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Simulation of Coal Production Costs in Conditions of Coal Mining Restructuring Process

Introduction

The process of hard coal mining industry restructuring in Poland has started together with the economic reform of the country at the beginning of 1990. Coal industry was at that time totally ineffective and unprofitable. Its role was not to make money but just to produce as much coal as possible to supply domestic market and to bring hard currency from exports. Coal prices at the domestic market were set at a very low level to secure a cheap source of energy both for industry and for domestic consumers. The costs of coal production were much higher than the coal prices achieved.

The main goal of the restructuring process was to make the coal mines profitable and able to survive on the competitive market. The efforts to decrease costs of coal production were undertaken. In spite of looking for internal cost savings in each of mine, the processes of closing of the most unprofitable mines started.

At the same time the efforts to increase coal prices were undertaken. The results of those efforts are illustrated at the figure 1, where the levels of costs and prices are shown in constant 2001 PLN (to neglect the high inflation over the years). The unit cost of sold coal had the decreasing tendency in the years 1988 – 2001. Coal prices, after the rapid increase in the years 1989 – 1991 and 1993 – 1994 had a steady decreasing tendency. It means that in 1995 – 2001 yearly average increase of coal prices was lower than inflation.

Unit profit on coal sale was negative in the years 1988 – 1999 with exclusion of the small positive result in 1994.

The decrease of unit costs of production was decelerated by subsequent decrease of coal production and sale.

In 1988 nearly 190 M. tonnes of coal was produced and sold. Deep economic crisis at the beginning of the reform caused the substantial decrease of demand for coal, especially in the domestic market. In 1990 coal sale decreased to about 150 M tonnes and lowered in the next years to stabilise at the level about 130 M tonnes in 1992 – 1997. Further substantial decrease of demand for Polish coal occurred in 1998, causing the necessity to revise the former restructuring programmes and introduce deep reform of coal industry in 1998.

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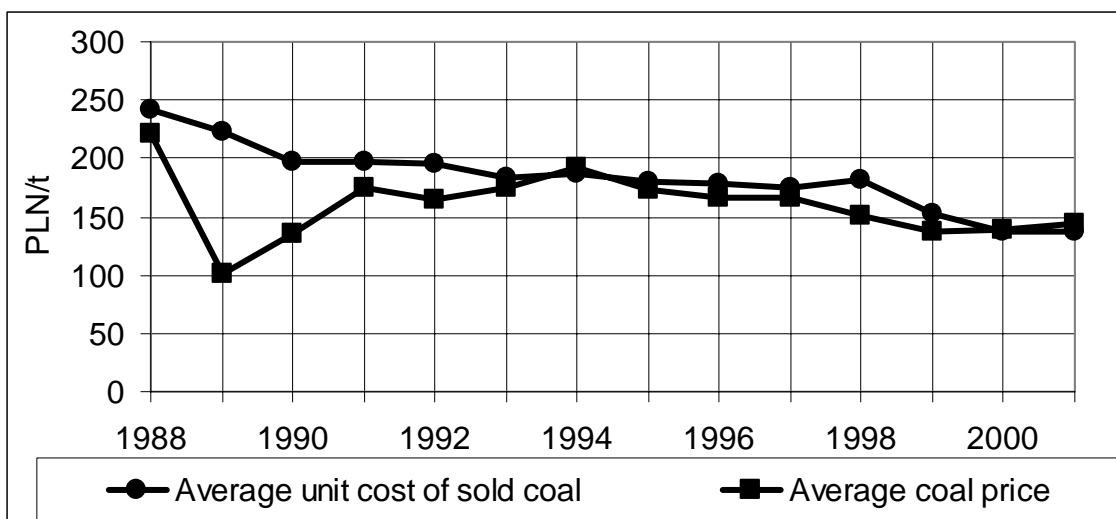Reviewed by Prof. Wiesław BLASCHKE

Figure 1: Average unit cost and unit price of coal in the years 1988 – 2001, in constant 2001 PLN.

Rys. 1. Średni jednostkowy koszt produkcji i cena węgla w latach 1988 – 2001, w cenach stałych 2001 r.

Results of coal mining industry reform 1998 – 2002

In 1998 coal sale decreased to 114.3 M t from 132.7 M tonnes in 1997. The average unit cost of coal production increased as the production capacity of he industry was not fully utilised. Also, as the demand was much lower the supply, coal prices substantially decreased. The industry noticed high losses. The forecasts for future coal demand were even worse so without special care of the government the industry would not survive.

In June 1998 Polish government has launched the "Reform of hard coal mining industry in Poland in the years 1998 – 2002" [2]. The programme was then corrected in 1999 [3] to add the industry additional incentives for regaining financial liquidity.

The reform is now in the final stage of its realisation.

Within 3 years 1998 – 2001 the industry achieved 5625.5 M PLN of the governmental subsidies (Karbownik, Turek [4]). The subsidies were used mainly for mines closure as well as for special payments granted to the miners that decided to leave their jobs in mining industry. In these 3 years mining industry decreased its production capacity by nearly 33 M tonnes/year. In 2001 there were only 41 coal mines operating, comparing to 70 coal mines that operated in 1990.

The employment has decreased by 97.3 thousand persons. Unit result on coal sale has increased from the loss of 24.29 PLN/t in 1998 to the profit of 2.37 PLN/t in 2000 and 7.58 PLN/t in 2001.

Net financial result of the industry changed from the high loss of –4276 M PLN in 1998 to the profit 176 M PLN.

It is worth noticing that in 2001, for the first time since the beginning of economic reform, the industry achieved the positive financial result. This result was attained mainly due to the positive operational result amounted to 1457 M PLN, while the result on financial operations was –1158 M PLN.

High costs of financial operation was the result of lack of financial liquidity that forced the mining companies to use expensive credits for financing current production.

The profit on coal sale as well as positive financial result show that finally, after many years, the mining industry may gain effectiveness and function on the competitive market.

Nevertheless, the following questions have to be answered: Is the industry able to retain and increase in future the effectiveness gained now? What are possible scenarios for the future development of the coal mining industry in Poland?

Future market conditions of Polish coal industry

The main feature of the Polish economy restructuring process is the change of the primary energy balance of the country. The decreasing role of coal can be noticed here and subsequent switch to more "noble" energy sources. This process has started a few years ago but is not finished yet. The experiences of the last few years confirm this thesis.

Domestic sale of coal dropped by 7.4 M tonnes or 8.5% within the last 4 years. In spite of the small increase of sale in 2001 comparing to the previous year, there is not reason to assume that in future there will be increase of coal sale. It can be expected [1] that in the nearest future Poland will have a surplus of imported gas, the source of energy very convenient in households. The rising competition with imported coal is forecasted when the conditions of joining by Poland the EU will reduce the existing restrictions in coal import.

Coal export in 1998 was at the level of 27.7 MLN t and decreased to 22.6 M t in 2001 i.e. 18.4%. Overproduction of coal in the world scale makes the export of Polish coal more and more difficult.

Total coal sale in 2001 was 101.8 M t, and was lower than in 1998 by 12.5 M t.

It can be expected then, that the demand for Polish coal will have the decreasing tendency.

In condition of decreasing demand it will be very difficult to keep coal prices at the level of 2001. It can be expected that the prices will not rise more than inflation. It means they will fall down in real terms.

As a result of those unfavourable market conditions, the income from coal sale will decrease.

What is more, if the coal sale is lower the ratio of production capacity utilisation will decrease causing the negative influence on unit cost of sold coal.

Having very small influence on income from coal sale due to external market conditions, the industry has to search for further cost savings.

Costs structure of Polish mining industry

Figure 2 shows the unit costs of sold coal in the years 1998 –2001. Till 2000 year the substantial decrease of the unit costs occurred. In nominal PLN/t the cost of sold cold decreased by more than 11%, while if the inflation is deducted by 24.8%. This can be treated as a very spectacular achievement of the reform. Nevertheless in 2001, in spite of efforts of coal companies, it was impossible to continue the reduction of unit costs of production in real terms. The increase of the cost was equal to inflation. That means, the possibilities of further savings are limited and further reduction of costs is difficult without special commitments.
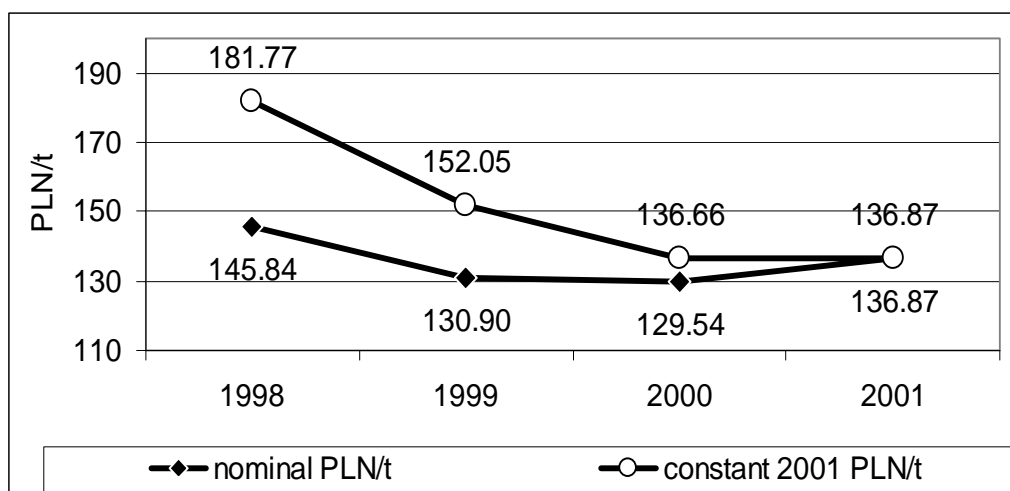

Figure 2. Average unit costs of sold coal in the years 1998 – 2001 in nominal PLN/t and constant 2001 PLN/t.

Rys. 2. Średni jednostkowy koszt sprzedanego węgla w latach 1988 – 2001 w cenach nominalnych i cenach stałych 2001 r.

Looking at the structure of the costs of sold coal (table 1) it can be seen that over 50% of total cost are costs of salaries. The salaries are the 100% fixed costs in condition of stable level of employment, if there is no possibility to adjust working force to the level of production.

Generally, Polish mining industry characterises very high percentage of fixed costs (above 76%). This is why the unit cost of sold coal is very sensitive to the level of production.

The non-salaries costs have already been decreased very substantially and further their reduction seems to be impossible. Looking to the drastic savings done is previous years those cost will rather grow a little faster than inflation.

The further cost reduction can be made on costs of salaries. This element of total costs has been examined in details to find its influence on unit cost of sold coal and finally on unit result on coal sale.

Table 1. Structure of the costs of sold coal and the model of the costs division into fixed
and variable costs on the basis of 2001.

Tabela 1. Struktura kosztów sprzedanego węgla i model ich podziału na koszty stałe
i zmienne na podstawie danych z roku 2001.

| | Specification of cost: | % of total cost | Costs division % | |
			Fixed cost	Variable cost
I.	Salaries	50.8	100	0
II.	Non salaries costs:	49.2	52.7	47.3
1	Depreciation	6.4	100	0
2	Materials	11.6	25	75
3	Energy	6.3	30	70
4	Services	14.7	62	38
5	Taxes and fees	4.1	30	70
6	Other costs	6.1	73	27
III	Total costs of sold coal	100.0	76.7	23.3

Simulation future costs of sold coal

Costs of salaries depend on the number of persons employed in the industry as well as their salaries. In 2001 the average employment was 146,344 persons and the average cost of salaries was 7,071 M PLN. The average cost of salaries per person and year was 48.3 thousand PLN.

The decrease of employment during 2001 took place gradually month by month and in the end of 2001 the employment of mining industry was 142,135 persons. It was lower than the 2001 average. Therefore, in 2002 the industry will benefit from the decrease of employment that took place in previous year, as the salary is to be paid to lower number of persons.

Assuming that market conditions in 2002 will remain stable i.e.

♦ coal sale will be at the level of 2001, and

♦ the rise of prices will be equal to inflation.

Assuming additionally that all costs, including costs of salaries per person, will rise as much as inflation, the total cost of salaries would decrease in 2002 (in constant 2001 PLN) to 6,868 M. PLN or by 2.9%, as a result of 2.9% decrease of average 2002 employment. Unit cost of salaries would decrease form the level of 69.48 PLN/t in 2001 to 67.48 PLN/t. The total unit cost would therefore decrease from 136.87 PLN/t in 2001 to 134.87, and the unit profit on coal sale would increase by 2.00 PLN/t.

The described evaluation may lead to conclusion that coal mining industry has already recovered, leading to the pressure on miners' salaries growth. The growth of salaries is a long lasting postulate of miners and become very strong after the industry achieved the positive financial result.

Table 2 shows the unit profit on coal sale that would be achieved in the years 2002 – 2007, evaluated with the assumption that in next two years salaries will rise 2% above the inflation (scenario 1).

Additional assumptions are:
1. There will not be any further decrease of employment.
2. All other costs will rise 0.5% per year in real terms i.e. 0.5% more than inflation.
3. Coal sale will decrease by 0.5 M t per year.
4. Coal price will decrease till 2005 by 0.5% per year in real terms.

Table 2. The evaluation of unit profit on coal sale in scenario 1

Tabela 2. Oszacowanie jednostkowego zysku ze sprzedaży węgla w scenariuszu 1.

			2001	2002	2003	2004	2005	2006	2007
1	Coal sale	M. t	101.8	101.3	100.8	100.3	99.8	99.3	98.8
2	Cost of salaries	M. PLN	7,071	7,005	7,145	7,145	7,145	7,145	7,145
		PLN/t	69.48	69.17	70.90	71.26	71.61	71.97	72.34
3	Non salaries costs	M. PLN	6,859	6,877	6 ,96	6,914	6,932	6,951	6,969
		PLN/t	67.39	67.91	68.43	68.95	69.48	70.01	70.55
3a	Out of which	Fixed	M. PLN	3,618	3,636	3,654	3,672	3,691	3,709	3,728
			PLN/t	35.55	35.90	36.26	36.62	36.99	37.36	37.74
3b		Variable	M. PLN	3,241	3,241	3,241	3,241	3,241	3,241	3,241
			PLN/t	31.85	32.00	32.16	32.33	32.49	32.65	32.81
4	Total costs of sold coal	M. PLN	13,930	13,882	14,041	14,059	14,077	14,096	14,114
		PLN/t	136.87	137.08	139.33	140.21	141.09	141.99	142.89
5	Coal price	PLN/t	144.45	143.73	143.01	142.29	141.58	141.58	141.58
6	Income on coal sale	M. PLN	14,701	14,556	14,412	14,268	14,126	14,056	13,985
7	Unit profit on coal sale	PLN/t	7.58	6.65	3.68	2.09	0.49	-0.41	-1.31

In table 2 total cost of salaries in 2002 is assumed to be 2% above the cost evaluated in the previous calculation, to take into account the benefit of employment decrease in 2001.

Non-salaries costs are divided into fixed and variable costs. Increase by 0.5% per year of those costs mean the increase of the total fixed costs, why unit cost is a function of coal sale. It also means the increase of unit variable cost by 0.5% per year, while total variable cost is a function of sale.

Total cost of sold coal is a sum of costs of salaries and non-salaries costs.

Unit profit of coal sale is a difference between coal price and unit cost.

The simulation shows that in assumed condition the unit profit on coal sale will vanish very soon.

If the salaries of miners are risen, the industry will loose the profitability within 4 years. The simulation shows that the industry simply cannot effort the increase of salaries.

The next simulation was done to check if without further decrease of employment the industry is able to generate profit on coal sale. Scenario 2 differs from the scenario 1 only by cost of salaries. It remains stable at the level of 6,868 M. PLN in constant 2001 PLN (the level of costs of salaries calculated for the average yearly employment as at the end of 2001).

In this case unit cost of sold coal will rise from the level of 7.58 PLN/t in 2001 to 8.01 PLN/t in 2002, but in next years will gradually decrease to only 1.50 PLN/t in 2007.

The decreasing tendency of unit profit shows that in conditions of worsening market conditions (lowering income from coal sale) the industry will loose its profitability in long term.

There are, therefore, two reasons for decreasing the employment of the industry. The first is to save on costs of salaries. The second reason is that in conditions of decreasing coal sale, production of coal will also be lower and without the decrease of employment the productivity of industry would become lower. Simply there would be too many people to produce coal.

Scenario 3 assumes that the decrease of employment in the years 2002 – 2007 will unsure the stable productivity of the industry. The assumptions concerning sale, prices and non-salaries costs remain as in the previous scenario.

In 2001 the average productivity was 695 t/person/year, but as the benefit of steady decrease the employment in 2001 it would rise to 713 t/person/year. To maintain this productivity while coal production (and sale) decreases by 0.5 M. t/year it is necessary to decrease employment by 1,405

person every second year (table 3), if the miners would leave their jobs gradually during the year. In that case the unit profit on coal sale will decrease from 8.01 PLN/t in 2002 to 3.22 PLN/t in 2007. Lowering unit profit on coal sale shows that such a scenario does not guarantee long term profitability of the industry.

Table 3 Evaluation of needed employment decrease to keep the productivity of industry on a stable level.

Tabela 3. Oszacowanie wymaganego obniżenia wielkości zatrudnienia dla zapewnienia utrzymania wydajności produkcji przemysłu węglowego na stałym poziomie.

			2002	2003	2004	2005	2006	2007
1	Coal sale	M. t	101.3	100.8	100.3	99.8	99.3	98.8
2	Cost of salaries	M PLN	6,868	6,834	6,800	6,766	6,732	6,698
		PLN/t	67.81	67.81	67.81	67.81	67.81	67.81
3	Demanded productivity	t/person/year	713	713	713	713	713	713
4	Demanded average employment	persons	142,135	141,433	140,732	140,030	139,328	138,626
5	Employment at the beginning of the year	persons	142,135	142,135	140,732	140,732	139,328	139,328
6	Employment at the end of the year	persons	142,135	140,732	140,732	139,328	139,328	137,925
7	Decrease of employment	persons	0	1,403	0	1,403	0	1,403
8	Unit profit on coal sale	PLN/t	8.01	6.77	5.53	4.29	3.76	3.22

Having in mind difficulties in achieving positive result on financial operations, mainly because of low financial liquidity of the industry, it is necessary to keep the result on coal sale at the level not lower than the one achieved in 2001.

In the next example (scenario 4) the needed decrease of employment is calculated to keep reach unit profit on coal sale in 2007 equal to the one achieved in 2001 (7.58 PLN/t).

It is assumed that the decrease of employment is stable, month by month and year by year, and that the employment restructuring will finish at the end of 2006.

The calculation is done in constant 2001 PLN.

The calculation start with evaluation of the total costs of salaries that will give 7.58 PLN/t unit profit on coal sale in 2007. The average employment in 2007 is the quotient of the total cost of salaries and the average salary per person per year and is equal to 129 709.
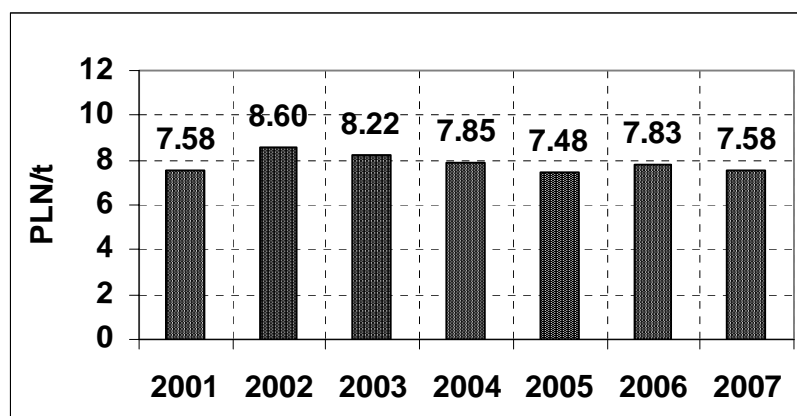

Figure 3. Unit profit on coal sale in the years 2001 – 2007 in scenario 4
(decrease of employment by 2,585 persons per year)
Rys. 3. Jednostkowy wynik ze sprzedaży węgla w latach 2001 – 2007 w scenariuszu 4
(spadek zatrudnienia o 2 585 osób rocznie)

In the end of 2001 there were 142,135 persons employed in coal mining. It means that during 5 years it is necessary to decrease employment by 12,426 persons or about 2,585 persons per year. Comparing to the decrease of employment in the years 1998 – 2001 (nearly 100 thousand persons), the needed decrease of employment in the years 2002 – 2006 is not very significant. If the industry

manage to do so, the unit cost of production, in spite of the decrease of sale, will fall down accordingly to the foreseen decrease of coal prices and the unit profit on coal sale will remain stable (fig. 3)

The results of simulations given here are only the example of the work that is undertaken to evaluate the possible conditions, in which Polish coal mining industry will have to exist in the future.

In shrinking market for Polish coal it is also necessary to continue the process of mines closure. The simulation of cost of sold coal should be done not only at the industry's level but also mine by mine, to unable to choose the less profitable mines for closure and to optimise the further restructuring process.

Conclusions

Polish coal mining industry, after many years of restructuring process, achieved in 2001 positive financial result. This does not mean that the reform of the industry is already finished.

The positive financial result of 2001 may easily vanish in unfavourable market conditions.

Further decrease of coal production cost is needed.

It seems that the slow decrease of employment will be unavoidable in the nearest future. Also, the further restructuring of coal mining industry is needed to adjust the production capacity of mines to future demand for coal.

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Abstract

The paper presents the history of restructuring process of coal mining industry in Poland as well as its present state. In the aspect of expected decrease of demand for Polish coal the possible activities of the industry to keep the profitability of production are searched.

The paper shows how the unit cost of sold coal depends on the level of production. The analysis employs the theory of fixed and variable costs. In unfavourable external conditions of decreased level of production and falling down coal prices, the possibilities of further decrease of costs of sold coal are explored in the paper.

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Symulacja kosztów produkcji węgla w warunkach restrukturyzacji górnictwa

Streszczenie

Artykuł przedstawia historię procesu restrukturyzacji górnictwa węgla kamiennego w Polsce oraz jego stan aktualny. W kontekście spodziewanego obniżenia zapotrzebowania na węgiel poszukiwane są takie działania, które zapewnią opłacalność produkcji węgla.

W artykule przestawiono zależność jednostkowego kosztu sprzedanego węgla od wielkości produkcji. W analizie zastosowano teorię kosztów zmiennych i stałych. W niesprzyjających zewnętrznych warunkach obniżającego się poziomu produkcji i spadających cen węgla w artykule zbadano możliwości dalszego obniżenia kosztów produkcji węgla.