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Procedia Economics and Finance 26 (2015) 389 – 395

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**Procedia**  
Economics and Finance  

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4th World Conference on Business, Economics and Management, WCBEM

## The Price Formation of Raw Wood in the Czech Republic and a Comparison with the Neighbor States

Petra Hlavackova<sup>a</sup>, David Brezina<sup>a</sup>, Andrea Sujova<sup>a\*</sup><sup>a</sup>*Mendel University in Brno, Zemedelska 3, Brno 613 00, Czech Republic*

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### Abstract

The paper deals with the price development and pricing models in the Czech Republic and the neighbour states (Austria and Germany). The price of wooden material is a complicated indicator in methodical terms. In each country different factors influence the price development. The price development of raw wood in the Czech Republic is extraordinary in many aspects. The position of wood producers and companies in the wood processing industry in the market influences the overall position of global economy and the impact of negative factors following from the development of global economy in the previous years. The price issues of individual ranges of raw wood and their development come under the market mechanism and its relation of demand and offer. The material for the analysis of pricing models was obtained with secondary research based on getting information from the publicly available scientific and specialised literature, domestic and foreign internet sources, information from statistical databases and consultations with experts from practice. The employed methods were the analysis, comparison, consolidation and synthesis. Gained results were processed with fundamental statistical methods (elementary characteristics of timelines, correlation and the significance test of correlation coefficient). With the gained results theoretical possibilities of future price changes in contract relations were formulated in the conditions of the Czech Republic.

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Peer-review under responsibility of Academic World Research and Education Center

*Keywords:* Analysis; price; price index; wood processing industry; supply; demand; raw wood;

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\* Andrea Sujova. Tel.: +420 545-134-075  
*E-mail address:* [andrea.sujova@mendelu.cz](mailto:andrea.sujova@mendelu.cz)

## 1. Introduction

The analysis of wood markets is a difficult endeavour for several reasons. First, wood markets tend to be imperfect markets. Uncertainties exist regarding the long-term development of forest wood supply due to varying climate change scenarios and the possible occurrence of calamities. Second, the theoretically available amount of wood is limited by natural tree growth and long-term ecological concerns, leading to the prescription of the *annual allowable cut* (AAC). This measure can be relatively easily estimated, yet the actually available amount of wood on a market depends strongly on other factors. For example, technological advances, especially in the harvesting industry, have increased productivity in recent decades, leading to long-term changes in production costs. Political agendas and legal restrictions also can enforce increased or decreased wood production, beyond what is economically justifiable. Societal values might demand accessibility to forests for functions other than wood production (Kostadinov et al. 2014). Other authors deal with raw wood market issues, for example Ranta et al. (2007) in Finland Olsson and Hillring (2013) in Sweden, Olsson and Hillring (2014) in Denmark, Knauf (2015) in Germany.

In Austria, forests cover 39,581 km<sup>2</sup>, i.e. 47.2% of the country's territory. This density of forest ranks Austria among the most forested countries in the EU (Vancura 2009a). Matejcek and Liskova (2011) say that according to official figures there are 170,548 forest owners in Austria. Less than one percent of owners own half of Austrian forests (on average more than 1,000 hectares per owner). On the other hand, 99% of forest owners own less than 200 hectares and approximately 38% of forest owners own even less than 3 hectares. The Federal Republic of Germany has an area of 357,023 km<sup>2</sup> of which the forest area accounts for approximately one third (31%, i. e. 11,075,799 hectares). Most of the forests are owned by private owners (43%), the State controls 34% of forest land and municipalities (and other subjects) the remaining 23% of forest land. (Vancura 2009b) In the Czech Republic, forests cover 33.3% of the territory, i.e. 2,599,142 hectares. State controls 60% of forest land, municipalities 17%, private individuals 22%, and the church and forestry cooperatives 1%. (MZE 2014)

The aim of the paper is analysis of selected aspects of price development and pricing models of raw wood in the Czech Republic and in neighbour states (Austria and Germany) over the reference period 2003 – 2013.

## 2. Methods

Evaluations of changes in price levels are commonly performed by using price indices that compare the relative price change between the current and base period. In terms of statistics, there are several possible ways of calculating price indices. According to Tosovska et al. (2010), the most common procedures include usage of such conventional indices as Laspeyres price index using weight of the base period, Paasche price index using weight of the current period and Fisher price index as a geometric mean of the two previous indices.

Data used for calculations was obtained from the Czech Statistical Office's (CSO) database, Holz-Kurier magazine, and the Statistical Office of the European Union (EUROSTAT). The basic reference period of the research was the period of years 2003 – 2013.

The results were processed by means of statistical methods used by trendline analysis (Arlt et al. 2002). A simple arithmetic average of time series was calculated as follows: (1)

$$\bar{y} = \sum_{t=1}^T y_t / T$$

Wherein:

- $y_t$  = the average value at some point of time series
- $T$  = the chronological average of time series

Dependences among the selected data were analysed using statistical method of correlation analysis. Strength of mutual dependence between selected relations was found out by calculating coefficient of correlation ( $r$ ). The formula for its calculation is:

$$R = \sqrt{1 - \frac{\sum(y - \hat{y})^2}{\sum(y - \bar{y})^2}} \tag{2}$$

Wherein:

- $y$  = the measured value of the indicator
- $\hat{y}$  = the model value of the indicator
- $\bar{y}$  = average of indicator values

The test of the correlation coefficient significance ( $t_R$ ) was performed by the formula: (3)

$$t_R = \frac{R \cdot \sqrt{n - 2}}{\sqrt{1 - R^2}}$$

Wherein:

- $R$  = the correlation coefficient
- $n$  = the number of measurements

The null hypothesis ( $H_0$ ) for this test argues that the correlation between variables is not provable in the base data file. The formula of test criterion of significance of the pair wise correlation coefficient has a Student distribution with  $(n - 2)$  degrees of freedom. If  $|t_R| > t_{\alpha, n - 2}$  (critical value), then we reject  $H_0$  (Drapela 2002). Test results were determined at the significance level  $\alpha = 0.05$ , i.e. the reliability of tests is 95%.

The actual calculation and graphical presentation of results was performed in Microsoft Office Excel 2013.

### 3. Results and Discussion

The most important product in the wood trade is coniferous wood, respectively the spruce roundwood. Figure 1 shows the price development of spruce assortments in the CR in years 2003 – 2013.

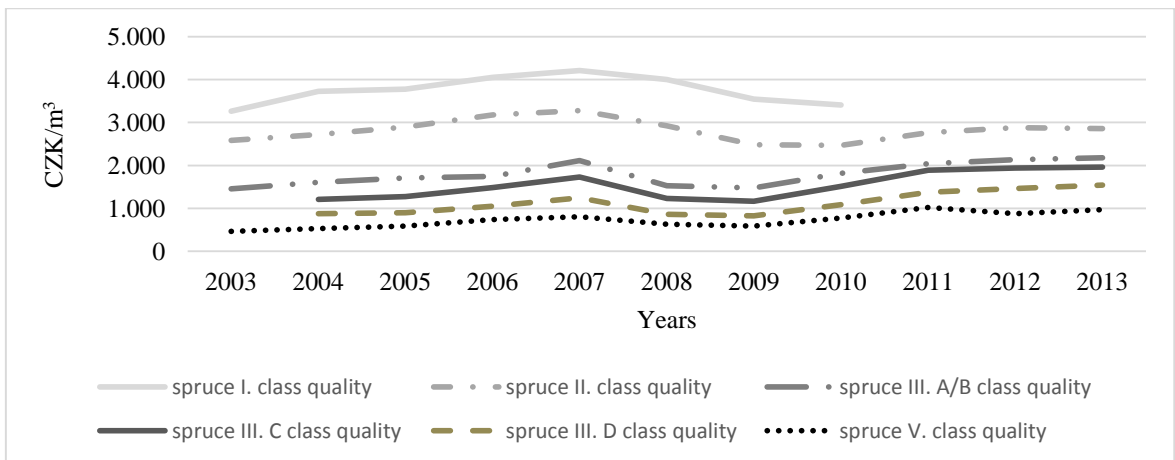


Fig. 1. The average annual price trend of the coniferous roundwood – spruce (CZE) in 2003 – 2013  
Source: CSO 2014; own processing

The course of the time series shows a balanced, slightly rising trend of prices of spruce roundwood in the Czech Republic since 2010, or 2011. Price of class I spruce reached its peak in 2007 (4,211 CZK/m<sup>3</sup>). Price of class II spruce is 2,800 CZK/m<sup>3</sup>. It peaked in 2007 – 3,276 CZK/m<sup>3</sup> and reached its lowest level in 2010 – 2,468 CZK/m<sup>3</sup>. Prices of class III A/B spruces have a growing trend, they peaked in 2013 – 2,175 CZK/m<sup>3</sup>. The same tendency has

the prices of class III D spruce which reached 1,539 CZK/m<sup>3</sup> in 2013. Class V spruce peaked in 2011 (1,018 CZK/m<sup>3</sup>).

In order to illustrate the situation in the Czech Republic we will compare trends in wood prices with the development of spruce roundwood prices in Austria and Germany (see Figure 2).

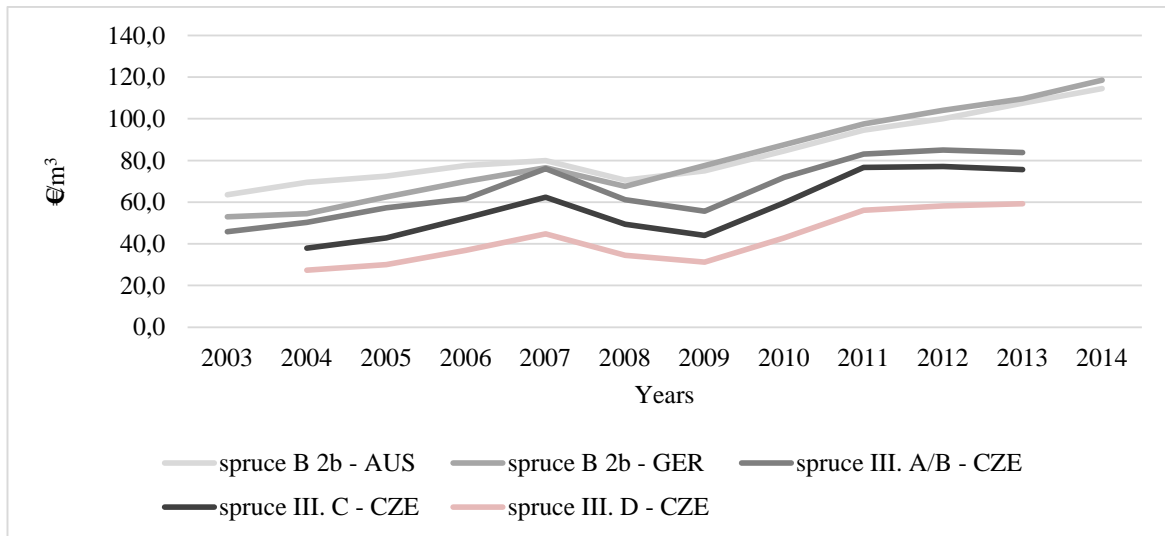


Fig. 2. The price trend of the spruce roundwood in the Czech Republic, Austria and Germany  
Source: CSO 2014, Holz-Kurier 2012; own processing

Figure 2 shows that in the Czech Republic are the lowest prices of the spruce roundwood among the three countries and that the price development differed in individual years. During the past four years, prices of the spruce roundwood had a rising trend in all monitored countries. By calculating the simple arithmetic mean the author found that during the reference period the average price of the spruce roundwood in Germany was approx. €81.54/m<sup>3</sup> (B 2b), in Austria €84.13/m<sup>3</sup> (B 2b), and in the Czech Republic €66.51/m<sup>3</sup> (III. A/B). The price difference between the Czech Republic and Germany in these assortments for the reference period amounted to €15.03/m<sup>3</sup>, the price difference between the Czech Republic and Austria was €17.62/m<sup>3</sup> (when applying the current conversion rate of 1 €27.66 CZK, the price differences are 415.73 CZK/m<sup>3</sup> in comparison with Germany and 487.37CZK/m<sup>3</sup> in comparison with Austria).

In the Czech Republic, raw wood pricing models for forests owned by the state (59.9% of state-owned forests is a property of Lesy CR) are different from the models used for state forests in Austria and Germany. Austrian Federal Forests, a. s. sell almost 90% of its raw wood at roadside ("OM" model). Forestry procurements are usually announced for 2 – 3 months, or longer (up to a maximum period of one year). (Reichl 2010)

Within their economic activity, Lesy Ceske republiky, s. p. (LCR, in English "Forests of the Czech Republic") use a complex procurement system, or "Contracts on forestry activities and sale of wood." These contracts are of a long-term nature (4 years). LCR sells a tree to a forestry company, the company fells the tree, skids it to roadside, ensures its bucking and the subsequent sale. Furthermore, on the basis of projects of LCR the forestry company ensures afforestation and the subsequent silvicultural treatment. The comprehensive agreement stipulates that prices will be adjusted depending on changes in the total wood price index for the group of deciduous and in the total wood price index for the group of conifers. In the Czech Republic, price indices and mean prices of raw wood are quarterly published by The Czech Statistical Office.

During the period 2011 – 2013, LCR on average participated in the total extraction of wood in the Czech Republic by 52.2% (7,965 thous. m<sup>3</sup>/year). A major part of sales performed by LCR takes place via comprehensive forestry orders concluded for certain contractual territorial units (CTU) – a "by the trunk" model. This volume represented in average 80.86% (6,442.33 thous. m<sup>3</sup>). This is a volume of raw wood which has to be indexed

(condition of the Czech Republic).

The analysis of the prices of raw wood and the price index used by the Czech Statistical Office for the most traded raw material in the Czech Republic (spruce roundwood Class A/B) was based on publicly available data with characteristics of aggregated indicators. The results are shown in charts (see Figure 3) and tables (see Tables 1 and 2) and commented on.

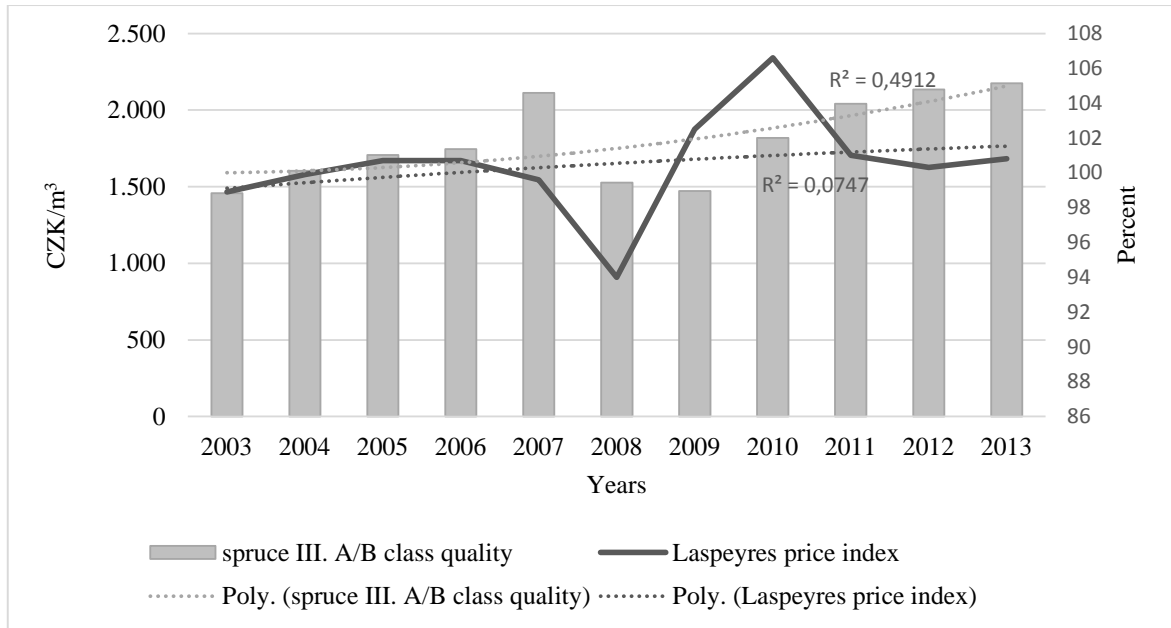


Fig. 3. Dependence of prices of spruce roundwood class III A/B and price indices in years 2003 and 2013  
Source: CSO 2014; own processing

The course of time series of spruce roundwood prices was interspersed with trend (polynomial) with the highest determination coefficient  $R^2 = 0.4912$  (i.e. the correlation coefficient  $R = 0.7009$ , the result is a price dependence of spruce logs in individual years). The course of time series of development of the price index was interspersed with trend (polynomial) with the highest determination coefficient  $R^2 = 0.0747$  (i.e. the correlation coefficient  $R = 0.2733$ , the result is a dependence of price index in individual years).

The trend values were used for calculation of the correlation coefficient in order to determine the dependence of spruce roundwood prices on the price index. The calculated correlation coefficient was subjected to test of significance of the correlation coefficient (see Tables 1 and 2).

Table 1. Trend values of spruce roundwood prices and the price index

| Index/year                             | 2003  | 2004  | 2005  | 2006  | 2007  | 2008  | 2009  | 2010  | 2011  | 2012  | 2013  |
|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Laspeyres price index (%)              | 99,0  | 99,3  | 99,7  | 100,0 | 100,4 | 100,6 | 100,7 | 100,9 | 101,2 | 101,3 | 101,5 |
| spruce III. A/B class quality (CZK/m³) | 1 590 | 1 604 | 1 640 | 1 675 | 1 700 | 1 735 | 1 790 | 1 850 | 1 900 | 2 055 | 2 175 |

Source: CSO 2014; own processing

Table 2. The test of the correlation coefficient significance

| The correlation coefficient | The test criterion | The critical value |
|-----------------------------|--------------------|--------------------|
| 0,8993                      | 5,0382             | 2,2010             |

Source: own processing

Table 2 shows that the critical value was exceeded, which confirmed a statistically significant dependence of prices of spruce roundwood class III A/B on the price index. This simple statistical test proved the correlation dependence of price indexation in one of the three main important business assortments of spruce in the Czech Republic. In other classes of spruce raw wood (i.e. III C and III. D), a statistically significant dependence between prices and the price index was not proved.

A deeper analysis and confirmation of the hypothesis of a strong mutual influence of the indexation system over market prices would require determination of time series for both variables, e.g. employment of the Box-Jenkins methodology.

The results led to the following recommendations and scenario solutions for indexation of raw wood prices in the Czech Republic (regarding trade relations between Lesy CR, s. p., as the seller, and subjects that buy wood):

- retention of the current system of index-based pricing and continue with its further improvements,
- creation of a price index which would include prices for goods and services characteristic for forestry,
- change in the margin range of Lesy Ceske republiky, s. p.,
- utilisation of mean prices obtained through the commodity exchange of raw wood,
- employment of the Czech National Bank's method of inflation targeting (adapted to the forestry-wood sector).

#### 4. Conclusion

The paper dealt with development of prices and pricing models of raw wood in the Czech Republic and in neighbour countries (Austria and Germany). The decline in wood prices in Europe in 2008 was mostly caused by the American mortgage crisis. Other local influences that affect prices of raw wood are, for example, windthrow disasters. The difference in prices of various spruce roundwood assortments between the Czech Republic and Germany over the analyzed period was on average €15.03/m<sup>3</sup>, between the Czech Republic and Austria it was €17.62/m<sup>3</sup>. State forests in Austria and Germany sell their raw wood at roadside ("OM" model). Sales of raw wood by the largest owner of state forests in the Czech Republic, Lesy CR, s. p., are performed via comprehensive forestry orders on contractual territorial units (CTUs) – "at trunk model" which uses price indexation of raw wood and which is specific for the Czech Republic. Employment of statistical index for adjustments of prices in contractual relations of Lesy CR, s. p. has faced much criticism. However, the idea of updating wood prices via indexation is not completely wrong and the system as such can be functional if designed neutrally both for the seller and the buyer.

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