundwood traded in Baltic Sea Area is pulpwood, but the domestic industry in the Baltic States is dominated by sawmilling, it is possible that the differences between wood assortments regarding openness to international trade affect their markets.

Development of roundwood prices is a key to understand how markets in different countries are functioning, to anticipate price changes for different roundwood assortments, and to assess how changes in these prices may affect the investment decisions of forest industry enterprises and their profitability development. On the supply side, the assessment and information of the development of roundwood prices certainly affect forest owners' wood selling behaviour.

Even though some analysis concerning regional integration of roundwood markets have recently been done in e.g. United States (Bingham *et al.* 2003) and Finland (Toppinen and Toivonen 1998), a deeper analysis of integration of international roundwood prices between the western and transition countries is still needed. The previous studies analysing market integration and linkages between roundwood prices have also had shortcomings with proper data sets. For example, integration between roundwood markets in Finland, Sweden and Austria was studied in Toivonen *et al.* (2002), but due to limited data, only simple regression analysis was used. Thorsen (1998) found that Nordic countries with largest forest product industries, i.e. Finland and Sweden, are price leaders with respect to smaller forestry countries, Norway and Denmark, in the market of spruce sawlogs, but did not consider any other wood assortments. Recently, roundwood market linkages between Nordic and Baltic countries have been studied by Mäki-Hakola (2004), who established indications of fairly strong connections between Finnish and Estonian spruce sawlog prices, but found only a low correlation between spruce pulpwood prices.

Partly, the deficiency of the studies is because of the lack of proper data sets from the Baltic Sea Area. For example, no monthly roundwood price data are available from big exporting countries like Sweden and Latvia. The recent statistics, however, containing time series of different assortment prices from Estonia and Lithuania have been improved in their quality and are becoming of adequate length and frequency for econometric research. Therefore, in this study we deepen the understanding of development of roundwood prices and market integration between Finland, Estonia and Lithuania by analysing how the roundwood prices in the Baltic Sea Area have evolved over time, and test whether there exist any long run relationships between different national wood assortment prices. In addition to the coniferous prices, i.e. pine and spruce sawlogs and pulpwood, we also analyse markets for birch sawlogs and pulpwood to receive a more complete understanding of the development of the roundwood price integration in the Baltic Sea Area.

Materials and methods

Institutional background of markets

The studied Baltic States differ from their land size and number of inhabitants. Despite this, the countries have similarities regarding forestry, roundwood market structures, forest industry, and its importance in the society. The share of forests of the total land area is 72% in Finland, about 50% in Estonia and 32% in Lithuania (Statistical Yearbook of Forestry (Finland) 2002, The Global Forest Resources Assessment 2000 FAO). Softwood species dominate the growing stock in each country. Finland's forest area is 21.9 million ha and the growing stock is about 1.9 billion m^3. Estonia has a forest area of 2.1 million ha and the growing stock is about 0.321 billion m^3. In Lithuania, there is about 2.0 million ha forest land, and the growing stock is 0.366 billion m^3.

In each country, forest industry is export oriented and it is among the most important sectors to earn export income (see Table 1). While pulp and paper industry in Finland is much larger than the wood sector, in Estonia and Lithuania it is the opposite. West Europe is the major export area for each country.

Forestry in all the studied countries is characterised by private and fairly fragmented ownership. In Finland, over 60% of productive forestland is owned by private inhabitants. There are about 300 000 private holdings (at least five hectares in size) by nonindustrial private forest owners (NIPFs). In Estonia, private forest ownership is developing through the land reform process. Currently, the number of private forest holdings is over 50 000, but it may increase to 100 000. The share of private forestland is expected to increase to about 60%. An average size of a private forest holding is expected to be roughly 10 hectares. In Finland the average size is over 30 hectares. In Lithuania, the share of privatised forests is 32%, and the share is expected to reach 50%. Current average size of a private holding is 4.5 hectares, and the number of holdings is close to 150 000 (Skutin and Tilli 2004, Toivonen and Mäki 1999, ECOSOC 2001, www.lvmi.lt/vmt).

The harvests in Estonia have doubled since 1997. Roundwood supply has increased sharply particularly from the privatised forests. In Finland, the share of harvests from net annual increment (NAI) was over 80% and in Estonia over 130% in 2001 (Tilli and Skutin, 2004). In Finland, harvests have remained quite stable during the last 8-10 years. In Lithuania harvest quantities have also remained stable during the last 5-8 years (accounting for 80% of NAI). The growth of the Lithuanian forest sector output has been clearly slower than that in the other two Baltic States.

In the Baltic States, domestic sawmill companies exploit sawlogs, but pulpwood is almost totally exported to Germany and Sweden. The number of actual buyers is clearly smaller for pulpwood than for sawlogs. The structure is changing quite rapidly towards smaller number of buyers also on the log markets;

Table 1. Production, Consumption and Trade of Roundwood and Sawnwood, mill.m^3 in Estonia, Finland and Lithuania (roundwood measured under bark, Finland: coniferous sawnwood)

	Roundwood			Apparent consumption	Sawn wood			Apparent consumption
	Harvests	Export	Import		Production	Export	Import	
1995								
Estonia	3.5	2.7	0	0.8	0.4	0.3	0	0.1
Finland	51.0	1.2	11.3	61.1	9.9	8.4	0.2	1.7
Lithuania	6.0	1.6	0	4.2	0.9	0.8	0	0.1
2001								
Estonia	10.2	3.7	0.6	7.1	1.7	1.1	0.2	0.8
Finland	52.2	0.4	12.0	68.1	12.8	8.1	0.3	5.0
Lithuania	5.7	1.3	0.1	4.5	1.3	0.7	0.3	0.9

Source: Eurostat Forestry Statistics 1998-2001, Statistical Yearbook of Forestry (Finland 2003) large international companies buy both sawlogs and pulpwood, and ship the pulpwood to their foreign factories. In Finland large companies utilise all assortments in their domestic factories.

As shown in Table 1, wood industry has grown significantly in Finland and Lithuania, but particularly in Estonia between 1995 - the early 2000s. Harvests have increased clearly only in Estonia. Despite this, sawlogs are turned as net import article in Estonia, reflecting the fact that production of sawn wood has grown as four-fold. In contrast, in Finland the growth has been about 35% during the same time period.

The development in Finnish sawmill industry has been turbulent; production and exports collapsed in the early 1990s, but grew strongly during the 1990s similarly as the sector in the Baltic States. The exports stagnated in 2000, but domestic demand has kept the production rising: in 2002, domestic consumption reached 5.4 million m^3, 54% more than in 1989. Boosted by investments, pulp and paper production were on a clear growth trend during the 1990s. The growth in the early 2000s has been modest.

Both demand and supply of roundwood have increased in Estonia and Finland during the last ten years, with the exception of years of economic recession in Finland. In Estonia, the demand for sawlogs has increased as manifold during the last ten years while the increase has been some tens of percent in Lithuania and Finland. The development in export demand for pulpwood is more difficult to estimate in Estonia and Lithuania. In Finland the demand for pulpwood has increased about 30% between 1990 and 2003. Large pulp mill investments might change drastically the demand-supply balance of pulpwood in the two Baltic States. A hardwood pulp mill is under construction in Estonia.

Estimation Method

Integration between Estonian, Finnish and Lithuanian roundwood markets will be studied using the theoretical framework of the law of one price (LOP). This fundamental principle of commodity arbitrage implies that the prices of equivalent inputs should equal in equilibrium (net of transaction costs) in studied countries when expressed in common currency. In practice, it is more complicated to find the equilibrium price levels because the adjustment of markets is occurring continuously. In our case, for example, we see Estonian and Lithuanian roundwood prices catching up with those of Finnish prices (Figure1). Therefore, *a priori* our analysis will more likely demonstrate the adjustment process of Estonian and Lithuanian wood markets than the actual state of equilibrium.

In order to understand the dynamics of these markets, it is essential to know time series properties of wood prices in the studied countries. In order for the LOP to hold in the long run, the prices need to be integrated of the same order. Previous studies analysing the integration of wood markets have started by testing nonstationarity of time series with augmented Dickey-Fuller (ADF hereafter) approach (Dickey and Fuller 1979) and using Johansen's estimation in testing for cointegration between variables that are found to be nonstationary. In the ADF test, the null hypothesis is nonstationarity and it is rejected only if the evidence against it is strong enough. In other words, the test conservatively supports nonstationarity in data. However, testing the null hypothesis of stationarity may provide different insights into market analysis. Therefore, along with the ADF test, we use also test introduced by Kwiatkowski *et al.* (1992) (KPSS hereafter), which is conservative for the opposite direction as compared to the ADF-test.

In testing cointegration between roundwood prices in Estonia, Finland and Lithuania, we start by using the multivariate version of statistical autoregressive model

$$z_t = A_1 z_{t-1} + \ldots + A_k z_{t-k} + u_t, \quad (1)$$

where z_t is (*n x 1*) vector of endogenous variables and each of the A_i is an (*n x n*) matrix of coefficients. k defines the lag length and u_t is the standard vector of error terms with normal IID assumptions. Equation (1) can be reformulated into a vector error correction (VECM) form

$$Äz_t = Ć_1 Äz_{t-1} + \ldots + Ć_{k-1} Äz_{t-k-1} + Šz_{t-k} + u_t, \quad (2)$$

where $\Gamma_i = -(I - A_1 - \ldots - A_i)$, (i = 1, …, k-1), and $\Pi = -(I - A_1 - \ldots - A_k)$. The rank of the Π matrix gives the number of cointegrating vectors in the system. If the rank of Π is zero, then Π is the null matrix indicating only a VAR process in differences and no cointegration between the variables. If Π is of full rank, the data at levels is already stationary. The most interesting case is when Π is of rank $0 < r < n$. Then, there are r cointegrating vectors describing the long-run equilibrium relationships, while the error correction mechanics embodies the short-run dynamics of the variables. To see this, the Π matrix can be decomposed as

$$Š = įā', \quad (3)$$

where both į and ā are (*n x r*) matrices. The columns of ā matrix give the cointegration vectors including information on the long-run relationships while the elements in į represent the error correction mechanism and the rate of adjustment of the process towards equilibrium. Technically, to get the most reliable estimates of the Π matrix, one should apply the multivariate maximum likelihood estimation of Johansen (1988) and Johansen and Juselius (1990).

Johansen's procedure is a stepwise analysis including the following steps[1]. First, to apply cointegration analysis one should work with time series that are known to be nonstationary. Second, given that the variables are nonstationary, one should select the precise form of the equation (2). Third, one should test the statistical significance of the number of cointegration relationships (rank r). Finally, one should estimate the cointegration equations and, if possible, impose restrictions on them. In this study, the form of the equation (2) is selected according to the Schwarz's goodness-of-fit measure and several diagnostic tests. The tests of rank of matrix Π are based on the standard trace and maximum eigenvalue tests. When the estimated value of trace test is smaller than the critical value, the null hypothesis of at least r_o cointegrating vectors can be accepted.

Data

The data consists of monthly time series of Estonian, Finnish and Lithuanian nominal delivery prices comprising the assortments of pine, spruce and birch sawlogs and pulpwood (i.e. six main wood assortments in these markets). The research period was 1996.1 – 2004.7 (for Estonian birch pulp wood 1998.1 – 2004.7) consisting of 103 observations, which should be sufficient for the cointegration analysis. Publication of roundwood prices is done through the Internet, so the possible lags in publication process should be short (Nordic Baltic Forestry Statistics 2004).

The Finnish prices are average delivery prices of roundwood bought from the non-industrial private forest owners, and are obtained from the Finnish forestry statistics. Even though delivery sales represent only about 20% of the total market sales in Finland, they are indicative of the whole market development due to the high correlation with stumpage prices (see also Rekikoski *et al.* 2001). The corresponding prices for Estonia are prices at the roadside as reported by the State Forest Management Center managing about 37% of forestland. Thus, prices refer to the state forests only, while prices for the wood from the private forests are not available for the study period. However, average prices for whole Estonia have a tendency to follow the prices from state forests, possibly with a small publication lag, but the actual price levels of small NIPF owners may be slightly lower. Lithuanian roundwood prices are based on sales data in state forest representing nearly 60% of all transactions in Lithuania. The data are roadside prices and collected by General Forest Enterprise. To make the data comparable between countries, all the time series of assortment prices are in a logarithmic form, measured over bark and transformed to Euros (€/m^3) by using average monthly exchange rates of the national currencies.

Results

Time Series Properties and Cointegration Analysis

To get an overview of the price developments in the studied countries and to obtain background and information to interpret the estimation results below, Figure 1 depicts the time series. According to the figures, the Finnish prices on average have been higher than those of Estonian and Lithuanian. However, there has been a clear convergence in nominal prices: while the Finnish prices have remained somewhat stable over time, the Estonian and Lithuanian prices typically contain a positive trend. Especially, this trend occurs in Estonian and Lithuanian sawlog prices and Estonian coniferous pulpwood prices. The last observations of the sample even indicate that Estonian pulpwood prices have exceeded the Finnish ones. Also, the fluctuations between Estonian and Lithuanian prices seem to have been more homogeneous than those between Finland and Estonia or Finland and Lithuania.

To ensure that the time series involved in the analysis are nonstationary we first run ADF and KPSS tests. However, a few remarks are worth mentioning before reporting the test results. First, in some cases the test statistics were highly sensitive to the inclusion of a constant and/or trend components in regressions. To be consistent in reporting, we included the trend in regression only if its coefficient was statistically significant.[2] Second, the number of the lags in regression is based on the Schwarz's information criteria. While in few cases this criterion led to the high tailed autoregressive process in regression and declined the power of the test statistics, we restricted the number of lags to be as small as possible, which still ensured that the error term was serially independent. Typically, the first lag fulfilled this requirement.

Keeping in mind these restrictions in estimation the test results are given in Tab. 2. According to both

[1] See Banerjee *et al*. (1993) or Harris (1995) for background and more technical details of the Johansen's method.

[2] If the data generating process is unknown, one should use a specification (constant and/or trend) which seems to be plausible description of the data and is according to the theory. See Hamilton (1994, p. 501) for more discussion.

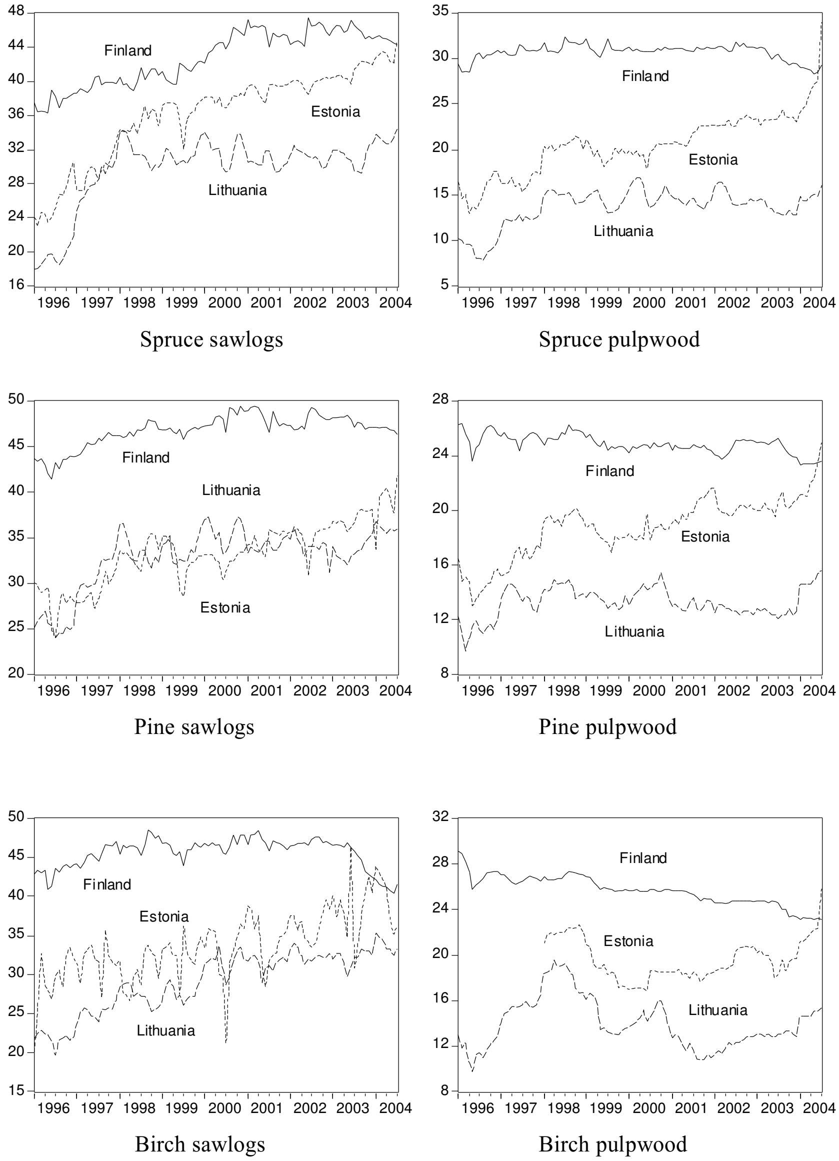

Figure 1. Roundwood Prices in Estonia, Finland and Lithuania, 1996.1-2004.7 (€/m^3 over bark)

alternative tests, the time series of Estonian spruce sawlogs and birch pulpwood, Finnish pine and spruce sawlogs, and prices for all Lithuanian sawlogs and spruce pulpwood in levels are nonstationary. Instead, the test statistics concerning Estonian pine pulpwood, Finnish birch sawlogs and spruce pulpwood, and Lithuanian birch pulpwood are conflicting. According to the ADF test, these series are nonstationary, while the KPSS test does not reject the hypothesis of stationarity. Even though the test results are conflicting, we include these series into the cointegration analysis but refrain from making any strong conclusion of the results concerning them. The first differences of the variables are all stationary, so there are no time series integrated of higher order than one.

The rest of the data, i.e. time series of Estonian pine and birch sawlogs, Estonian spruce pulpwood, Finnish pine and birch pulpwood together with Lithuanian pine pulpwood are found to be stationary, so they are excluded from the cointegration analysis. It can be noted that simple correlations between stationary pine pulpwood prices in Finland and Estonia is negative and of value 0.23, and overall, the correlations between pulpwood prices in different countries are lower than between sawlog prices. However, between possibly nonstationary prices in pulpwood and sawlogs, spurious correlations are possible and nothing can be concluded about these interrelationships.

To proceed with cointegration analysis, we next tested the adequate lag structure of the vector autoregressive model (1). The choice between the number of lags in VAR models is based on the Schwarz's information criteria. Since residuals of VAR models should be statistically well behaved, we test their normality, het-

Table 2. ADF-Nonstationarity and KPSS-Stationarity Tests for Variables

					ADF	KPSS	ADF	KPSS
Estonia	**Sawlog**	Pine	C,T	0	-4.413**	0.095	-9.250**	0.167
		Spruce	C,T	0	-2.459	0.266**	-9.197**	0.197
		Birch	C,T	0	-7.639**	0.060	-14.659**	0.267
	Pulpwood	Pine	C,T	0	-2.574	0.122	-12.843**	0.098
		Spruce	C,T	3	-5.065**	0.111	-4.780**	0.243
		Birch	C,T	0	-0.110	0.232**	-7.609**	0.422
Finland	**Sawlog**	Pine	C	1	-1.825	0.788**	-13.224**	0.193
		Spruce	C,T	0	-2.767	0.213*	-10.297**	0.265
		Birch	C	0	-1.761	0.239	-11.918**	0.359
	Pulpwood	Pine	C,T	0	-3.628*	0.056	-11.000**	0.062
		Spruce	C	0	-2.686	0.255	-9.212**	0.383
		Birch	C,T	2	-4.633**	0.117	-7.501**	0.064
Lithuania	**Sawlog**	Pine	C	0	-2.469	0.692*	-9.693**	0.200
		Spruce	C	1	-2.931	0.624*	-6.384**	0.328
		Birch	C,T	0	-3.059	0.232**	-9.578**	0.228
	Pulpwood	Pine	C	1	-3.053*	0.167	-9.633**	0.077
		Spruce	C	1	-2.252	0.562*	-7.322**	0.071
		Birch	C	1	-1.770	0.232	-9.038**	0.100

The asterisks * and ** denote that the null hypothesis is rejected at 5% and 1% level, respectively. In ADF the null hypothesis is that the time series is nonstationary, while KPSS tests stationarity as a null hypothesis.

eroscedasticity and autocorrelation. The test for homoskedasticity of the residuals is an extension of White's test to systems of equations. This test statistics is obtained by regressing each cross product of the residuals on the cross products of the regressors, and testing the joint significance of the regression. Residual serial correlation is tested using a standard LM-test and Ljung-Box test for the joint hypothesis that all the lagged autocorrelation coefficients are simultaneously equal to zero. The test for normality of residuals is based on Doornik-Hansen test which is a multivariate extension of the standard Jarque-Bera test comparing the third and fourth moments of residuals to those from the normal distribution.

Table 3. Diagnostic Test on the Residuals of VAR Models

Assortment		Countries	Lags	Homoskedasticity	Autocorrelation		Normality
					LM-test	Box-Ljung	
Sawlog	**Pine**	Fin – Ltu	1	0.2596	0.1114	0.5958	0.0008
	Spruce	Est – Fin	1	0.0562	0.0106	0.1941	0.0000
		Est – Ltu	2	0.0183	0.5977	0.4738	0.0147
		Fin – Ltu	2	0.1499	0.1055	0.0604	0.0127
		Est-Fin-Ltu	1	0.0258	0.0506	0.2194	0.0002
	Birch	Fin – Ltu	1	0.0516	0.1617	0.0249	0.0785
Pulpwood	**Spruce**	Fin – Ltu	1	0.5929	0.0007	0.0001	0.0012
	Birch	Est – Ltu	1	0.3921	0.0323	0.3018	0.0000

The reported values are p-values associated to the test statistics. The test statistics for autocorrelation is based on 12 lags.

Table 3 depicts the results for the diagnostic tests. To avoid excessive reporting only the probability values associated to the test statistics are shown. If the calculated p-value is lower than 0.05 (i.e. 5% significance level), the null hypothesis of homoskedasticity, no autocorrelation and/or normality are rejected. According to the information criteria, one-lag model typically minimized the loss functions with the exception of models for Estonian and Lithuanian, and Finnish and Lithuanian spruce sawlogs, which required two lags. However, the diagnostic tests for assortments revealed that the residuals for this one-lag model are not well behaving: the assumption of normality of residuals is typically rejected. Also, the test statistics for the model of Estonian and Lithuanian spruce sawlogs reveal that the residuals are heteroskedastic. While the different test statistics for autocorrelation are sometimes contradictory, the autocorrelation problem is evident for the model of Finland and Lithuanian spruce pulpwood. To improve the statistical performance of the models we also tried to include more lags in VAR models. Typically, these experiments did not eliminate the non-normality or heteroskedastic structure of error terms. According to Gonzalo (1994), however, the results for Johansen's cointegration analysis should not be biased despite the abnormality of the residuals, while the heteroskedasticity may lead to the inaccurate statistical inferences of the following cointegration test results.

To identify the possible long-run cointegation relationships, a pairwise analysis is a test of null hypothesis that there are no cointegration vectors against the alternative that there is one. Table 4 shows the results for cointegration analysis. According to the maximum eigenvalue test statistics only the system estimation for spruce sawlogs contains one cointegration vector. The trace statistics indicate long-run relationship between Estonian and Lithuanian and between Finnish and Lithuanian spruce sawlogs. Thus, cointegration tests indicate that only these markets of spruce sawlogs would be integrated between countries. In case prices in all three markets are found to be nonstationary, the system of three variables can be used to test the hypothesis of full market integration against the nested integration, and then the null hypothesis is rejected if the test statistic exceeds the critical value. The correspondent test statistics for system of three spruce sawlog prices gives support for two cointegration vectors, which is consistent with the results from pairwise analyses.

Table 4. Results for Johansen's Cointegration Analysis

Pair	Assortment		Hypothesis	Eigenvalue	Test Statistics		p- values	
					λ_{Trace}	λ_{Max}	λ_{Trace}	λ_{Max}
Fin – Ltu	**Sawlog**	**Pine**	r = 0	0.1141	18.363	12.232	0.0893	0.1729
			r ≤ 1	0.0589	6.131	6.131	0.1808	0.1808
Est - Fin		**Spruce**	r = 0	0.0999	19.330	10.837	0.0668	0.2641
			r ≤ 1	0.0791	8.493	8.493	0.0670	0.0670
Est – Ltu		**Spruce**	r = 0	0.1331	22.166*	14.280	0.0270	0.0880
			r ≤ 1	0.0758	7.886	7.886	0.0869	0.0869
Fin – Ltu		**Spruce**	r = 0	0.1432	20.424*	15.455	0.0475	0.0584
			r ≤ 1	0.0485	4.969	4.969	0.2868	0.2868
Est – Fin - Ltu		**Spruce**	r = 0	0.1961	46.848*	22.042	0.0018	0.0543
			r ≤ 1	0.1677	24.806*	18.541*	0.0110	0.0188
			r ≤ 2	0.0601	6.265	6.265	0.1712	0.1712
Fin – Ltu		**Birch**	r = 0	0.0572	7.874	5.949	0.8345	0.7937
			r ≤ 1	0.0189	1.925	1.925	0.7925	0.7925
Fin - Ltu	**Pulpwood**	**Spruce**	r = 0	0.0840	16.178	8.863	0.1662	0.4487
			r ≤ 1	0.0699	7.315	7.315	0.1108	0.1108
Est - Ltu		**Birch**	r = 0	0.0621	5.395	4.937	0.9714	0.8937
			r ≤ 1	0.0059	0.458	0.458	0.9963	0.9963

The p-values give the lowest significance level at which a null hypothesis can be rejected. In Table, the asterisk * denotes that the null hypothesis is rejected at 5% level.

Discussion and conclusions

This study has analysed the development of Estonian, Finnish and Lithuanian roundwood prices for pine, spruce and birch in both sawlogs and pulpwood, and tested for the existence of long run equilibrium relationships between the national prices. While roundwood prices from the Baltic States are from the public forests and the Finnish prices are for roundwood bought from the private forest owners, it is assumed that these prices represent best the general market development in these countries. Any price deviations between different supplier sources likely existing in the Baltic States should therefore not form a major hindrance to the present analysis, which focuses on the longer term price relationships.

The demand-supply equilibrium on the roundwood markets has developed somewhat differently in Finland, Estonia and Lithuania since the beginning of 1990s. Demand and supply of roundwood have increased in each country, but it seems that this development has been most evident in Estonian spruce and pine sawlog markets. According to the results, the Finnish roundwood prices have remained somewhat stable over the time period 1996 – 2004, while the Estonian and Lithuanian roundwood prices have contained a clear positive trend. Especially, the rising trend has occurred in sawlogs and Estonian coniferous pulpwood prices. The Finnish market for especially pulpwood is effected by the increasing use of imported wood, which may dampen the domestic price development.

Although the Estonian and Lithuanian roundwood prices have converged against to those of Finnish prices, the statistical analysis indicated long run equilibriums existing only between spruce sawlog prices between Estonia and Lithuania, and between Finland and Lithuania. This result is likely due to spruce sawlogs being the most important (by volumes and value) assortment in Estonia and Lithuania, which causes these prices to reflect most clearly actual market development. For example, in the case of birch sawlogs and pulpwood, the markets are clearly smaller especially in Finland as compared to coniferous species. The markets for birch may be more prone to heterogeneous product quality and other sources of randomness in price fluctuations, which makes it difficult to model any price interrelationships.

Another explanation for cointegration test results may be found originating from common export markets of sawnwood especially in Germany and the UK that form the basis for more uniform price development of sawlogs in the Baltic Sea Area. The rise in Estonian spruce sawlog price has been so rapid that it may therefore be difficult to find any equilibrium relation between Estonian and Finnish spruce sawlogs.

On the other hand, the markets for pulpwood in Estonia and Lithuania differ from sawlog markets by nature: in the Baltic countries pulpwood is an export product without significant own pulping capacity, and the residual demand of this less developed market is mainly purchased by foreign companies (e.g. Stora-Enso) to be exported in their production facilities in Sweden and Finland. Nevertheless, it should be noted that also pulpwood price increases have been remarkable, especially in Estonia, which could reflect dynamic interrelationship between sawlog and pulpwood markets in the Baltic States. However, this issue was out of the scope of the present study.

Thus, the regional roundwood supply and demand characteristics still play an important role in the roundwood markets of these three countries. Although the roundwood prices have converged in the Baltic Sea Area, the still undergoing transition of economies in the Baltic States shows in the roundwood markets. Importantly, there are structural changes ongoing in forest ownership and privatisation of roundwood supply, new forest industry investments are being planned which increase roundwood demand, and international trade flow patterns of both products and raw materials of forest based industries are shifting. In particular, if large pulp mill investments take place in Lithuania and Latvia, this would probably have major markets impacts on roundwood markets. Production of one million ton of pulp would require from three to five million cubic meters pulpwood, which is over a third of the current pulpwood harvests in the three Baltic States. Exports from the Baltic States would probably be reduced, and increasing demand would put pulpwood markets on further upward price pressure at least in the Baltic States.

Taking the above mentioned development into account, development in roundwood prices, *ceteris paribus*, will likely continue constituting eventually an integrated and efficiently functioning roundwood market in the Baltic Sea Area. This will be reflected in the new long run equilibrium price levels for different wood assortments. In any case, the results point out for the importance of analysing wood prices by specific assortments than by aggregate sawlogs or pulpwood. In future research on the Baltic Sea Area roundwood market, a more complete understanding should be the target, especially when using methods that capture price convergence in markets under structural change. Consequently, other methods should be used in studying the convergence of the markets where assortment specific prices seem to have no statistical tendency for long run equilibrium relationships.

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ДИНАМИКА ЦЕН НА КРУГЛЫЙ ЛЕС В ЭСТОНИИ, ФИНЛЯНДИИ И ЛИТВЕ

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Резюме

В данном исследовании представлен анализ развития рынка круглого леса в Эстонии, Финляндии и Литве на основе номинальных ежемесячных промежутков формирования цен на поставки пиловочника и баланса сосны, ели и березы в период с января 1996 г. по июль 2004 г. В исследовании, с помощью метода соинтеграции Йохансена, рассматривается вопрос, существует ли долгосрочная взаимосвязь между ассортиментом древесины и ценами на определенные породы в вышеуказанных трех странах. Эстонские и литовские цены на круглый лес приблизились к уровню Финляндии, однако, долгосрочные сбалансированные взаимосвязи были выявлены только по еловому пиловочнику между Эстонией и Литвой, а также между Финляндией и Литвой. Данные результаты указывают на то, что рынки круглого леса в Балтийском регионе еще не интегрированы, за исключением компонента елового пиловочника. Таким образом, региональные характеристики спроса и предложения на круглый лес в этих странах продолжают играть важную роль.

Ключевые слова: Балтийский регион, рынки круглого леса, анализ соинтеграции, долгосрочные экономические отношения