A New Coal Pricing Model Based on EVA in Coal-power Value Chain

Qiang ZHANG
School of Management, China University of Mining & Technology, Beijing, China
Production Command Center, Shenhua Group, Beijing, China
thuqzhang@126.com

Keywords: Coal Pricing, EVA, Value Chain.

Abstract. China began its market oriented coal pricing reform since 2012 but great price fluctuation came with the reform. Government, coal mining companies and power plants are all eager to find a reasonable pricing method which can be accepted by both upstream and downstream of the coal-power value chain. A new pricing method based on the return of capital (which is measured with EVA) is proposed in this paper and minimum, maximum & equilibrium price models are established here. Finally, the 5500cal/kg thermal coal at Bohai Sea is taken as a case and the equilibrium coal price is 518.0RMB per ton than both upstream and downstream of coal-power chain can gain same return per capital invested.

Introduction

In 1978, China began to implement reform and opening up policy, and the economy was changed from planned to market. However, the market reform for energy was significantly later than other industries. Coal pricing reform is actually a progress that the government control declined but market power enhenced. Overall, there have been four coal pricing stages in China: planning pricing, dual-track coal pricing, government guidance pricing and market oriented pricing [1]. At the end of 2012, the National Development and Reform Commission aboished the government guidance pricing policy and the traditional coal ordering annual meeting, recognized as a milestone of market oriented coal pricing.

However, lacking of market pricing experience and methods, China’s coal mining companies and government have been exploring and trying a variety of pricing methods, different in pricing cycle, price makers and pricing models. There have been great fluctuation not only in coal price but also in coal pricing method since 2012. Both upstream and downstream of coal-power value chain look forward to a reasonable coal pricing model to reduce coal price volatility and get a long-term equilibrium price which can be accepted by both sides.

Current Coal Pricing in China and Abroad

Coal pricing is not a problem only for China but also for other countries. It can be seen from fig.1 that coal prices have fluctuated at home and broad since 2012. Rachit Tiwari and S Bhattacharya et al. (2015) discussed coal pricing systems adapted in different countries, but there is no conclusion of a reasonable pricing system [2]. Sermin Elveli (2006) used the hedonic model to analyze 10 thermal power companies in Turkey. The regression results show that coal calorific value and electricity price are important factors influencing coal price [3]. Mithat Uner et al. (2007) used the synchronization equation measurement model to analyze the factors affecting the price of coal in Turkey from 1997 to 2006 in Aegean region. The study found that coal prices rising (decreasing) depends on the decline in coal production (increase) [4]. José C. Reston Filho et al. (2014) established a hybrid model to predict Brazilian energy prices by considering ARIMA and the neural network model [5]. Gyanendra Singh Sisodia et al. (2015) summarized the main models of short- and long-term pricing of energy and the relationship with emerging markets [6]. Anthony Swan et al. (1999) discussed the different between benchmark pricing and the “fair treatment”[7]. Indonesia started the benchmark pricing mechanism
since 2010 and combined four international and domestic price indexes to get the monthly benchmark price. Russia abolished dual-track coal pricing and began market coal pricing in 1993. He Ling-yun, Li Yan (2009) tested the fluctuation characteristics and causality of coal, electricity and oil price, and indicated that there is dual-causality between the coal and electricity price. Chi-Jen Yang et al. (2012) found that high coal prices and capped electricity prices in China discouraged coal-fired power generation, triggering widespread power shortages [8]. Ding Zhihua et al. (2011) discovered the long term influence of coal price fluctuations on the PPI is 0.263%. The corresponding value for the CPI is 0.157% [9].

Figure 1. Coal price fluctuation in China and abroad.

### Propose a New Coal Pricing Model Based on EVA in Coal-power Value Chain

Jan Bejbl and Julius Bemš et al. (2014) proposed a new method for determining the base coal price, consisting of defining the reference fuel chain for electricity and heat production based on brown coal [10]. It was built on the notion that the degree of risk of the involved parties should be reflected in the modified amount of revenue per capital invested. The resulting price is then an economically justified price which encourages a respect for the specific features of the market in question and set the base price of the commodity in a way acceptable for both the extractive and the productive components of the fuel chain. However, the paper just introduced a required return per capital r, but there was no definition and methods to calculate the return per capital.

Based on the research of Jan Bejbl and Julius Bemš et al, this paper introduced EVA and EPA (EVA per capital cost) to measure to return of capital for both upstream and downstream in coal-electricity chain. Then cost volume profit (CVP) analysis was applied to analyse the construction of EVA of coal mining companies and power plants.

Coal-power value chain is defined as follows. It includes coal production, railway transportation, ports, shipping and thermal power generation. We assume that coal mining companies and power plants make coal transaction at ports. Therefore, the coal price discussed in this paper is the FOB price and we just take the 5500cal/kg thermal coal as a benchmark.

Economic Value Added (EVA) was proposed by Stewart in 1980s. It’s the net profit after tax minus capital cost. EVA has been implemented as the core assessment factors for state owned central companies since 2010 in China. In order to unify the assessment and calculation, the SASAC of China issued the “central companies executives operating performance assessment Interim Measures” and defined the formula of EVA as follows.

\[
EVA = Pr - \lambda \cdot A
\]

Where \( Pr \) is the net profit after tax; \( A \) is the total capital, \( \lambda \) is the capital cost rate.

Pr and A are adjusted as follows:
\[ P_r = P_{r0} + (I + R) \times (1 - 25\%) \]  
\[ A = eq + li - cl i - cp \]  
\[ I_R = + + \times − \]  
Where \( P_{r0} \) is the net profit after tax, \( I \) is the interest expense and \( R \) is R&D expensed.

Then we use CVP analysis to establish the EVA formula for coal production companies and power generation companies respectively.

\[ EV_A = p_c q_c - (C_p + C_I) q_c - T_c - \zeta_c + (l_c + R_l) \times 75\% - \lambda_c A_c \]  
Where \( EV_A \) is the EVA of a coal mining company, \( p_c \) is the coal price at ports, \( q_c \) is coal sales volume which we hypothesize that all the coal produced can be sold out at ports, \( C_p \) & \( C_I \) are coal production cost and transportation cost per ton, \( T_c \) is the tax and \( \zeta_c \) is non-recurring gains.

\[ EV_A = p_c q_c (1 - \epsilon) - q_e \delta p_e - q_e C_e - T_e - \zeta_e + (l_e + R_l) \times 75\% - \lambda_e A_e \]  
Where \( EV_A \) is the EVA of one power plant, \( p_e \) is the power price at which power generation sells electricity to State Grid companies, \( \epsilon \) is the service consumption rate of power plants, \( q_e \) is the power generated by power plants, \( \delta \) is coal consumption rate for power generation.

Minimum cost coal price is calculated from the view of the mining company, respecting that the required revenue per capital invested can just cover all the costs associated with the coal mining and transportation. That is \( EV_A = 0 \). Hence, we get the minimum cost coal price \( p_{\min} \).

\[ p_{\min} = \frac{\sum_i (C_p + C_I) q_{ci} + \sum_i (T_c + \zeta_c) - 75\% \times \sum_i (l_i + R_l) + \lambda \sum_i A_i}{\sum_i q_{ci}} \]  

Where \( i \) indicates coal mining companies in the value chain.

Maximum permissible coal price is calculated from the view of the power plants, respecting that the required revenue per capital invested and all the costs associated with the production of power. Hence, we get the maximum permissible coal price \( p_{\max} \).

\[ p_{\max} = \frac{p_e \sum_j q_{ej} (1 - \epsilon_j) - \sum_j q_e C_{ej} - \sum_j (T_{ej} + \zeta_{ej}) + 75\% \times \sum_j (l_j + R_l) - \lambda \times \sum_j A_j}{\sum_j q_{ej} \times \delta_j} \]  
where \( j \) indicates power plants in the value chain.

At last, EPA is introduced into the model to gain the equilibrium coal price. EPA is defined as EVA per capital cost, that is \( \frac{EPA}{\lambda A} = \frac{EVA}{\lambda A} \). The proposed methodology is therefore based on the assumption that the profit is divided in proportion to the capital invested for both coal mining companies and power plants. The equilibrium coal price can then be defined under the condition:

\[ EPA_c(p_c) = EPA_e(p_e) \]  
Where \( EPA_c \) and \( EPA_e \) indicate the EPA for all the coal mining companies and power plants respectively. Hence, we can get the formula of equilibrium coal price \( p_0 \).

\[ p_0 = \frac{A_c (l N_c - C_p - T_c - \zeta_c + 0.75T_{c} + 0.75\zeta_{c} - 0.75I_{c} - 0.75I_{c}) - A_e (C_p + C_I + T_c + \zeta_c - 0.75I_{c} - 0.75I_{c})}{A_c Q_c + A_e Q_e} \]  

Where \( A_c \) and \( A_e \) are the capital of all coal mining companies and power plants in the value chain respectively. \( Q_c = \sum_i q_{ci} \) is all the coal sold. \( Q_e = \sum_j q_{ej} \) is all the power generated.
\[Q_{ec} = \sum_j q_{ej} \delta_j \] is all the coal consumed by power plants. \[C_{e}^+ = \sum_j q_{ej} C_{ej}^+ \] is all the cost of power plants except coal cost. \(T_c^+\) and \(T_e^+\) are the total tax of coal mining and power generation respectively. \(\xi_c^+\) and \(\xi_e^+\) are the total non-recurring gains respectively. \(C_p^+\) and \(G_t^+\) are the total production and transportation cost of coal mining companies. \(I_c^+, I_e^+\) & \(R_c^+, R_e^+\) are the interest expenses and R&D expenses of coal mining companies and power plants respectively.

**Case Study**

Ports around Bohai Sea is the most important hub for coal transaction and transportation. The coal price in these ports is taken as the price flag of China coal prices. In these ports, the four olygopoly coal companies are Shenhua, China Coal, Datong coal, Yitai and their market share is more than 70%, indicating that the region’s CR4 can reach more than 70%. There are many power plants in the coal transaction market, but the Five power plants and the Six coastal power plants are the most important downstream users in the value chain and they are the main participators in coal price negotiation. Actully, five power plants and the six coastal power plants are just different classification and there are totally seven power plants here among them. Hence, the four coal mining companies and seven power plants (Huaneng, Huadian, Datang, Guodian, Shanghai Dianli, Zhejaing Dianli and Guangdong Dianli) are selected to representative upstream coal mining and downstream power generation industry respectively. All the data used are from their published 2015 annual financial report. We just calculate the price of 5500cal/kg thermal coal.

![Figure 2. Min, max and equilibrium coal prices at Bohai ports.](image)

The result can be seen from fig.2 that the minimum cost coal price \(p_{min}\) is 456.8RMB/t, and the maximum permissible coal price \(p_{max}\) is 666.9RMB/t. Hence, the upstream and downstream companies can negotiate in the price interval from 456.8 to 666.9RMB/t. The equilibrium price is 518RMB/t, where both coal mining companies and power plants can gain the same return per capital and the return is 1.0 which means they can gain 1.0 from 1.0 capital cost.

According to CVP analysis, the total fixed cost of coal enterprises does not change with the sales volume, so when the sales volume changes, the unit fixed cost will be changed accordingly. As a result, the unit cost of coal production increases when sales volume declined. In this paper, the material, power, fuel, labor and other cost items are taken as variable cost items, and others as fixed costs. Assuming the total coal volume in 2015 as a benchmark level of 100%, we calculate the coal price when coal volume declines to 90% and 80% respectively.
It can be seen from the results that the minimus price and equilibrium price will rise when coal production volume decrease. Because the price should rise to make up the loss of volume declined to make sure that the profit can cover all the costs.

**Summary**

China government, coal mining companies and power plants all want to discover a coal pricing method and an equilibrium price which can be accepted by both upstream and downstream in coal-power chain to reduce price fluctuation and stablize the value chain. This paper proposes a new pricing method base on the return of capital for both upstream and downstream. We take EVA and EPA to value the return of capital invested. Repecting on the view that both upstream and downstream in coal-power value chain shoul get the same return from capital invested, we established the minimum price, maximum price and equilibrium price model. Finally, 5500cal/kg thermal coal at Bohai sea ports was taken as a case to test the three piring models. The result showed that the price interval for coal companies and power plants negotiaton is from 456.8 to 666.9RMB/t, and both upstream and downstream can gain the same return per capital at the price of 518.8RMB/t. However, the minum and equilibrium prices will rise if coal production volume declines because coal mining companies have to gain more profit from price to make up the profit loss from volume declined.

**References**


