COST ANALYSIS AND ASSESSMENT IN THE POLISH HARD COAL MINING INDUSTRY IN YEARS 2006-2011

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Abstract: The purpose of the hereby article to analyze and assess costs in the Polish hard coal mining industry in years 2006-2010 during the period of economic improvement on the market of traditional energetic resources. It is an issue which significantly affects the competitiveness of Polish coal on the world markets. In the light of the results, the improvement of competitiveness will be possible if the salaries rise is decreased and also the effectiveness of employment restructuring is improved.

Keywords: cost analysis and assessment, Polish hard coal mining.

1 Introduction

The hard coal mining industry is a branch that until recently has been thought to be in the stage of decline. However, in the last 3 years the sector has begun to experience revival due to the increase in demand on traditional energy resources. Together with this revival the chances of Polish hard coal mining industry surviving or even developing are rising. However, their realization depends on the competitiveness of Polish coal on the global markets. The competitiveness on the other hand is decreased by unit costs of production that are growing in time.

Due to the importance of this problem, in this paper the production costs of in Polish hard coal mining industry in years 2006-2011 have been analyzed and assessed. The objective of this paper is to determine the scale of changes in production costs as well as their reasons. The results can be used in further stages of cost management in order to improve the efficiency of Polish mining industries.

2 The analysis and assessment of costs as the stages of cost management – overview of literature

The analysis and assessment of costs is the second stage of cost management (Horngren *et al*., 2009). It is preceded by cost planning which should be followed by cost recording as the part of chosen cost account as well as by cost control. The main task of the analysis and assessment is to provide information in regards to the level, structure and changes of production costs in various profiles and systems. The information received constitute a basis for making decisions concerning changes in the cost policy of the enterprise (Groot and Budding, 2004). The main goal of those changes is to improve the operational effectiveness achieved mainly by the reduction of costs and/or optimizing their structure.

In the Polish hard coal mining industry the costs are recorded in the traditional accounting systems in the functional and generic system. The modern cost accounting systems implied by the management accounting are not being used (Kaplan and Anderson, 2004). It is a big disadvantage, as the currently used cost accounting systems do not provide information about the costs of particular processes or objects, thus it prevents the assessment of their effectiveness (Hope and Fraser, 2003). The Polish mining enterprises do not use the method of planning costs either. The process of managing costs is therefore defective, bereft of the planning function and in result, also deprived of the motivational function. Enterprises have no reference point, which could be the base for the assessment of final results in the area of costs (Nourzad, 2002). These disadvantages could remain unnoticed or could be insignificant in the enterprises with a stable level of costs. However, in the mining enterprises, strongly and systematically increasing costs constitute a serious threat for the operational effectiveness (Van Helden, 2005). This is the reason for the need for introducing radical changes in cost management the cause of which is the analysis conducted in the further part of the paper (Modell, 2010).

3 Research methodology

Production cost analysis and assessment was conducted in years 2006-2011 for the whole sector in which there are three big state-owned coal partnerships functioning and two other private mining enterprises (Groot and Budding, 2008). In the research there were statistical methods and cause and effect analysis used. For this purpose there were fixed base and chain dynamics indexes as well as structure ratios adopted.

In the first of the research stages there was the analysis of level and total changes of unit production cost made. The analysis was conducted in the current and fixed prices, comparing the results with the total amount of production in the examined period.
Next, the circumstances of changes in unit production cost were presented in a more detailed way, in the context of generic costs analysis. The further analysis was conducted in the current prices and it concerned:

- identification of structure of coal production cost and average unit production cost of hard coal in the hard coal mining in Poland in a generic approach,
- dynamics analysis of separate groups of generic costs in the hard coal mining in Poland.

Cost analysis in a generic system was conducted with the assumption of the following cost positions:

- payroll with surcharges (including salaries, social insurance and other benefits),
- material and energy consumption,
- amortization,
- foreign services,
- other generic costs (including taxes and fees as well as other costs).

4 Data analysis – total and unit costs

Cost dynamics in the hard coal mining is directly linked to the production dynamics. Over the period of 2006-2011 the hard coal production was systematically decreasing (table1) (Karbownik and Turek, 2011).

Table 1. Hard coal production in years 2006-2011

Specification	**Years**		
	2006	**2007**	**2008**
Coal production [million tons]	100.87	93.00	88.34
Production dynamics [fixed base = year 2006]	100.00%	98.62%	93.68%
Production dynamics [variable base]	100.00%	92.20%	94.99%
Specification	**Years**		
	2009	**2010**	**2011**
Coal production [million tons]	76.25	76.10	75.40
Production dynamics [fixed base = year 2006]	80.86%	80.70%	79.96%
Production dynamics [variable base]	86.31%	99.80%	99.08%

Source: own work based on the data from the Ministry of Economy

The most rapid changes in the production level occurred in years 2007-2009. In 2009 the production was stable at the level of 75-76 million tons, which constituted about 80% of production from 2006. The basic reason for such drastic changes in extraction of

this resource in Poland was the economic deterioration on the world market of hard coal and low competitiveness of Polish coal resulting from high and still rising production cost (Ferguson, 2006). The image of hard coal as an energetic resource was also negatively affected due to the introduction of restrictions regarding carbon dioxide emission by the European Union (Zieliński, 2003).

In the analogical period, the decrease of hard coal production was accompanied by the increase of coal production costs (table2) (Michalak, 2012).

Table 2. Total production cost of hard coal in years 2006-2011

Specification	**Years**		
	2006	**2007**	**2008**
Coal production cost [thousand PLN]	17 550 722	17 477 636	19 665 962
Production dynamics [fixed base = year 2006]	100.00%	99.58%	112.05%
Production dynamics [variable base]	100.00%	99.58%	112.52%
Specification	**Years**		
	2009	**2010**	**2011**
Coal production cost [thousand PLN]	19 994 847	19 865 282	21 607 669
Production dynamics [fixed base = year 2006]	113.93%	113.19%	123.12%
Production dynamics [variable base]	101.67%	99.35%	108.77%

Source: own work based on the data from the Ministry of Economy

According to the data included in table 2, in spite of the fact that the hard coal production decreased by over 20% in the period of six years, the hard coal production cost rose by over 23%. The highest increment of production cost was noted in 2008. In 2010 coal production cost slightly declined (by 0.65%) in comparison with year 2009 but in 2011 increased (by 8.7%) in comparison with year 2010.
Total cost increase with a decreasing hard coal production results in a high growth of unit production cost of hard coal (table 3).

Table 3. Unit production cost of hard coal in a sector in years 2006-2011

Specification	**Years**		
	2006	**2007**	**2008**
Unit production cost [PLN]	174.00	187.93	222.62
Unit cost dynamics [fixed base = year 2006]	100.00%	108.01%	127.94%
Unit cost dynamics [variable base]	100.00%	108.01%	118.46%
Specification	**Years**		
	2009	**2010**	**2011**
Unit production cost [PLN]	262.23	261.04	286.57
Unit cost dynamics [fixed base = year 2006]	150.71%	150.02%	164.70%
Unit cost dynamics [variable base]	117.79%	99.55%	109.78%

Source: own work based on the data from the Ministry of Economy

In the examined period (except for year 2010) it is possible to observe a steady increase of coal unit production cost. The highest dynamics of production cost growth occurred in 2008 and 2009 when the unit production cost was rising by about 18% in comparison with the year before. The high dynamics of production cost rise was stopped in year 2010 when the coal unit production cost decreased by about 0.5% in comparison with the previous year. However, the attention should be paid to the fact that the level of this cost in a previous year was already very high and constituted over 150% of cost from the base year – 2006. In 2011 the coal unit production cost started to increase again by almost 10% when comparing with year 2010 (Jonek-Kowalska, 2011).

The high dynamics of average unit production cost growth is a significant threat for the economic-financial situation of mining enterprises and for the competitiveness of Polish hard coal in the face of other world producers and also of other energetic carriers. When searching for the reason of such disturbing dynamics of production cost, in the first turn one should relate to the inflation rate and the analyzed values should be compared in fixed prices. Next, the analysis should be conducted on the structure of average unit production cost of hard coal.

In order to make the assessment of unit production cost changes in the Polish hard coal mining objective, the costs of the examined period were presented in the fixed prices of year 2011. The results of objectification conducted are included in table 4.

Table 4. Inflation rates and unit production cost in the hard coal mining in current and fixed prices from year 2011

Specification	**Years**		
	2006	**2007**	**2008**
Average yearly inflation (CPI)	1.01%	2.48%	4.16%
Growing inflation	14.50%	13.35%	10.61%
Average unit production cost of coal in current prices [PLN/t]	174.00	187.93	222.62
Average unit production cost of coal in fixed prices from year 2011 [PLN /t]	207.79	222.18	256.82
Unit cost change in fixed prices in comparison with the previous year	100.00%	106.93%	115.59%
Specification	**Years**		
	2009	**2010**	**2011**
Average yearly inflation (CPI)	3.50%	2.60%	4.3%
Growing inflation	6.19%	2.60%	-

Average unit production cost of coal in current prices [PLN/t]	262.23	261.04	286.57
Average unit production cost of coal in fixed prices from year 2011 [PLN /t]	290.44	279.35	286.57
Unit cost change in fixed prices in comparison with the previous year	113.09%	96.18%	102.59%

Source: own work

According to data included in table 4, inflation in years 2008 and 2009 increased significantly in the current prices. It is one of the reasons for intensive rise of this cost. Omitting inflation and expressing the average unit production cost of hard coal in the fixed prices from year 2011, the highest dynamics of this cost may still be observed in years 2008 and 2009. Nevertheless, in the next year, that is 2010, the average unit production cost expressed in the fixed prices decreased for the first time by about 3.8% in the examined period in comparison with the year before. However, it is not a steady tendency because in 2011 the unit production cost of hard coal was increasing again. On the basis on the analysis of unit cost in the current and fixed prices, it may be stated that this cost is systematically growing in time despite the production decrease (Jonek-Kowalska and Turek, 2012).

5 Data analysis – generic costs

In table 5 there is a compilation of total generic costs presented in the hard coal mining in years 2006-2011 in a valuable depiction. In table 6 their structure is included.

Table 5. Production cost in the hard coal mining in a generic system in years 2006-2011

Costs [thousand PLN]	**Years**		
	2006	**2007**	**2008**
Payroll with surcharges	8 481 943	8 630 960	9 889 622
Materials and energy consumption	3 485 513	3 445 073	3 759 059
Amortization	1 509 408	1 488 080	1 735 616
Foreign services	3 247 624	3 145 190	3 560 004
Other generic costs	826 234	768 333	721 661
Total	**17 550 722**	**17 477 636**	**19 665 962**
Costs [thousand PLN]	**Years**		
	2009	**2010**	**2011**
Payroll with surcharges	10 005 807	9 330 025	10 762 616
Materials and energy consumption	3 880 070	3 614 761	3 979 668
Amortization	1 713 200	1 779 587	1 847 458
Foreign services	3 525 505	3 342 309	3 723 607
Other generic costs	870 265	1 798 600	1 294 320
Total	**19 994 847**	**19 865 282**	**21 607 669**

Source: own work based on the data from the Ministry of Economy

Table 6. The structure of production cost in the hard coal mining in a generic system in years 2006-2011

Costs	**Years**		
	2006	**2007**	**2008**
Payroll with surcharges	48.33%	49.38%	50.29%
Materials and energy consumption	19.86%	19.71%	19.11%
Amortization	8.60%	8.51%	8.83%
Foreign services	18.50%	18.00%	18.10%
Other generic costs	4.71%	4.40%	3.67%
Total	**100.00%**	**100.00%**	**100.00%**
Costs	**Years**		
	2009	**2010**	**2011**
Payroll with surcharges	50.04%	46.97%	49.81%
Materials and energy consumption	19.41%	18.20%	18.42%
Amortization	8.57%	8.96%	8.55%
Foreign services	17.63%	16.82%	17.23%
Other generic costs	4.35%	9.05%	5.99%
Total	**100.00%**	**100.00%**	**100.00%**

Source: own work

Additionally, in table 7 there is the value of separate generic costs presented in a unit depiction, in calculation per one ton of extraction.

Table 7. Structure of production cost in the hard coal mining a generic system in years 2006-2011

Costs [PLN]	**Years**		
	2006	**2007**	**2008**
Payroll with surcharges	84.09	92.81	111.95
Materials and energy consumption	34.56	37.04	42.55
Amortization	14.96	16.00	19.65
Foreign services	32.20	33.82	40.30
Other generic costs	8.19	8.26	8.17
Total	**174.00**	**187.93**	**222.62**
Costs [thousand PLN]	**Years**		
	2009	**2010**	**2011**
Payroll with surcharges	131.22	122.60	142.74
Materials and energy consumption	50.89	47.50	52.78
Amortization	22.47	23.38	24.50
Foreign services	46.24	43.92	49.38
Other generic costs	11.41	23.63	17.17
Total	**262.23**	**261.04**	**286.57**

Source: own work

The highest value of coal production cost occurred in year 2011 and also in the same year the highest rise in the unit production cost took place. In the structure of this cost in all the analyzed years the highest share belongs to the payroll with surcharges constituting about 50% of total production cost. The cost of payroll with surcharges for social insurance and other benefits in 2006 amounted to about 8 481 million PLN and in the conditions of decreasing production in the sector of hard coal, it was increasing until year 2009 when it reached the value of 10 005 million PLN. In 2010 payroll with surcharges showed a declining tendency for the first time in the examined period and fell to the level of 9 330 million PLN. That year the share of the cost of payroll with surcharges was the lowest in the structure of production cost and equaled 46.97%. However, in the last year of the analysis the value of payroll increased to the highest level in the examined period and amounted to 10 762 million PLN and the share of payroll in the structure of unit production cost increased to almost 50%. The value of payroll in the unit production cost equaled from 84.09 PLN/t in the first year of the analysis to do 142.74 PLN/t in year 2011. In year 2010 the unit cost of payroll with surcharges decreased for the first time in the researched period and amounted to 122.60 PLN/t; nonetheless, in the subsequent year this cost grew again (Zieliński, 2006).

The highest share after payroll in the coal production cost belongs to the material and energy consumption cost and foreign services cost. In the examined period they had a similar value and constituted about 16% to almost 20% of total production cost. The share of these two positions in the structure of production cost was decreasing year by year until 2011 when it slightly grew. The materials and energy cost constitute from 19.86% in 2006 to 18.20% of total production cost in 2010. In 2011 its share equaled 18.42%. The materials and energy consumption cost amounted from 3 485 million PLN in 2006 to 3 979 million PLN in 2011, what after calculating per the unit of production equaled from 34.55 PLN/t in 2006 to 52.78 PLN/t in 2011. However, the foreign services cost decreased its share in the structure of production cost from the level of 18.5% in 2006 to 17.23% in 2011. The foreign services cost amounted to 3 247 million PLN in 2006 to 3 723 million PLN in 2011, what after calculating per 1 ton of coal produced equals from 32.20 PLN/t to 49.38 PLN/t.

Amortization – as the next coal production cost according to the share – constitutes from 8.5% to almost 9% of total cost. The amortization cost increased in the examined period from the level of 1 509 million PLN in 2006 to nearly 1 847 million PLN in 2011, what after calculating per 1 ton of production equals almost 15 PLN/t in 2006 and to 24.5 PLN/t in 2011.

The lowest share in the production cost structure, in the most part of the examined period, belongs to other generic costs which include taxes and fees and other costs. In year 2006 they equaled about 826 million PLN what constituted 4.71% of total production cost. After calculating these cost per ton of coal they amounted to 8.19 PLN/t. In the subsequent years the value of other generic costs remained at a similar level until the year 2010. At that time the value of these costs in the production cost structure increased twice and they constituted over 9% of total production cost but their value grew to the level of almost 1 800 million PLN, what after calculating per 1 unit of production amounted to 23.63 PLN/t. In year 2011 the share of other generic costs in the total cost structure decreased to 6%.

A completion of the structure analysis of generic costs is the identification of changes among the separate cost positions in time. It would allow to answer the question which of these costs influenced the most the increase of unit production cost of hard coal in Poland in the examined period (Ivanova *et al.*, 2007). In tables 8 and 9 there are the percentage changes presented of the separate positions of generic costs in comparison with year 2006 (fixed base) and to the previous year (variable base).

Table 8. Changes in total generic costs in the hard coal mining in years 2006-2011 (fixed base=2006)

Costs	**Years**		
	2006	**2007**	**2008**
Payroll with surcharges	100.00%	101.76%	116.60%
Materials and energy consumption	100.00%	98.84%	107.85%
Amortization	100.00%	98.59%	114.99%
Foreign services	100.00%	96.85%	109.62%
Other generic costs	100.00%	92.99%	87.34%
Total	100.00%	99.58%	112.05%
Costs	**Years**		
	2009	**2010**	**2011**
Payroll with surcharges	117.97%	110.00%	126.89%
Materials and energy consumption	111.32%	103.71%	114.18%
Amortization	113.50%	117.90%	122.40%
Foreign services	108.56%	102.92%	114.66%
Other generic costs	105.33%	217.69%	156.65%
Total	113.93%	113.19%	123.12%

Source: own work

Table 9. Changes in total generic costs in the hard coal mining in years 2006-2011 (variable base)

Costs	**Years**		
	2006	**2007**	**2008**
Payroll with surcharges	100.00%	101.76%	114.58%
Materials and energy consumption	100.00%	98.84%	109.11%
Amortization	100.00%	98.59%	116.63%
Foreign services	100.00%	96.85%	113.19%
Other generic costs	100.00%	92.99%	93.93%
Total	100.00%	99.58%	112.52%
Costs	**Years**		
	2009	**2010**	**2011**
Payroll with surcharges	101.17%	93.25%	115.35%
Materials and energy consumption	103.22%	93.16%	110.09%
Amortization	98.71%	103.88%	103.81%
Foreign services	99.03%	94.80%	111.41%
Other generic costs	120.59%	206.67%	71.96%
Total	101.67%	99.35%	108.77%

Source: own work

In the examined period the other generic costs were rising the most. However, due to their low share in the total cost structure, it did not have a great impact on the final cost value. The strongest influence on costs increase was caused by the rise of

payroll and materials and energy consumption costs. These are the positions of the highest share in total costs rising dynamically in time. Below there is a detailed analysis presented concerning the changes in generic costs by years.

6 Analysis of data – the determinants of costs

In **year 2007** the majority of the positions of costs had the value close to the value from year 2006. The highest increase in costs was noted that year in the position of payroll with surcharges. These costs did rise by 1.76% even despite the decreasing the level of employment in the hard coal mining industry by 3.3% in comparison to year 2006. The growth of the share of payroll with surcharges in the structure of production cost is particularly significant for the unit cost of production because of the highest value of this position in the system of generic costs. Furthermore, the lack of correct relations between the rise of payroll and the increase of working efficiency can be observed. In the systems of payroll used, the efficiency factor has little significance. Apart from the payroll, other costs positions in year 2007 presented the negative dynamics. The costs of raw materials and energy experienced a slight decrease (1.16%). Other positions of generic costs in the analyzed period also decreased their share in the structure of costs of coal production in comparison to year 2006. The share of amortization decreased by 1.4%, the share of foreign services by 4.15% and the share of other generic costs by approximately 7%.

In **year 2008** the highest rise in the unit production cost could be noted and at the same time positive dynamics could be observed in almost all cost positions. The highest rise of costs in comparison to the previous year was noted in the position of amortization as well as payroll with surcharges and foreign services. Payroll increased by almost 15%. The costs of foreign services increased by over 13%. The largest increase in this period was in the area of costs of drilling and mining services as well as renovation services. Other costs of foreign services were characterized by the increase between 10 to 20% (transport, renting of machines and mining equipment, loading stone and methane removal). In the examined period only the costs of coal processing did decrease. In year 2008 in comparison to year 2007 also the amortization costs and the costs of the energy and materials consumption grew, even despite the decreasing the level of hard coal mining production by almost 5%. The only position of costs that decreased was the other generic costs that have no significant influence on the structure of total costs. Therefore, over 12% increase of the unit cost of hard coal mining production was influenced mainly by the increase of amortization, the costs of payroll with surcharges and of foreign services. To a lesser extent it was influenced by the costs of materials and energy consumption, although this influence was still significant.

In **year 2009** the increase in unit cost mining cost of hard coal mining was noted once again, although the dynamics of the rise was significantly weakened (increase by over 1.6% in comparison to the previous year). In the examined period the level of payroll with surcharges rose again. This process was accompanied by a rise of the employment level by 0.7%. The increase of unit cost was also influenced by the rise of costs of energy and materials consumption, the other generic costs as well as taxes and fees.

In **year 2010** there was a stop in the rapid rise of the coal production costs. The share of the most important positions of generic costs i.e. the share of payroll, energy and materials consumed and the share of foreign services in the structure of production costs decreased in comparison to the previous year. In that year other generic costs rose significantly but their value is not significant in the structure of coal production cost (Jonek-Kowalska and Turek, 2011).

In **year 2011** again the increase of costs in the hard coal mining industry can be observed. The total costs rose by 8.77% in comparison to year 2010 and the largest increase (approximately 15%) was achieved by payroll. High (approximately 11%) increase regarded also the position of foreign services. Other generic costs which include the costs of representation and advertising, taxes and fees as well as other basic operational costs in year 2011 decreased by approximately 30% in comparison to the previous year (Oczkowski and Sharma, 2005).

7 Conclusions

A significant increase of mining costs in the examined period was caused mainly by the rise of payroll. In the Polish hard coal mining industry the trade unions continuously insist on increases of salaries and oppose reducing the employment level even despite the systematically decreasing mining production. The demands of the trade unions are partly motivated by the worsening geological and mining conditions related to the deepening of mines and to the mining production focus. These circumstances make the unit mining cost rise while the total general effectiveness per one employee is continuously decreasing (Basci *et al.*, 2007). The lack of a motivational system tied to the results of work provides additional complication to the already difficult situation. The rise of total and unit costs in the examined period was also influenced by the increase in prices of materials and energy. The rise in foreign services is caused by the growing scale of works commissioned based on outsourcing to external companies, which should reduce the costs and simplify the structure of basic production processes realized in the enterprise.

The Polish hard coal mining industry is considered to belong to the ten largest producers of hard coal. It has rich and valuable deposits. Under favorable business circumstances Polish mining production may achieve the rise in effectiveness, under the condition that:

1. the rate of the increase of payroll will be limited,
2. there will be a rise in the effectiveness of actions in the area of employment restructuring,
3. pro-effectiveness motivational system will be implemented,
4. cost management will be improved by the implementation of planning and calculating the costs in terms of processes (Lapsley and Wright, 2004),
5. actions aimed at reducing costs in other areas will be intensified.

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