ORIGINAL RESEARCH ARTICLE

Evaluating variation in logged timber costs and raw timber prices during the period, 2001–2009, for the Regional Directorate of the State Forests in Zielona Góra

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Abstract. The rate of change in the cost of logged timber and prices of raw timber during the period, 2001–2009, was examined for the Regional Directorate of the State Forests in Zielona Góra. A logarithmic evaluation of average rate of change indicated that the rate of increase in timber harvest costs was higher than the rate of increase in the average price of raw timber and likewise the price of most log grades. The average increase in raw timber value was 2.51% annually.

The price of low-diameter raw timber (slash) increased 8.61%, and the price of large-diameter timber increased 1.94% annually, while the price of large coniferous segments increased 1.75% and broadleaf segments increased 2.98% annually. At the same time, the timber logging costs increased more than the timber price, to 4.17%, or 4.19% when administrative costs related to timber logging are included.

Key words: forest management, economics, marketing, prices, costs, rate of growth

1. Introduction

In Poland, forest management is implemented according to forest management plans developed every 10-year-period and approved by the Minister of the Environment. Forest management activities included in management plans are based on principles of sustainable forest management and correspond to the adopted silvicultural methods. The level of allowable cut considerably affects implementation of forest functions while maintaining principles of sustainability and multi-functionality of forest management (Borecki et al. 2012). Other economic factors influencing forest management activities include costs of wood production and timber harvesting as well as profits from timber sales, which depend on prices of specific timber assortments.

Management activities in forests oftentimes become an issue for various interest groups and participants (Czuba 2003; Szujecki 2003; Bernadzki 2004, 2005; Czuba,

Przypaśniak 2006; Poznański 2011; Adamowicz 2012). Implementation of sustainable forest management principles in practice requires higher costs of forest management activities. Costs could be reduced by using, among others, natural forest regeneration and better work organisation (Szramka 2005, 2009). The value of non-timber forest functions is many times higher than commercial forest value. It should be underlined that provision of non-timber functions will undoubtedly cause the increase in production costs and decrease in profits from timber sales, burdening the budget of the State Forests National Forest Holding and increasing costs for enterprises working with timber resources. Carrying these costs is however inevitable due to adopted agreements on forest management signed by European and many other world countries. This issue is mentioned, among others, by Klocek and Płotkowski (1997), Hałuza and Musiał (2004) and Szramka (2004). Cost of wood production, which includes costs of harvesting timber, means of production, subjects of labour and human

capital used in production process, is the important element in forest management planning (Adamowicz 2012).

Forest management distinguishes the process of wood production 'on stump', which is measured by the annual yield of forest stands, and also the process of wood production 'near stump', which is defined by the quantity of harvested log assortments in a given economic year. The process of wood production 'near stump' is tightly related to the costs of timber cutting and skidding, which compose prices of timber products. Therefore, the analyses and conclusions on costs (production and personal) related to timber cutting and skidding as well as prices of raw timber constitute an important element of modern forest management practices.

2. Aim and scope of the study

The basic research goal of current study was comparison of the rate of change in costs of wood production 'near stump' and prices of raw timber in the Regional Directorate of the State Forests in Zielona Góra as a case study. The study analysed prices of selected log assortments and changes in costs of timber cutting and skidding.

The study covered the period 2001–2009. Such a research period was selected due to the fact that the years 2001 and 2009 start and end the successive economic cycles on the timber market (Ratajczak 2011). Thus, such a period was suitable for the economic analysis of changes in prices of log assortments and costs of timber cutting and skidding.

3. Methods

The data were collected from the financial records of 20 forest districts of the Regional Directorate of the State Forests in Zielona Góra. The collected data allowed implementing the unit analysis of selected parameters of forest management (prices and costs).

The analysis covered averaged costs of selected log assortments and two cost categories: wood production costs (technical or direct costs increased by the general management costs of permanent workers who participated in timber cutting and skidding) and personal costs (production costs increased by the administrative costs of core activities of forest management during timber cutting and skidding). The study used nominal costs and prices due to the fact that the research goal related to the rate of change in costs and prices and inflation rate had a similar proportional effect on both analysed categories.

The evaluation of the average rate of change in elements of forest management was based on the logarithmic method. Initially, the dynamic coefficient of variation was based on the quotient of a variable in a respective and a previous year.

$$\frac{Wd_t}{Wd_{t-1}} \qquad (1)$$

where:
Wd_t – value of analysed variables in respective years (t),
Wd_{t-1} – value of given variable in a previous year.

Common logarithm was then calculated for the received results.

$$\log \frac{Wd_t}{Wd_{t-1}} \qquad (2)$$

where:
– symbols are the same as in formula 1.

Further, the sum of logarithms estimated for respective years was calculated.

$$\sum_{t=2}^{n} \log \frac{Wd_t}{Wd_{t-1}} \qquad (3)$$

where:
– symbols are the same as in formula 1.

Afterwards, the quotient of 1 and number of observations decreased by 1 was found.

$$\frac{1}{n-1} \qquad (4)$$

where:
n – number of observations.

Next, the following equation was received after inserting equation elements:

$$\log \overline{A} = \frac{1}{1-n} \sum_{t=2}^{n} \log \frac{Wd_t}{Wd_{t-1}} \qquad (5)$$

where:
$\log \overline{A}$ – common logarithm,
– other symbols are similar to formulas 1–4.

The average rate of change was defined by the fact that the logarithm of a figure with a known base (which for common logarithm is equal to 10) could be calculated by raising that base to the power equal to the result of the logarithm. If is written by the equation 5, then

$$\overline{A} = 10^{\left(\frac{1}{1-n}\sum_{t=2}^{n}\log\frac{Wd_t}{Wd_{t-1}}\right)} \qquad (6)$$

$$STZ = \left(\overline{A}-1\right)\cdot100\% \qquad (7)$$

where:
$\overline{A}$ – number within a logarithm,
– other symbols are the same as in formulas 1, 4 and 5.

And finally, the average rate of change was calculated according to the following pattern:

where:
STZ – average rate of change,
– other symbols as in formula 6.

The results for the average rate of change were expressed in percent.

Table 1. The average prices of selected timber assortments in the Regional Directorate of the State Forests in Zielona Góra in 2001–2009

Assortments**	Average price (PLN/m³), in the year:									
	2001	2002	2003	2004	2005	2006	2007	2008	2009	ā*
Timber in total	99.90	90.23	94.15	104.57	112.35	114.52	127.25	133.65	121.77	110.93
Large-diameter timber	111.08	100.78	104.03	115.61	124.34	124.15	134.96	142.32	129.54	120.76
Large-diameter coniferous timber	113.60	102.97	106.38	117.44	126.18	126.05	136.61	144.22	130.47	122.66
WA0+…+WD	167.87	158.29	166.25	172.99	181.30	178.00	188.64	201.39	171.92	176.29
WA1	701.00	0.00	528.74	694.83	662.11	681.44	818.84	866.44	0	550.38
WB1	356.73	267.08	254.76	254.15	271.45	272.54	275.24	300.51	260.45	279.21
S10	107.42	97.81	99.77	106.18	117.78	121.27	131.95	142.74	126.63	116.84
S2a+S2b So, Md	89.40	85.68	87.00	97.30	107.73	106.88	117.15	123.51	116.29	103.44
S2a+S2b Św, Jd	95.62	88.40	86.07	92.96	108.79	109.82	115.92	117.25	109.88	102.75
S4	44.94	43.54	38.58	45.60	55.15	57.17	61.73	66.61	71.33	53.85
Large-diameter broadleaved timber	97.85	88.05	90.60	105.36	114.78	115.01	124.63	131.62	123.77	110.19
WA0+…+WD	181.02	167.83	176.34	207.82	215.49	225.49	244.64	254.02	214.57	209.69
WA1	981.78	882.98	883.78	1076.58	1089.71	1176.30	1299.07	1484.23	0.00	986.05
WB1	215.09	200.06	201.51	221.91	231.26	239.54	244.34	253.18	212.57	224.38
S2a+S2b	72.38	66.12	65.94	70.47	85.66	87.35	92.96	98.20	104.87	82.66
S4	51.41	47.78	46.43	55.30	67.49	68.90	74.66	83.08	87.96	64.78
Small-diameter coniferous and broadleaved timber	30.00	25.60	26.57	30.31	36.38	46.31	57.56	61.85	58.10	41.41
M1	33.06	27.44	30.29	35.07	42.75	58.28	72.22	80.43	77.18	50.75
M2	20.68	19.68	17.43	17.99	19.67	20.53	21.13	21.57	21.55	20.03

Source: Report LPIO-9 RDSF in Zielona Góra 2012, own elaboration
* mean prices of timber products in RDSF in Zielona Góra during the period of 2001–2009
** W – large-diameter logs, with upper diameter ≥ 14 cm (inside bark); A, B, C, D – large-diameter timber assortments based on quality and size (A – highest grade); 0 – general purpose wood (sawmill wood); 1 – special purpose wood (valuable assortments – veneer, plywood, matchwood, electricity poles); S – medium-diameter timber, with upper diameter (inside bark) ≥ 5 cm and lower diameter < 24 cm; S1 – medium-size long logs (mine and construction support timber); S2 – medium-size piled timber for industrial manufacturing (such as particle board production); S3 – round wood for industrial processing (poles of general use and for production of particle boards); S4 – large firewood; M – small-diameter round timber with lower diameter < 5 cm (inside bark); M1 – small-diameter timber for industrial processing (wooden posts); M2 – small firewood (GUS 2012); So – Scots pine; Md – European larch; Św – European spruce; Jd – Silver fir

4. Research results

Average prices of various log grades were calculated from the source data (LPIO-9) collected in the period 2001–2009 in the Regional Directorate of the State Forests in Zielona Góra (Table 1).

Based on the research conducted, the average price of 1 m³ of timber was 110.93 PLN during the whole study period. The price of large-diameter coniferous segments reached the level of 122.66 PLN, the price of broadleaved large-diameter segments 110.19 PLN, and small-diameter segments 41.41 PLN. During the same period, the average price of 1 m³ of timber in the State Forests was 128.29 PLN (17.36 PLN higher than the price in the Regional Directorate) and the price of broadleaved large-diameter segments 128.62 PLN (18.43 PLN higher than the Regional Directorate price), and for small-diameter

timber 38.72 PLN (2.69 PLN lower than the Regional Directorate price) (Adamowicz 2012).

In the Zielona Góra Regional Directorate, the average price of large-diameter coniferous segments WA0-WD was 176.29 PLN/ m³, which is 33.40 PLN/m³ lower than price of large-diameter broadleaved timber. Relatively high unit price was attached to the coniferous timber of WA1 assortment – 550.38 PLN/m³ – and very high price to broadleaved timber of that assortment – 986.05 PLN/m³ – while average price of WB1 assortment coniferous timber was 279.21 PLN/m³, and broadleaved timber of the same assortment 224.38 PLN/m³.

The highest price in the medium-diameter timber group was given to the assortment S10 – 116.84 PLN/m³; from the S2a+S2b group coniferous 103.44 PLN/m³ and 102.75 PLN/m³. The average prices of coniferous timber of S2a+S2b assortments were 20.78 PLN/m³

Table 2. The average rate of change in prices of various timber assortments in the Regional Directorate of the State Forests in Zielona Góra in 2001–2009

Timber assortments	$\sum \log$	$\log \bar{A}$	$\bar{A}$	$\Delta\,(\%)$
Timber in total	0.085975	0.010747	1.025054	2.51
Large-diameter timber	0.066768	0.008346	1.019403	1.94
Large-diameter coniferous timber	0.060132	0.007517	1.017458	1.75
WA0+…+WD	0.010353	0.001294	1.002984	0.30
WA1	-4.845718	-0.605715	0.247905	-75.21
WB1	-0.136615	-0.017077	0.961442	-3.86
S10	0.071451	0.008931	1.020778	2.08
S2a+S2b So, Md	0.114205	0.014276	1.033417	3.34
S2a+S2b Św, Jd	0.060370	0.007546	1.017528	1.75
S4	0.200639	0.025080	1.059449	5.94
Large-diameter broadleaved timber	0.102055	0.012757	1.029809	2.98
WA0+…+WD	0.073842	0.009230	1.021481	2.15
WA1	-4.992014	-0.624002	0.237683	-76.23
WB1	-0.005118	-0.000640	0.998528	-0.15
S2a+S2b	0.161033	0.020129	1.047440	4.74
S4	0.233238	0.029155	1.069436	6.94
Small-diameter coniferous and broadleaved timber	0.287055	0.035882	1.086130	8.61
M1	0.368202	0.046025	1.111796	11.18
M2	0.017897	0.002237	1.005164	0.52

Source: own elaboration
Symbols are the same as in the Table 1.

higher than broadleaved timber of that assortment. The price of broadleaved firewood was 10.93 PLN/m³ higher than coniferous firewood. The prices of coniferous and broadleaved firewood in the Regional Directorate in Zielona Góra were respectively 6.54 PLN/m³ and 9.11 PLN/m³ lower than in the State Forests.

The next analysis was done on the average rate of change for prices of specific timber assortments. Based on the research conducted, the average price of timber in general was growing 2.51% annually during the study period. At the same time, the rate of change for large-diameter coniferous timber was lower and equal to 1.75% annually. During that period, the price of broadleaved large-diameter timber was growing 2.98% annually. The smallest positive rate of change was related to coniferous timber of the assortment WA0 – WD (0.30%) and assortment M2 (0.52%), while the highest growth was for the assortment M1 (11.18%). The research also noted a high rate of change for broadleaved (6.94%) and coniferous (5.94%) firewood, while for the assortments S2a+S2b this value was smaller. For this assortment, prices were growing 4.74% for broadleaved and 3.34% for coniferous segments annually. During the study period, a decrease in prices which concerned special timber assortments WA1 and WB1 was also noted (Table 2).

Based on the conducted analysis, costs of timber cutting and skidding (wood production) increased from 40 212.1 thousand PLN in 2001 to 71 272.9 thousand PLN in 2009, which equals to 177.24% with simultaneous increase in harvested timber volumes from 1396.9 thousand m³ to 1785.7 thousand m³ to 127.83% (Table 3).

During the study period, there were two cases of decrease in cutting and skidding costs noted in 2005 and 2009, while in the remaining years, these costs were increasing. Personal costs were growing along with logging costs and were 19% higher.

The analysis of the average rate of change in unit costs of timber cutting and skidding showed the average growth of logging costs at the level of 4.17% and personal costs at the level of 4.19% annually (Table 4).

5. Summary and conclusions

The average rate of changes in timber prices and costs of wood production with special consideration of personal costs of timber harvesting were inspected in the current study. The results were analysed and evaluated, with the following conclusions formulated as the outcome:

1. During the study period in the Regional Directorate of the State Forests in Zielona Góra, the average timber price was growing 2.51% annually. The growth in prices of small-diameter timber was 8.61% and of large-diameter timber 1.94% annually, while prices of coniferous large-diameter timber were growing 1.75% and broadleaved 2.98% annually. Unlike the tendency for most timber assortments, the prices of coniferous and broadleaved special timber assortments WA1 and WB1 were decreasing.

Table 3. Costs of timber cutting in the Regional Directorate of the State Forests in Zielona Góra in 2001–2009

Costs		Timber cutting – costs, in years								
		2001	2002	2003	2004	2005	2006	2007	2008	2009
timber cutting (thous. PLN)	production	40 212.1	47 408.5	52 786.2	57 725.6	52 285.2	51 896.8	64 577.7	70 405.0	71 272.9
	personal	47 828.0	59 617.9	65 616.9	69 504.7	63 898.6	65 282.1	77 493.3	82 661.2	84 891.1
per unit (PLN/m³)	production	28.79	30.97	31.53	32.09	30.99	31.86	36.96	41.67	39.91
	personal	34.24	38.95	39.19	38.64	37.87	40.08	44.35	48.92	47.54

Source: Data from the Regional Directorate of the State Forests, own elaboration

Table 4. Average rate of change in unit cutting and skidding costs in the Regional Directorate of the State Forests in Zielona Góra in 2001–2009

	Costs	$\sum \log$	$\log \bar{A}$	$\bar{A}$	$\Delta (\%)$
per unit	production	0.141840	0.017730	1.041670	4.17
	personal	0.142525	0.017816	1.041875	4.19

Source: Own elaboration

2. In the Regional Directorate of the State Forests in Zielona Góra during the study period, the costs of wood production were growing 4.17% and personal costs of timber harvesting 4.19% annually.

3. The rate of growth of wood production costs 'near stump' was higher than the rate of growth of the average timber price and the rate of growth of prices related to most timber grades.

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References

Adamowicz K. 2012. Ocena zmian gospodarki leśnej prowadzonej przez Państwowe Gospodarstwo Leśne Lasy Państwowe w handlu drewnem [Evaluation of changes in forest economy conducted by Polish State Forests (Państwowe Gospodarstwo Leśne Lasy Państwowe) in the aspect of raw wood sale in Poland]. Poznań, Uniwersytet Przyrodniczy. ISBN 1896-1894.

Bernadzki E. 2004. Niektóre wskaźniki możliwości pozyskania drewna w lasach państwowych i ich interpretacja (głos w dyskusji) [Some indicators of the possibility to harvest timber in State Forests and their interpretation. Voice to the discussion]. *Sylwan*, 148: 5–9.

Bernadzki E. 2005. Możliwości użytkowania w Lasach Państwowych. *Las Polski*, 1: 12–13.

Borecki T., Pieniak D. Wójcik R. 2012. Realizacja użytkowania przedrębnego w Lasach Państwowych w okresie 1999–2004 [Intermediate harvest realised in the State Forests in the period 1999−2004]. *Sylwan*, 156 (11): 848–854.

Czyba M. 2003. Urządzanie lasu. Warszawa, PWRiL. ISBN 83-09-01769-3.

Czuba M., Przepaśniak J. 2006. Przebudowa drzewostanów w planowaniu urządzeniowym. Warszawa, CILP. ISBN 83-89744-22-8.

GUS. 2012. Leśnictwo 2012. Warszawa, Główny Urząd Statystyczny. ISSN 1230-574X.

Hałuzo M, Musiał R. 2004. Ocena zasobów i potencjalnych możliwości pozyskania surowców dla energetyki odnawialnej w województwie pomorskim. Słupsk, Biuro Planowania Przestrzennego.

Klocek A., Płotkowski L. 1997. Las i jego funkcje jako dobro publiczne. Kongres Leśników Polskich 24–26.04.1997. Białystok, Lublin, Łódź, Olsztyn, Radom, Toruń, Warszawa. T 2, referaty część 2, sekcje tematyczne IV–VI: 149–169. ISBN 8390767392.

Podgórski M. 1974. Zarys ekonomiki gospodarstwa leśnego. Poznań, Akademia Rolnicza.

Poznański R. 2011. Prognoza użytkowania Lasów Państwowych na okres 2011–2020 [Forecast of the harvest in the State Forests for the 2011−2020 period]. *Sylwan,* 12: 827–834.

Ratajczak E. 2011. Popyt na drewno w Polsce – zmiany strukturalne oraz możliwości zaspokojenia, in: Strategia rozwoju lasów i leśnictwa w Polsce do roku 2030. Sękocin Stary, Instytut Badawczy Leśnictwa. ISBN 978-83-62830-01-5.

Szramka H. 2004. Bilans otwarcia leśnictwa polskiego w momencie przystąpienia do Unii Europejskiej [Polish forestry opening balance in moment accession to European Union]. *Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu*, 6 (4): 198–207.

Szramka H. 2005. Ekonomiczne aspekty różnych sposobów odnawiania lasu [Economic aspects of different ways of renovation of forest]. *Sylwan*, 149 (11): 59–65.

Szramka H. 2009. Wpływ systemów wynagradzania na koszty pozyskania drewna [Influence of pay systems on costs of acquiring wood]. *Zarządzanie ochroną przyrody w lasach,* 3: 192–200.

Szujecki A. 2003. Przyszłość Lasów Państwowych. Optymalny model. *Głos Lasu,* 10: 7–9.

Contributions

K.A. – designed and supervised the study and wrote the manuscript; H.K. – performed all the experiments, analysed data and wrote the manuscript.

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