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Highlights

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Forestry industry trade by degree of wood processing in the enlarged European Union countries

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- Relative comparative trade advantage index as a competitiveness measure
- Kaplan–Meier survival rates and Markov transition probability matrices differ.
- Degree of wood processing affects wood chain international competitiveness.
- Finished wood products are crucial for competitive forestry industry trade.
- More efficient wood chain management is a challenge for new member states.

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A B S T R A C T

This paper analyses the forestry industry trade of the New Member States (NMS-11) of the European Union (EU) on the enlarged EU-27 markets, focusing on three groups of wood products: raw wood, semi-finished and finished wood products in the 1999–2010 period. The best performing NMS-11 country in the forestry industry trade with the enlarged EU-27 is Cyprus with a trade surplus mostly based on finished or at least semi-finished wood products. The results suggest a convergence in the forestry industry trade specialisation of the NMS-11 countries. A significant variation in the mobility of the forestry industry trade specialisation is found, but with a deterioration in forestry industry trade specialisation patterns over time. The results suggest the crucial role that the wood-processing and furniture industries can play with finished wood products and their backward linkages to raw wood and semi-finished wood products for forestry industry competitiveness. Forestry industry management should focus on better quality and greater trade competitiveness in the vertical wood industry supply chains from lower to higher value-added and marketed wood products.

1. Introduction

Forestry industry trade in raw wood and semi-finished wood products has represented one of the single most important traded agro-food and forestry industry products from the New Member States (NMS) from the Central and Eastern European (CEE) countries to the old member states of the European Union (EU-15) (Bojnec and Fertő, 2007a, 2007b). As argued by Bojnec and Fertő (2011), for the forestry industry trade in raw wood and semi-finished wood products of Hungary and Slovenia with Austria, the NMS from the CEE countries might export to the EU-15[1] lower value-added raw wood and semi-finished wood products and, vice versa, import higher value-added processed wood products. Thus far, there has not been any evidence on the forestry industry trade of differentiated wood products for the Mediterranean NMS (Cyprus) and on trade competitiveness for the forestry industry by raw wood, semi-finished and finished wood products on the enlarged EU-27 for the NMS-11.[2]

We investigate what has happened to the forestry industry trade flows in the NMS-11 countries that joined the existing EU-15 countries. There is a wealth of literature on the impacts of specialisation on countries' export performance. The theoretical literature on growth and trade predicts that a country's comparative advantage is a dynamic concept and develops endogenously over time. The growth rate of a country might be permanently reduced by a 'wrong' specialisation (e.g., Grossman and Helpman, 1991; Lucas, 1988; Young, 1991). Another strand of research emphasises the role of factor accumulation in determining the evolution of international trade (Deardorff, 1974; Findlay, 1970, 1995). Based on different theoretical predictions, there is increasing empirical literature on trade dynamics. Research on industrial countries finds a strong persistence of comparative advantage (e.g., De Benedictis and Tamberi, 2004; Redding, 2002), whilst there is contrary

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[1] The following countries are considered to be the EU-15: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.

[2] The following countries are considered to be the NMS-11: the NMS-9 from the EU enlargement on the 1st of May 2004 (the Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia) and the NMS-2 from the EU enlargement on the 1st of January 2007 (Bulgaria and Romania). In addition, Malta, which joined the EU on the 1st of May 2004, is the NMS-12. It has been identified as an outlier in the empirical analysis with relatively small or no trade in raw wood base, neither from domestic forestry base nor from imports and with relatively larger trade in semi-finished and finished wood products. This is the reason that Malta is excluded from the presented results in this paper, so that instead of the NMS-12, the presented results are for the NMS-11 countries.

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evidence, i.e., relatively high mobility in trade specialisations for CEE countries (e.g., Bojnec and Fertő, 2008; Fertő and Soós, 2008; Zaghini, 2005).

The aim of this paper is to investigate, via the application of various empirical approaches, whether the NMS-11 countries have recently changed their specialisation in the forestry industry trade by the degree of wood processing. The main methodological assumptions of the research are that the relative comparative trade advantage (RTA) index is a close approximation of the forestry industry trade competitiveness for the NMS-11 countries on the enlarged EU-27 markets, which is used as a benchmark of relative comparison. Among the main limitations of the research is the omitted NMS-11 forestry industry trade with the rest of the world outside the EU-27. This would require a new calculation and comparison of the results, using the world trade as the benchmark of comparison for the NMS-11 trade both in trade with the EU-27 countries and in trade with the countries in the rest of the world. The situation is similar for presented calculations, which are based on a single year and not on the basis of contiguous years and an average of a number of years, and thus might be biased to trade oscillations by individual years, particularly for smaller countries.

This paper contributes to the literature on the forestry industry trade between the NMS-11 and the enlarged EU-27 markets in the following four directions: first, it provides an empirical analysis of the forestry industry trade by raw wood, semi-finished and finished wood products for the NMS-11 on the enlarged EU-27 markets before and after the EU-27 enlargement. Second, following the previous literature (Dieter and Englert, 2007), which analysed the competitiveness of Germany in the global forest industry sector, this paper contributes the empirical analysis of the RTA index as a competitiveness measure for the NMS-11 on the enlarged EU-27 markets by the degree of wood processing. Third, unlike any previous studies, this paper contributes a duration analysis of the relative comparative trade advantage or relative comparative trade disadvantage pattern and mobility between different RTA states. Finally, it derives forestry, wood processing, marketing, and wood supply chain implications for international competitiveness in the forestry industry trade for raw wood, semi-finished and finished wood products.

2. Literature review

Toppinen and Kuuluvainen (2010) provide a review of literature on forest sector modelling in Europe focusing on econometric research on forest sector markets (demand and supply modelling, market integration, forecasting forest sector markets and prices, industry location, and factor demand, substitution and technical change) and the application of the forest sector models with a synthesis of research and conclusions for studying the forest industry and forest product markets. Only a smaller number of studies have been related to the forestry industry trade.

Bonnefoi and Buongiorno (1990) analysed the 'revealed' comparative export advantage (RXA) index of the forest products trade. They find its positive relation with a country's net trade, extensive forest resources and other resources, and income or domestic demand. For countries with negative RXA in their total forest products trade, they identify three sub-groups in relation between forest resources relative to domestic demand. The relation between RXA, forest resources and demand was tested with an empirical model, which explained a large part of the variation in the net trade of five commodity groups: round wood, sawn wood, wood-based panels, wood pulp, and paper and paperboard, between the early 1960s and 1980s. They find a strong positive relation between net trade and wood availability, and a strong negative relation between net trade and level of domestic demand, reflected by income.

The previous studies on the forest sector development in the NMS-11 have focused on different aspects of the forestry industry development and different aspects of CEE countries' forest industry development, institutional changes and forest industry supply chain management. Kangas and Niskanen (2003) analyse trade in forest products between the EU and the CEE accession candidates. Toppinen et al. (2005) investigate dynamics of round wood prices in Estonia, Finland and Lithuania. Hänninen et al. (2007) analyse the pass-through of sawn wood and saw log prices between the new (Estonia and Czech Republic) and old EU member countries (Austria and Finland) as exporters to German markets. Whilst the transmission process differed between countries, price transmission exhibited similarities between old and new EU member countries and convergence in sawn wood and saw log prices. Using qualitative analysis, Brodrechtova (2008) investigates factors influencing export marketing strategies in the Slovakian forest products industries.

Liberalisation of trade with the tariff reductions most likely affected the commodity composition of world wood trade with a shift from raw materials to more processed products (Zhu et al., 2001). Dieter and Englert (2007) analyse the global competitiveness of the German forest industry sector against the international timber markets according to the three processing levels: raw wood, semi-finished and finished wood products. They employ two competitiveness indicators: first, the revealed comparative advantage by using the means of the Balassa index and Aquino index; second, the constant market share by disaggregating the overall export growth of a country into four different effects: the world growth effect, the commodity-composition effect, the market-distribution effect, and a residual interpreted as the competitiveness effect. The highest Balassa index values are shown by Russia for raw wood, by Finland for semi-finished wood products, by Poland and to a lesser extent for Germany for finished wood products in global timber markets. The Aquino index confirms that countries that are Q3 specialised in timber commodity exports are also significant timber importers, which is an indication of an intra-industry trade. The constant market share analysis suggests that the leading timber exporters in absolute terms experienced low export growth rates, and vice versa. They identify a strong positive relationship between a country's timber export growth rate and its competitiveness effect. Most of the Eastern European countries show this pattern with high growth rates and high positive competitiveness effects. One striking finding was that Germany's export growth has been driven more by the overall world growth in timber markets than by the German forest industry sector.

Bojnec and Fertő (2011) investigate the price, quality, and non-price competition of Hungarian and Slovenian trade in raw and semi-finished wood products with Austria. In matched two-way trade in similar products, Hungary is shown to have experienced surpluses at lower export-to-import unit values, whilst Slovenia has had a deficit at higher export-to-import unit value.

The sustainable development of the forest sector chains is seen as an important factor in different value-adding wood production and wood supply chains and in providing other ecosystem services covering the environmental, economic and social aspects of sustainable development (Päivinen et al., 2012). Public policies with institutional quality can be considered to be an additional dimension essential for achieving the sustainable development of forestry–wood chains.

This paper adds to the literature on the forestry industry trade between the NMS-11 with the enlarged EU-27 markets in the following three substantial directions: first, in comparison to Kangas and Niskanen (2003), by an updated, widened and deepened analysis of the forestry industry trade between the NMS-11 and the enlarged EU-27 markets before and after the EU-27 enlargement; second, in comparison to Dieter and Englert (2007), Han et al. (2009) and Bojnec and Fertő (2011), by the focus on the RTA index in the forestry industry trade competitiveness and in the RTA patterns; third, the Kaplan–Meier estimator of the survival function, non-parametric log-rank test, different unit root tests for panel data analysis, Markov transition probability matrices and mobility indices are introduced in the forestry industry trade analyses. Finally, the officially reported forestry industry trade is analysed. China, Brazil and Russia are likely to play predominant roles in the use of illegally harvested timber (Dieter, 2009). In the cross-border areas between some NMS-11 and between the NMS-11 and the old EU-15, there can also be notable unreported wood harvesting and less transparent unreported forestry industry trade, which is beyond the focus of our research (e.g., Solberg et al., 2010). For example, Gerasimov and Karjalainen (2006) analyse industrial round wood flows into, within, and out of the northwest regions of Russia. They estimated unreported round wood flows as being at 23% of total industrial round wood production, which can be even higher in export-oriented regions with poorly developed forest industries.

3. Methodology

The concept of 'revealed' comparative export advantage was introduced by Liesner (1958); it was later redefined and popularised by Balassa (1965, 1977) and therefore known as the 'Balassa index', which is now widely used empirically to identify a country's weak and strong export sectors (e.g. Bojnec, 2001; Bojnec and Fertő, 2012). In the case of the forestry and wood sectors, it has been used by Dieter and Englert (2007) and Han et al. (2009).

The Revealed Comparative Export Advantage (RXA) index is defined by Balassa (1965) as follows:

$$RXA = (Xij/Xit)/(Xnj/Xnt)$$

where X represents exports, i is a country, j is a commodity, t is a set of commodities, and n is a set of countries, which are used as the benchmark outlet markets for comparisons. RXA is based on observed trade patterns. It measures a country's exports of a commodity relative to its total exports and to the corresponding export performance of a set of countries, e.g., the enlarged EU-27. If RXA > 1, then a comparative export advantage on the enlarged EU-27 markets is revealed.

Critics of the RXA index as a trade specialisation index have called attention to the asymmetric value problem, problems with logarithmic transformation (De Benedictis and Tamberi, 2004) and the importance of simultaneous consideration of the import side. Thus, Vollrath (1991) offered an alternative specification of revealed comparative advantage, called the relative comparative trade advantage (RTA), which simultaneously accounts for exports as well as imports. It is calculated as the difference between the relative export advantage (RXA) and its counterpart, the relative import penetration advantage (RMA):

$$RTA = RXA–RMA$$

where,

$$RMA = (Mij/Mit)/(Mnj/Mnt)$$

where M represents imports. Thus,

$$RTA = [(Xij/Xit)/(Xnj/Xnt)]-[(Mij/Mit)/(Mnj/Mnt)].$$

If RTA > 0, then a relative comparative trade advantage is revealed, i.e., a sector in which the country is relatively more competitive in terms of its trade than the benchmark EU-27 outlet market of comparison. Similarly to the RXA index, the RTA index is also based on observed trade patterns. It measures a country's exports and imports of a commodity relative to its total merchandise exports and imports, respectively, to the corresponding export and import performance of a set of countries (EU-27), which are used as the benchmark of comparison. The NMS-11 forestry industry trade with countries outside the EU-27 is not analysed.

We classify the RTA index into three categories: RTA < 0 refers to all those product groups with a relative comparative trade disadvantage; RTA = 0 refers to all those product groups at a breakeven point without relative comparative trade advantage or relative comparative trade disadvantage; and RTA > 0 refers to all those product groups with a relative comparative trade advantage. These boundaries are consistent with theoretical interpretations appropriate for cross-country comparisons.

Positive trade theory assumes that trade patterns are stable over time. However, recent empirical evidence shows that at highly disaggregated level trade relationships are often extremely short-lived (e.g., Besedeš and Prusa, 2006a, 2006b; Nitsch, 2009) especially in the NMS-11 countries (Bojnec and Fertő, 2012; Fertő and Soós, 2009). Thus, in the first step, we analyse the duration of revealed trade advantage (RTA > 0). Calculating the duration of the RTA > 0 appears to be straightforward: it is simply the time (measured in years) that a revealed trade advantage (RTA > 0) has been in existence (without interruption). Applying statistical techniques from survival analysis (Cleves et al., 2004), duration can be calculated as a sequence of conditional probabilities that a revealed trade advantage (RTA > 0) continues after it has already survived for t periods or a certain period of the analysed years. More specifically, the duration of the RTA > 0 is estimated by the survival function, S(t), across product types by using the non-parametric Kaplan–Meier product limit estimator. We assume that a sample contains n independent observations denoted (t_i; c_i), where $i = 1, 2,\ldots$, n, t_i is the survival time, and c_i is the censoring indicator variable C (i.e., RTA) taking a value of 1 if failure occurred (RTA ≤ 0), and 0 otherwise for observation i. Moreover, we assume that there are m < n recorded times of failure. The rank-ordered survival times are denoted as $t(_1) < t(_2) < \ldots < t(_m)$. However, n_j denotes the number of subjects at risk of failing at $t(_j)$ and d_j denotes the number of observed failures. The Kaplan–Meier estimator of the survival function is then:

$$\hat{S}(t) = \prod_{t(i)<t} \frac{n_j - d_j}{n_j}$$

with the convention that $\hat{S}(t) = 1$ if t < t(1). Given that many observations are censored, we then note that the Kaplan–Meier estimator is robust to censoring and uses information from both censored and non-censored observations. It is assumed that a sample contains n independent observations denoted (t_i; c_i), where $i = 1, 2,\ldots$, n, t_i is the survival time, and c_i is the censoring indicator variable C taking a value of 1 if failure occurred, and 0 otherwise. It is assumed that there are m < n recorded times of failure as non-censored observations. The rank-ordered survival times are denoted as $t(_1) < t(_2) < \ldots < t(_m)$, whilst n_j denotes the number of subjects at risk of failing at $t(_j)$, and d_j denotes the number of observed failures.

We also check the equality of survival functions for the RTA indices across product groups using a non-parametric log-rank test. The log-rank test is defined as $E_{ij} = n_{ij}d_j / n_j$, where the expected number of failures in group i at time t_j, under the null hypothesis is of no difference in survival rates for the RTA indices among the r groups of the NMS-11 countries. The chi-squared test statistic is calculated as quadratic from $\mathbf{u}'\mathbf{V}^{-1}\mathbf{u}$ using the row vector

$$\mathbf{u} = \sum_{j=1}^{k} W\left(t_j\right)\left(d_{1j} - E_{1j}, \ldots, d_{rj} - E_{rj}\right)$$

and the $r \times r$ variance matrix $\mathbf{V}$, where the individual elements are calculated by

$$V_{il} = \sum_{j=1}^{k} \frac{W^2\left(t_j\right) n_{ij} d_j \left(n_j - d_j\right)}{n_j\left(n_j - 1\right)} \left(\delta_{ij} - \frac{n_{ij}}{n_j}\right)$$

where $i = 1,\ldots,r$, $l = 1,\ldots,r$, and $\delta_{il} = 2$ if $i = l$ and 0 otherwise. The weight function (W_{tj}) is what characterises the different flavours of the tests. In the case of the log-rank test, $W_{tj} = 1$ when n_{ij} is non-zero (Cleves et al., 2004).

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To evaluate the trade specialisation dynamics, we have to investigate the entire distribution of RTA indices from one period to the next. In other words, we focus on the stability of the RTA indices over time. At least two types of stability from one period to the next can be distinguished: (i) stability of the distribution of the RTA indices, and (ii) stability of the value of the RTA indices for particular product groups.

In the empirical literature, the analysis of the first type of stability of the RTA indices is applied to better understand the evolution of trade specialisation. To empirically test the convergence/divergence hypothesis, the Galtonian regression framework is the traditional approach (e.g., Bojnec and Fertő, 2008; Hinloopen and van Marrewijk, 2001). However, the literature on the economic growth and productivity convergence sheds light on serious drawbacks of the cross-sectional nature of ordinary least square (OLS) analyses (Evans and Karras, 1996). Consequently, time series investigation of the convergence hypothesis often relies on panel unit root tests of the null hypothesis on the existence of the panel unit root or the stationarity of panel datasets using a variety of tests. Different asymptotic assumptions are made regarding tests appropriate for the number of panels in balanced datasets or for unbalanced datasets and the number of panel time periods. The null hypothesis is that the panels contain a unit root, and the alternative is that the panels are stationary. The rejection of the null hypothesis of a unit root is commonly interpreted as evidence that the series are stationary and have converged to their equilibrium state, since any shock that causes deviations from equilibrium eventually dropped out. The extension of these tests to the panel framework has significantly influenced the literature on how to measure the convergence of macroeconomic variables (e.g., gross domestic product, productivity growth rate, and inflation rate). During the previous decade, a number of panel unit root tests have been developed (Baltagi, 2008). Considering the well-known low-power properties of unit root tests, we employ a battery of them: the Levin et al. (2002) method (common unit root process), the Im et al. (2003) method (assuming individual unit root processes), and the ADF–Fisher Chi-square and PP–Fisher Chi-square (Choi, 2001; Maddala and Wu, 1999).

The second type of stability is the stability of the value of the RTA indices for particular product groups and a country from one period to the next is investigated in two ways. First, we employ the Markov transition probability matrices (Meyn and Tweedie, 1993) to identify the persistence and mobility patterns of RTA indices and to obtain deeper insights into the RTA behaviour of a particular product group over time.

We restricted our concern to whether the relative comparative trade advantage pattern has been lost or gained for a particular product group during the analysed period. Thus, we classify products into two categories: products with relative comparative trade disadvantage patterns (RTA < 0) and products with relative comparative trade advantage patterns (RTA > 0). In addition, we also investigate a long-run (LR) probability of remaining in a specific state of the Markov transition probability matrices assuming an infinite LR period.

The degree of mobility in patterns of relative comparative trade advantage can be summarised using an index of mobility. This formally evaluates the degree of mobility throughout the entire distribution of RTA indices and facilitates direct cross-country comparisons. The index M_1, following Shorrocks (1978), evaluates the trace (tr) of the Markov transition probability matrix. This M_1 index thus directly captures the relative magnitude of diagonal and off-diagonal terms, and can be shown to equal the inverse of the harmonic mean of the expected duration of remaining in a given cell:

$$M_1 = \frac{K - \mathrm{tr}(P)}{K - 1}$$

where K is the number of cells, and P is the Markov transition probability matrix. A higher value of M_1 index indicates greater mobility, with a value of zero indicating perfect immobility.

Second, to test the equality of different Markov transition probabilities matrices, we apply Anderson and Goodman's (1957) test statistics, which under null hypothesis $p_{ij} = \overline{p_{ij}}$, for each state i has an asymptotic distribution: $\sum_j n_i^* \frac{(p_{ij} - \overline{p_{ij}})^2}{\overline{p_{ij}}} \sim \chi^2(m-1), n_t^* = \sum_{t=0}^{T-1} n_t(t)$, where m is the member of states, p_{ij} is the estimated, $\overline{p_{ij}}$ is the probabilities under null, and $n_t(t)$ describes the number of sectors in cell i at time t.

4. Data

To conduct the empirical analysis on the RTA indices for raw wood and wood product trade by the NMS-11 with the EU-27, we use detailed trade data from Eurostat Comext by the years 1999–2010. The annual sample consists of 73 items at the five-digit level in the Standard International Trade Classification (SITC) system.

Following Dieter and Englert's (2007) classification, three groups of raw wood and wood products are distinguished: raw wood, semi-finished wood products and finished wood products. Table 1 presents trade in raw wood and wood products in 1999 and 2010 by the NMS-11. Statistical databases, in general and particularly for smaller countries, reveal substantial changes from the initial to the final analysed year, which can be biased to a single year trade data for smaller countries. Three groups of the NMS can be identified according to the net trade position and its patterns over time: first, a net exporter with the increased trade surplus owing to faster absolute increases of exports than imports (Cyprus); second, net importers with increased trade deficits owing to faster absolute increased imports than exports (Hungary, Latvia, Lithuania, Poland, Romania and Slovakia) or net importers with reduced trade deficits owing to faster absolute increased exports than imports (Bulgaria) or increased exports and a slightly reduced imports (Slovenia). Trade deficits are particularly large in absolute terms for Poland, Romania, Latvia and Lithuania. Third, a shift from being a net importer to a net exporter is much more due to rapid increases in exports than imports (Czech Republic and Estonia).

In addition, it is worth analysing which groups of forestry and wood products are crucial for the trade balance and its improvements or deteriorations. The best performing country (Cyprus) has achieved trade surpluses particularly in finished wood products as well as in semi-finished wood products and raw wood products. The causality looks backward from the higher value-added finished products to semi-finished wood products and raw wood. Looking in the opposite direction, it can be seen that the least well-performing countries, which have achieved a greater trade deficit in finished wood products, have substantial trade deficits related to the finished wood products in Poland and Romania as well as in some other NMS.

Mixed results are found for trade in raw wood and semi-finished wood products. Trade surpluses in semi-finished wood products are found for Hungary and Slovenia as well as for Bulgaria in 2010.

These summary statistics on wood trade structures and patterns in their developments suggest mixed findings on a positive association in the vertically integrated wood supply chains. The rationale for some differences across forestry–wood chains can be explained by different supply chain strategies in the causality between primary forestry and the forestry industry: wood is a strategic raw material for the wood and furniture industries, which can significantly increase the value-added and competitiveness of forestry products. They can be sold to domestic and/or international markets as raw wood for lower value-added products or as a higher value-added semi-finished and finished wood products. This is a reason to develop competitive forestry–wood chains to increase the value-added of products and the competitiveness of the forestry industry supply chain on international markets. Without developed and competitive trade in finished wood products and semi-finished wood products, competitive raw wood trade in a vertically underdeveloped

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Table 1
Forestry industry exports, imports and trade balance in 1999 and 2010 (millions of euros).

	1999				2010			
	Total	Raw wood	Semi-finished wood products	Finished wood products	Total	Raw wood	Semi-finished wood products	Finished wood products
Exports								
Bulgaria	42.2	2.0	7.5	32.7	149.3	0.8	42.7	105.8
Cyprus	68.6	1.5	26.7	40.5	147.2	3.2	38.4	105.5
Czech Republic	548.8	35.4	136.4	377.0	1417.1	114.6	294.4	1008.1
Estonia	68.3	1.5	19.6	47.2	229.0	41.1	85.6	102.3
Hungary	449.8	11.0	139.9	298.8	703.4	36.9	241.6	424.9
Latvia	61.3	3.3	11.4	46.5	162.5	14.8	59.0	88.7
Lithuania	67.3	0.2	24.0	43.1	224.3	17.0	101.9	105.3
Poland	589.1	13.5	162.9	412.7	1574.3	39.5	531.1	1003.7
Romania	97.9	0.3	43.0	54.6	418.7	1.6	138.8	278.3
Slovakia	180.0	3.4	50.0	126.7	791.2	10.0	171.7	609.6
Slovenia	253.5	12.2	95.8	145.5	473.6	9.7	203.8	260.1
Imports								
Bulgaria	102.6	8.9	45.8	47.9	217.0	17.8	42.5	156.7
Cyprus	6.8	0.1	0.2	6.5	16.2	0.2	5.3	10.6
Czech Republic	1352.2	159.6	316.3	876.4	2368.2	299.4	528.5	1540.3
Estonia	544.9	187.0	174.9	183.1	760.2	143.9	232.3	384.1
Hungary	623.8	66.6	132.6	424.6	875.6	39.3	163.1	673.2
Latvia	726.8	159.1	455.3	112.4	945.1	251.7	498.3	195.2
Lithuania	260.4	32.8	117.3	110.3	816.6	83.4	131.9	601.3
Poland	2624.6	42.2	406.4	2176.0	6302.5	203.0	516.6	5582.9
Romania	632.9	46.5	136.5	449.9	1301.2	42.4	215.1	1043.6
Slovakia	397.3	60.8	152.1	184.4	1158.2	153.3	223.0	781.9
Slovenia	686.7	15.2	93.7	577.8	686.5	65.1	77.0	544.3
Trade balance (exports − imports)								
Bulgaria	−60.4	−6.9	−38.3	−15.2	−67.7	−17.0	0.2	−50.9
Cyprus	61.8	1.4	26.5	34.0	131.0	3.0	33.1	94.9
Czech Republic	−803.4	−124.2	−179.9	−499.4	−951.1	−184.8	−234.1	−532.2
Estonia	−476.6	−185.5	−155.3	−135.9	−531.2	−102.8	−146.7	−281.8
Hungary	−174.0	−55.6	7.3	−125.8	−172.2	−2.4	78.5	−248.3
Latvia	−665.5	−155.8	−443.9	−65.9	−782.6	−236.9	−439.3	−106.5
Lithuania	−193.1	−32.6	−93.3	−67.2	−592.3	−66.4	−30.0	−496
Poland	−2035.5	−28.7	−243.5	−1763.3	−4728.2	−163.5	14.5	−4579.2
Romania	−535.0	−46.2	−93.5	−395.3	−882.5	−40.8	−76.3	−765.3
Slovakia	−217.3	−57.4	−102.1	−57.7	−367	−143.3	−51.3	−172.3
Slovenia	−433.2	−3.0	2.1	−432.3	−212.9	−55.4	126.8	−284.2

Source: Own calculations based on Eurostat Comext database.

forestry industry supply chain is also less likely to successfully develop. The reason might be in the quality of raw wood, but more likely in unorganised and underdeveloped markets and marketing activities with surpluses of supplies of raw wood and thus mismatches in the markets, which creates negative backward effects for raw wood trade, wood prices and forestry management.

5. Results

5.1. Relative comparative trade advantages (RTAs)

Descriptive statistics of the RTA indices show their large variations by the NMS-11 and over the analysed period (Table 2). First, except

Table 2
Descriptive statistics of RTA indices, 1999–2010.

	Bulgaria	Cyprus	Czech Republic	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Slovakia	Slovenia
Maximum	14,752.4	4414.9	4266.4	122.1	813.2	89.2	11,463.8	6723.6	20,353.8	18,544.7	5951.2
Minimum	−137.5	−239.4	−3458.3	−153.4	−13.9	−577.3	−55.5	−162.3	−3084.4	−5306.2	−306.4
Standard deviation	525.2	152.7	200.5	18.0	27.6	42.5	397.2	233.3	730.9	686.9	211.6
Mean	23.5	7.0	2.0	−7.3	0.7	−15.4	13.6	7.1	30.0	10.1	7.7
Median	−0.1	0.4	−0.2	−2.1	0.0	−0.5	−0.9	−1.5	−0.6	−0.2	0.0
RTA > 0	288	602	293	168	427	267	234	112	224	304	341
RTA = 0	127	157	78	121	120	123	112	82	87	90	98
RTA < 0	461	117	505	587	329	486	530	682	565	482	437
N	876	876	876	876	876	876	876	876	876	876	876
Mean of RTA											
Raw wood	−8.1	1.2	−38.9	−22.4	4.6	−60.9	−5.8	−3.7	−36.4	−69.6	−3.8
Semi-finished wood products	−1.4	16.2	4.6	−3.7	0.2	−13.9	−2.0	0.7	25.0	−18.8	6.8
Finished wood products	48.4	3.3	13.4	−4.7	−0.1	−1.9	12.3	14.3	53.9	52.7	11.9

N relates to the number of cases: RTA > 0, RTA = 0 and RTA < 0.
Source: Own calculations based on Eurostat Comext database.

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Table 3
Kaplan–Meier survival rates for RTA indices (12 years).

	Total	Raw wood	Semi-finished	Finished	Log-rank test
Bulgaria	0.0834	0.0000	0.0672	0.1511	0.0000
Cyprus	0.3045	0.1051	0.1953	0.5010	0.0000
Czech Republic	0.1025	0.0165	0.0981	0.1563	0.0012
Estonia	0.0233	0.0000	0.0126	0.0416	0.0241
Hungary	0.1898	0.0898	0.1919	0.2334	0.0002
Latvia	0.0460	0.0000	0.0214	0.1098	0.0000
Lithuania	0.0423	0.0170	0.0707	0.0394	0.0016
Poland	0.0164	0.0089	0.0491	0.0054	0.1099
Romania	0.0373	0.0000	0.0318	0.0588	0.1403
Slovakia	0.0826	0.0089	0.0941	0.1180	0.0000
Slovenia	0.0972	0.0208	0.1493	0.1068	0.0017

Source: Own calculations based on Eurostat Comext database.

for Estonia and Latvia, the RTA index is greater than zero, which suggests a relative comparative trade advantage. The RTA index is particularly large for Bulgaria, Romania, Lithuania and Slovakia. Second, except for Cyprus, and, to a lesser extent for Hungary, most forestry industry trade observations are with RTA < 0, suggesting a greater number of products with relative comparative trade disadvantages than with relative comparative trade advantages or a neutral position, i.e. neither with relative comparative trade advantages or disadvantages. This suggests that relative comparative trade advantages in the NMS are mostly focused on a smaller number of forestry industry-traded products or niche products. Finally, it is intriguing to note possible similarities and differences in the structures of the RTA indices by the degree of the forestry industry product processing.

5.2. Duration of relative comparative trade advantage

As expected, the Kaplan–Meier survival rates, by analysing the chance to survive the relative comparative trade advantage (RTA > 1) by the NMS-11 and by the forestry industry product groups (raw wood, semi-finished and finished wood products), confirmed a decline in the chance of RTA survival over 12 years (Table 3). However, differences are seen between the NMS-11 and between forestry industry product groups. First, Cyprus is the country with the highest RTA survival rates, owing to comparatively higher RTA survival rates for semi-finished wood products and for finished wood products. Second, Hungary is ranked on the second place owing to comparatively relatively higher RTA survival rates for semi-finished and finished wood products as well as for raw wood. Third, there is a group of countries with relatively moderate RTA survival rates: the Czech Republic, Slovenia, Bulgaria, Slovakia and to a lesser extent Latvia and Lithuania. Finally, there is a group of countries with comparatively relatively low RTA survival rates and insignificant results on long-rank nonparametric tests for the equality of the Kaplan–Meier survival rates for the RTAs across raw wood, semi-finished and finished wood products at a two percent level of significance. This group of the NMS consists of Romania, Poland and, to a lesser extent, Estonia.

Except for Slovenia, Lithuania and Poland, the Kaplan–Meier survival rates for the RTA indices after 12 years are higher for finished wood products than for semi-finished wood products. The Kaplan–Meier survival rates for the RTA indices after 12 years are higher for semi-finished wood products than for raw wood. To summarise, these results imply mixed findings among the NMS-11 countries on the equality of survival functions across the forestry–wood chain product groups. It cannot be concluded that the NMS-11 countries with the highest Kaplan–Meier survival rates for the RTA indices after 12 years for finished wood products also have higher Kaplan–Meier survival rates for the RTA indices after 12 years for semi-finished wood products and raw wood products. Some NMS-11 countries experienced zero Kaplan–Meier survival rates for the RTA indices after 12 years for raw wood: Bulgaria, Estonia, Latvia and Romania. However, the more-developed wood processing in the NMS-11 can enhance increased competition on the enlarged

Table 4
Panel unit root tests for RTA indices without and with trend (p-values).

	Levin–Lin–Chu	Im–Pesaran–Shin	ADF–Fisher Chi-square	PP–Fisher Chi-square
Without trend				
Bulgaria	0.0000	0.0385	0.0085	0.0000
Cyprus	0.0000	0.0000	0.0000	0.0000
Czech Republic	0.0010	0.2198	0.0192	0.0000
Estonia	0.0078	0.2729	0.2477	0.0000
Hungary	0.0000	0.0000	0.0005	0.0000
Latvia	0.0001	0.2269	0.0886	0.0000
Lithuania	0.0000	0.0848	0.0438	0.0000
Poland	0.0000	0.0375	0.0034	0.0000
Romania	0.0000	0.0000	0.0000	0.0000
Slovakia	0.0000	0.0000	0.0001	0.0027
Slovenia	0.0000	0.0011	0.0000	0.0000
With trend				
Bulgaria	0.0000	0.0089	0.0003	0.0000
Cyprus	0.0000	0.0000	0.0000	0.0000
Czech Republic	0.0000	0.0000	0.0000	0.0000
Estonia	0.0352	0.0000	0.6205	0.3777
Hungary	0.0000	0.0000	0.0024	0.0000
Latvia	0.0000	0.0000	0.2035	0.0846
Lithuania	0.0000	0.0000	0.3789	0.1128
Poland	0.0001	0.3410	0.1218	0.0000
Romania	0.0000	0.0000	0.0000	0.0000
Slovakia	0.0000	0.0000	0.0000	0.0000
Slovenia	0.0000	0.0798	0.0787	0.0000

Source: Own calculations based on Eurostat Comext database.

EU-27 markets as a reason for the greater chances of the RTA's long-term survival. This implication may be in line with both theoretical predictions of trade theory stating that differentiated products may exhibit longer duration (e.g., Helpman and Krugman, 1985; Rauch and Watson, 2003) and previous empirical findings (Besedeš and Prusa, 2006b; Q9
Bojnec and Fertő, 2012; Fertő and Soós, 2009; Nitsch, 2009). Q10

Table 5
Markov transition probability matrices for RTA indices by country 1999 and 2010.

	Bulgaria		Cyprus		Czech Republic	
	RTA < 0	RTA > 0	RTA < 0	RTA > 0	RTA < 0	RTA > 0
RTA < 0	85.82	14.18	76.92	23.08	81.25	18.75
RTA > 0	26.92	73.08	11.51	88.49	35.14	64.86
Total	66.75	33.25	31.63	68.37	66.38	33.62
Long run probability	65.50	34.50	33.28	66.72	65.21	34.79
	Estonia		Hungary		Latvia	
	RTA < 0	RTA > 0	RTA < 0	RTA > 0	RTA < 0	RTA > 0
RTA < 0	92.12	7.88	84.21	15.79	91.34	8.66
RTA > 0	37.18	62.82	14.81	85.19	21.69	78.31
Total	81.44	18.56	50.93	49.07	69.74	30.26
Long run probability	82.51	17.49	48.40	51.60	71.47	28.53
	Lithuania				Poland	
	RTA < 0	RTA > 0			RTA < 0	RTA > 0
RTA < 0	91.48	8.52			93.01	6.99
RTA > 0	26.39	73.61			50.98	49.02
Total	73.97	26.03			87.67	12.33
Long run probability	75.59	24.41			87.94	12.06
	Romania		Slovakia		Slovenia	
	RTA < 0	RTA > 0	RTA < 0	RTA > 0	RTA < 0	RTA > 0
RTA < 0	90.40	9.60	86.15	13.85	86.99	12.01
RTA > 0	30.14	69.86	27.17	72.83	20.58	79.42
Total	74.72	25.28	65.88	34.12	61.27	38.73
Long run probability	75.84	24.16	66.24	33.76	61.27	38.73

Source: Own calculations based on Eurostat Comext database.

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5.3. Dynamics of relative comparative trade advantages

We analyse the dynamics of RTA indices using unit root tests (Table 4). In all cases, we employ both drift without and with trend specifications as a deterministic component; the lag length has been chosen according to the Modified Akaike Information Criterion (MAIC) proposed by Ng and Perron (2001). The results of four different panel unit root tests clearly confirmed that we cannot accept the panel unit root hypothesis for Bulgaria, Cyprus, Hungary, Romania or Slovakia. The majority of tests also reject the existence of a panel unit root for the Czech Republic, Poland, Slovenia and Lithuania. Four of eight tests confirm the presence of panel unit root for Estonia and Latvia. Overall, we can conclude that the RTA indices are probably stationary for all countries except for Estonia and Latvia. This implies that for nine NMS countries, we can reject the null hypothesis on the existence of the panel unit root and accept the alternative hypothesis of convergence of the RTA indices by the NMS-11 countries. These results imply that the NMS-11 countries have over time become more similar than different with regard to forestry industry trade competitiveness in the exposed increased competition in the enlarged EU-27 markets. From a theoretical point of view, these findings do not provide support for the divergence hypothesis of new trade theory.

5.4. Intra-distribution dynamics

The intra-distribution dynamics of the RTA indices are investigated using the Markov transition probability matrices and mobility indices (see also Geweke et al., 1986). Table 5 presents the Markov transition probability matrices for the RTA indices for the probability of staying or passing from one state to another between the starting year (1999) and the ending year (2010). The diagonal elements of the Markov transition probability matrix indicate the probability of persistently staying with a relative comparative trade advantage pattern (RTA > 1) or a relative comparative trade disadvantage pattern (RTA < 1). The other elements of the Markov transition probability matrix provide further information on the dynamics of the RTA indices, showing the probability of passing from one state to another.

Except for Cyprus, there is a greater than 80% probability that the NMS countries will remain with a relative comparative trade disadvantage (RTA < 1). However, except for Cyprus and Hungary, the probability of staying with relative comparative trade advantage (RTA > 1) is less than 80%. At less than 50%, Poland has a particularly low probability.

Except for Cyprus, there is a low probability (less than 20%) that products with a relative comparative trade disadvantage (RTA < 1) might shift to a relative comparative trade advantage (RTA > 1). Except for Cyprus and Hungary, much higher are the chances (more than 20% and for Poland almost 51%) that those products with a relative comparative trade advantage (RTA > 1) may move backward by a switch to a relative comparative trade disadvantage (RTA < 1). These findings suggest that the relatively low proportion of the NMS-11 forestry industry trade during the analysed period has remained within this RTA > 0 classified trade category.

The Markov transition probability matrices, except for Cyprus and to a lesser extent for Hungary, confirm the NMS countries' forestry industry trade competition difficulties on the enlarged EU-27 markets, as the probability of remaining RTA < 1 or of shifting from a relative comparative trade advantage (RTA > 1) to a relative comparative trade disadvantage (RTA < 1) is relatively high.

The long-run probabilities indicate that there is a probability of between 61% and 88% for the majority of NMS-11 countries to continue to have a comparative export disadvantage (RTA < 0), except for Cyprus and Hungary.

Table 6 reports the mobility index, M_1, which summarises the degree of mobility in the RTA indices. Between the NMS-11 countries, M_1 for the degree of mobility throughout the entire distribution of the RTA indices is between 0.30 for Latvia, indicating relatively low mobility, and 0.58 for Poland, indicating relatively low to modest mobility. Among the higher instances is the Czech Republic, whilst among lower are Hungary, Slovenia, Lithuania and Cyprus. The results reinforce the findings of previous research, namely that the NMS-11 countries show a considerable degree of trade specialisations (Bojnec and Fertő, 2008; Fertő and Soós, 2008; Zaghini, 2005).

Anderson and Goodman's (1957) test rejects the equality of all Markov transition probability matrices relative to estimated benchmarks. In other words, changes across different RTA forestry industry product groups were significant for each of the NMS-11 and forestry and wood industry product groups.

The NMS-11 countries in the mobility of the RTA indices can be explained by the growth of total forestry industry trade of the NMS-11 countries and the ratio between the growth of their forestry industry trade to EU-27 markets and the growth of their total forestry industry trade. The increase of the EU-27 markets' forestry industry trade share means a (relative) shift in trade structures to more demanding EU-27 markets and away from the traditional ones. The growth of trade in finish wood products can energise the forestry industry trade mobility pattern for the growth of trade in semi-finished wood products and raw wood.

Table 6
Mobility indices and test statistic for equality of Markov transition probability matrices based on RTA indices, 1999 and 2010.

	M1 (RTA)	Anderson–Goodman statistics p-Value (RTA)
Bulgaria	0.41	0.000
Cyprus	0.35	0.000
Czech Republic	0.54	0.000
Estonia	0.45	0.000
Hungary	0.31	0.000
Latvia	0.30	0.000
Lithuania	0.35	0.000
Poland	0.58	0.000
Romania	0.40	0.000
Slovakia	0.41	0.000
Slovenia	0.34	0.000

Note: M1 can take values: 0 < M1 < 2.
Source: Own calculations based on Eurostat Comext database.

6. Implications for the international competitiveness of forestry industry supply chains

The empirical results have clearly confirmed the crucial role in the forestry industry trade that is played by the finished wood products and to a lesser extent that of the semi-finished wood products for the structure of forestry industry exports/imports and for forestry industry trade surplus/deficits. This finding has significant implications for the forestry industry supply chains' international competitiveness, from primary raw wood through wood processing and the furniture industry up to marketing and supply chain management in the forestry industry sector.

At the primary stage, forestry implications are related to forest management in terms of wood types and wood quality. Among them are the appropriate selection of trees with regard to micro-climatic natural and environmental conditions and expected economic market conditions in terms of demand for differentiated wood assortments and wood quality, which can yield higher income and value-added from forest management. A better quality of raw wood can provide better selling opportunities and higher prices. This can be also beneficial for sustainable forestry industry development and the rational use of raw wood and other forestry potentials.

Wood processing can play a substantial role in increasing wood product differentiation and in increasing the value-added of products processed from wood. Prices for raw logs can be increased if they are further processed into higher value-added products. This also reduces transportation costs per unit of product value on longer distances and contributes to more sustainable management of renewable natural resources.

From an economic perspective on international competitiveness, the marketing of products of the forestry industry sector from raw wood, semi-processed wood products and finished wood products at different levels of the forestry industry supply and marketing chains is necessary. At the primary forestry level, associations of forest owners who are selling primary raw wood directly from forest to different direct and indirect users can be beneficial. Producers and marketing associations of producers can play a crucial role in better organising the marketing of primary raw wood and in improving the bargaining power of dispersed producers in the market. In addition to the marketing of primary raw wood, wood processing and the furniture industry can play a crucial role in improving the international competitiveness of the forestry industry sector. In some cases, in addition to favourable economic policies, foreign direct investments have been significant for forest industries' exports and international competitiveness (e.g., Uusivuori and Laaksonen-Craig, 2001). Their role can be particularly valuable in regions with rich natural forestry factor resources, but underdeveloped or internationally uncompetitive local or domestic forestry industry sectors to bring new technologies and ways of conduction of businesses, which can improve the economic efficiency in value chains and international competitiveness.

In promotion and marketing activities, some other institutions in the forestry industry sector can also be beneficial, such as chambers of forestry, producers and forestry cooperative associations in sustainable forestry industry development, wholesale and retail trade chains either organised by wood processing and furniture industry, or by large specialised supermarkets. Therefore, there are various possible ways of internationalising the forestry industry sector to integrate international trade and to improve international competitiveness by setting up and developing the forestry industry markets at different levels of the vertical supply chain of differentiated wood quality products and at different forestry industry sector locations in long-term sustainable development.

7. Conclusions

This paper has analysed the forestry industry trade of the NMS-11 on the enlarged EU-27 markets. Except for Cyprus, the NMS have experienced a lack of comparative relative trade advantages with difficulties in the forestry industry exports to the enlarged EU-27 markets. This is particularly true for Estonia and Latvia, which have experienced comparative relative trade disadvantages in each stage of the forestry industry supply chain. Hungary has experienced comparative relative trade advantages in raw wood. Most other NMS-11 countries have experienced comparative relative trade advantages either in each stage of the forestry industry supply chain (Cyprus) or in semi-finished and finished wood products (the Czech Republic, Romania, Slovenia, and Poland) or only in finished wood products (Bulgaria, Lithuania, and Slovakia). The mixed results are also found for the survival rates of the comparative relative trade advantages and for the intra-distribution dynamics of the comparative relative trade advantage indices by the NMS-11 countries.

For the majority of the NMS-11 countries, finished wood products have played the crucial role in forestry industry supply chains, which can be based on a higher value-added wood manufacturing and furniture industry and more advanced marketing chain management. A competitive wood processing industry can improve opportunities for the competitive sale of raw wood between domestic and foreign competitors and can provide opportunities for vertical quality differentiated products. Therefore, it can play a decisive role in the promotion of competition for raw wood and for wood quality differentiation with wood processing and the use of wood as a renewable source of higher value-added finished wood products to increase the competitiveness of both the export of raw forest wood and the export of semi-finished and finished wood industry products. For some of the NMS-11 (e.g., Romania, Poland and to a lesser extent for Estonia, Slovenia, Lithuania, the Czech Republic and Hungary), trade in semi-finished wood products and raw wood is in a similar direction correlated with trade in finished wood products. The effect might be only temporary. A relative abundance of raw wood can allow for both the export of raw wood and the export of semi-finished and finished wood products. This coincidence could be because there might be market barriers for forest owners. Once they are overcome, the abundance of raw wood can affect both the domestic and foreign markets. However, when a domestic industry increases capacities substantially, it can become a net importer of raw wood and a substantial exporter of semi-finished and finished wood products.

The significant difference in the forestry industry trade between the NMS-11 countries on the enlarged EU-27 markets, particularly between the Mediterranean NMS country (Cyprus) and the ex-communist NMS-10 countries from the CEE; moreover, convergence in forestry industry trade competitiveness over time implies that the forestry industry trade and its comparative relative trade advantages are not necessary related only to natural forest factor resources, but particularly to wood manufacturing and furniture industry efficiency and supply chain management in the direction of international competitiveness. The export growth of higher value-added finished wood products can also contribute to more trade and exports for semi-finished wood products and raw wood. Finished wood products can generate the development of supply chains with stronger backward demand-side linkages for intermediate use and through more developed supply chains for export markets.

Among issues for future research, forestry industry sector supply chain internationalisation through trade represents only one possible mode for the internationalisation of the NMS-11 forestry industry sector. The enlarged EU-27 markets also provide opportunities for some other ways of cooperation and internationalisation in the forestry industry sector and in the development of supply chains, such as foreign direct investments, technical, research and development and other co-operation, including European policies for rural and regional development. Among issues for future research is the analysis of competitiveness of the forestry industry trade of the NMS-11 with countries outside the EU-27, where some of the NMS-11 may have performed with increasing competitiveness, but not with regard to the EU-27 trade.

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