

Research on Optimal Cut Coal Production Overcapacity Output in Coal-Rich Province of China

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Abstract. Recently, global economy is undergoing a structural change. The current world economic structure is mainly characterized by low growth rates in the economy, investment and trade, as well as low coal prices, interest rates and inflation. Overcapacity is a problem in many traditional industries. With the deterioration of overcapacity in coal-rich province of China, how to reduce coal production overcapacity is becoming an urgent problem to be solved. China's coal market is still under the pressure of excess production capacity, the structural overcapacity has not been completely resolved. The coal industry is highly market-oriented, so the market mechanism plays an important role in the market downturn performance. Based on the Cournot competition model, this paper obtains the optimal cut coal production overcapacity output of coal production enterprises, the scenario of each firm enters the market in normal coal production capacity is analysed, in excess coal production capacity scenario without or with cut coal production overcapacity output. The analysis as show that: optimal cut coal production overcapacity output is the optimal choice for coal production enterprises in coal-rich province of China.

1. Introduction

World economy is currently undergoing a major structural transformation focused on achieving better quality growth that is more economically and environmentally sustainable, meanwhile, many industries serious excess capacity problems had serious negative effect on economic and social development. Overcapacity is a problem in many traditional industries. Through certain government and market measures to solve the excess capacity, it can alleviate the social problems caused by corporate bankruptcy caused by coal production overcapacity.

It is widely recognized that policy can play a central role in economic theory. Broadly speaking, they can be categorized as (i) direct, and (ii) indirect. Direct policies have been a key element in recent growth literature [1,2]. Indirect policies can be classified into monetary and fiscal policy. The former,



have been extensively used in the context models to explain some puzzles impact on growth [3-5], and asset prices [6-8]. Fiscal policy has been used in the context of welfare improving [9-10].

In this paper, a capacity competition model is developed in normal and excess capacity environmental. Cut coal production overcapacity output is one of direct policies. Without cut coal production overcapacity output, firms will reduce profits or even loss in excess capacity environmental. Recently, several researchers have examined cut coal production overcapacity output in coal and showed that the results are drastically changed [11]. However, existing researches did not consider optimal cut coal production overcapacity output [12].

2. Modeling

Consider coal industry with a large number of symmetric final goods producers. There are m firms that compete in quantity. The firms produce homogeneous products and compete in Cournot competition model. Firm $i=1, \dots, m$ is a producer.

Let superscript N denote the equilibrium output in normal coal production capacity scenario, assume that the inverse demand function is $P^N = a - bQ^N$, where P is Price, Q is the total output, a , b is constant. Also, let superscript E denote the equilibrium output in excess capacity environmental without cut coal production overcapacity output, assume that the inverse demand function is $P^E = r - bQ^E$, r is constant and $r < a$. At last, let superscript EC denote the equilibrium output in excess capacity environmental with cut coal production overcapacity output, assume that the inverse demand function is $P^{EC} = r - bQ^{EC}$.

Assume that when excess capacity occurs, the government adopts cut coal production overcapacity output to resolve excess capacity. The marginal production cost is $d > 0$. When each firm obtains maximum profit in normal coal production capacity scenario, the total output is Q^N . When each firm's form normal capacity to excess capacity without cut coal production overcapacity output, the total output is Q^E . When each firm obtains maximum profit in excess capacity environmental with cut coal production overcapacity output, the total output is Q^{EC} . Optimal cut coal production overcapacity output C is the normal capacity optimal output subtracts the excess capacity with cut coal production overcapacity output optimal output.

$$C = Q^N - Q^{EC} \quad (1)$$

The cut coal production overcapacity output results in changes as following. First, the total output reduces. Second, the market prices will increase. Third, the firms choose their outputs to maximize their profits.

3. Analysis

3.1. In normal coal production capacity scenario

If m final goods producers enter the market in normal coal production capacity scenario, the final goods producer maximizes profit is

$$\text{Max} \pi_i^N = q_i^N (a - b \sum_{i=1}^m q_i^N) - q_i^N d \quad (2)$$

Equilibrium output of i firm is

$$q_i^N = \frac{a - d}{(m + 1)b} \quad (3)$$

Market price of i firm is

$$p^N = \frac{a + md}{m + 1} \quad (4)$$

Profit of i firm is

$$\pi_i^N = \frac{(a-d)^2}{(m+1)^2 b} \quad (5)$$

Thus, in normal coal production capacity scenario, total output is $Q^N = \sum_{i=1}^m q_i^N = \frac{m}{m+1} \frac{a-d}{b}$, total

$$\text{profit is } \pi^N = \sum_{i=1}^m \pi_i^N = \frac{m}{(m+1)^2} \frac{(a-d)^2}{b}.$$

3.2. In excess coal production capacity scenario

3.2.1. Without cut coal production overcapacity output. If m final goods producers enter the market in excess coal production capacity scenario without cut coal production overcapacity output. Output of i firm is

$$q_i^E = q_i^N = \frac{a-d}{(m+1)b} \quad (6)$$

Market price of i firm is

$$p^E = r - bQ^E = \frac{r + md + m(r-a)}{m+1} \quad (7)$$

Profit of i firm is

$$\pi_i^E = \frac{(a-d)(r-d+m(r-a))}{(m+1)^2 b} \quad (8)$$

Thus, each firm in excess coal production capacity scenario, without cut coal production overcapacity output, total output is $Q^N = \sum_{i=1}^m q_i^N = \frac{m}{m+1} \frac{a-d}{b}$, total profit is

$$\pi^N = \sum_{i=1}^m \pi_i^N = \frac{m}{(m+1)^2} \frac{(a-d)(r-d+m(r-a))}{b}.$$

Proposition 1. When each firm form normal capacity to excess coal production capacity scenario, without cut coal production overcapacity output, the market price will decline, the profit will reduce.

Proof. Follows form(4)and(7),comparing p^N and p^E , because $r < a$, have $\frac{r + md + m(r-a)}{m+1} < \frac{a + md}{m+1}$. Follows form(5)and(8),comparing π_i^N and π_i^E , because $r < a$, have

$$\frac{(a-d)(r-d+m(r-a))}{(m+1)^2 b} < \frac{(a-d)^2}{(m+1)^2 b}.$$

3.2.2. With cut coal production overcapacity output. If m final goods producers enter the market in excess coal production capacity scenario with cut coal production overcapacity output, the i final goods producer maximizes profit is

$$\text{Max} \pi_i^{EC} = q_i^{EC} (r - b \sum_{i=1}^m q_i^{EC}) - q_i^{EC} d \quad (9)$$

Equilibrium output of i firm is

$$q_i^{EC} = \frac{r-d}{(m+1)b} \tag{10}$$

Market price of i firm is

$$p^{EC} = \frac{r+md}{m+1} \tag{11}$$

Profit of i firm is

$$\pi_i^{EC} = \frac{(r-d)^2}{(m+1)^2 b} \tag{12}$$

Thus, in normal coal production capacity scenario, total output is $Q^{EC} = \sum_{i=1}^m q_i^{EC} = \frac{m}{m+1} \frac{r-d}{b}$,

total profit is $\pi^{EC} = \sum_{i=1}^m \pi_i^{EC} = \frac{m}{(m+1)^2} \frac{(r-d)^2}{b}$.

Proposition 2. When each firm in excess coal production capacity scenario, cut coal production overcapacity output, the market price will rise, the profit will increase.

Proof. Follows form(7)and(11), comparing p^E and p^{EC} , because $r < a$, have $\frac{r+md}{m+1} > \frac{r+md+m(r-a)}{m+1}$. Follows form(8)and(12), comparing π_i^E and π_i^{EC} , because $r < a$, have $\frac{(r-d)^2}{(m+1)^2 b} > \frac{(a-d)(r-d+m(r-a))}{(m+1)^2 b}$.

3.3. Optimal cut coal production overcapacity output

From equation (3), the reachable matrix is available:

Optimal cut coal production overcapacity output C is

$$C = Q^N - Q^{EC} = \frac{m}{m+1} \frac{a-r}{b} \tag{13}$$

Optimal cut coal production overcapacity output is illustrated in Figure 1.

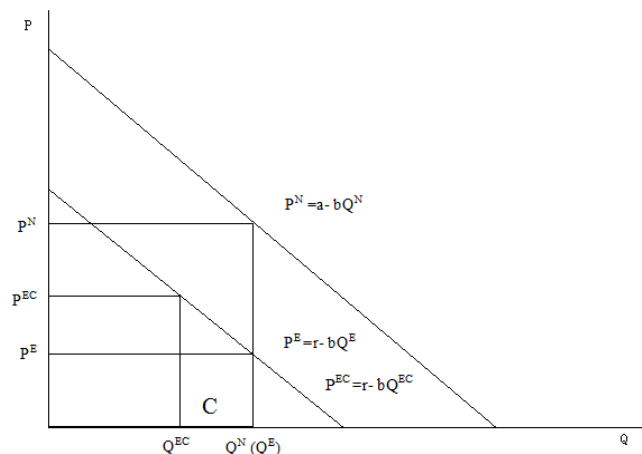


Figure 1. Optimal cut coal production overcapacity output.

Proposition 3. When each firm form normal capacity to excess coal production capacity scenario, the total output excess, if each firm wants to get the maximum profit, optimal cut coal production overcapacity output is the normal capacity optimal output subtracts the excess capacity with cut coal production overcapacity output optimal output.

Proof. Follows form(3)and(10),comparing Q^N and Q^{EC} , because $r < a$, have $\frac{m}{m+1} \frac{r-d}{b} < \frac{m}{m+1} \frac{a-d}{b}$. Q^N is the normal capacity optimal output ,and Q^{EC} is the excess capacity

with cut coal production overcapacity output optimal output ,we have $C = Q^C - Q^{EC} = \frac{m}{m+1} \frac{a-r}{b}$.

4. Conclusion

In this paper, the scenario of each firm enters the market in normal coal production capacity is analysed, in excess coal production capacity scenario without or with cut coal production overcapacity output. The analysis as show that: optimal cut coal production overcapacity output is the optimal choice for coal production enterprises in coal-rich province of China.

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