

Analysis of Factors Influencing the Volatility of Coal Industry Development Under the Double Carbon Policy

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Abstract: At present, the global carbon dioxide concentration is approaching the threshold, and the climate problem is more prominent than ever, which seriously threatens people's daily life. The value of coal is constrained by many aspects, including coal mine cost, international coal transportation price, macroeconomic policies of the world, global coal price, coal mine inventory, and the rising price of alternative resources, etc. This article focuses on the supply and demand situation and policy measures of the world coal industry to study the main reasons affecting the supply and demand situation and price changes of the world coal industry, and put forward relevant suggestions, in order to provide some reference and significance for the development of coal industry. This article focuses on the supply and demand situation of the world coal industry and the policy measures, and puts forward relevant suggestions, with a view to providing certain reference and significance for the development of the coal industry.

Keywords: Coal market; Industry fluctuations; Policy recommendations; Carbon dioxide.

1. Introduction

At present, the global carbon dioxide concentration is approaching the threshold, and the climate problem is more prominent than ever, which seriously threatens people's daily life, in response, all countries in the world have accelerated the low carbon development of energy.

In September 2020, General Secretary Jinping Xi clearly put forward the 3060 targets at the 75th United Nations Congress, which ushered in a historic turn in China's carbon emission reduction. 3060 targets specifically mean that China should achieve carbon peak in 2030 and carbon neutral in 2060, and the "double carbon" strategy has elevated China's green development path to a new height. The "double carbon" strategy has elevated China's green development path to a new level, which is of great significance for coping with the world's great changes, establishing a community of human destiny, and promoting the harmonious development of man and nature.

China is a major energy consumer, and coal, as one of the most important primary energy sources in China, consumes more than 70% of the primary energy. Therefore, coal is closely related to China's trade development, economic construction and other aspects, and has a direct relationship with the development of the national economy. In the past, the large amount of unreasonable consumption of coal has caused a series of environmental problems, and in this situation the country began to implement a double carbon policy to speed up energy saving and emission reduction. At the same time, China's economy still needs to develop, and the current development of new energy is not enough to support the rapid development of China's economy, which means that coal cannot be completely replaced, the coal industry is still related to all aspects of China's development. With the introduction of "carbon peak" and "carbon neutral" targets and related policies and programs (see Table 1 for a summary of China's dual carbon policies), the volatility of the coal industry, as an important part of China's energy structure, has become an issue of concern while upgrading technology and developing

new energy sources. As the world's largest developing country and the world's largest carbon emitter, it is a very difficult task for China to accelerate both development and emission reduction. At the same time, China is accelerating the construction of a socialist modernization country, and the dual carbon target is the key to accelerate the construction of ecological civilization and promote high-quality development in China, as well as the key to determine the next development direction of the coal industry.

Table 1. The combing of national policies on double carbon

Date of introduction	Policy name
2020.09	<Seventy-fifth General Debate of the United Nations General Assembly>
2020.12	<White Paper on China's Energy Development in a New Era>
2021.02	<Measures for the Administration of Carbon Emission Trading (Trial Implementation) >
2021.03	<Carbon Neutral Action Plan for Carbon Peaking>
2021.06	<The First High-level Forum on "Joint Action for Carbon Neutrality" >
2021.10	<Action Plan for Carbon Neutrality by 2030>
2022.01	<Comprehensive Work Plan for Energy Conservation and Emission Reduction in the 14th Five-Year Plan>
2022.10	<Notice on Piloting Carbon Emission Evaluation in the Environmental Assessment of Industrial Park Planning>
2022.11	<Guiding Opinions on Accelerating the Establishment of a Sound Economic System for Green, Low-Carbon and Circular Development>
2022.11	<Guiding Opinions on Coordinating and Strengthening Work Related to Climate Change Response and Ecological Environmental Protection>
2022.12	<The 14th Five-Year Plan for Ecological and Environmental Monitoring>

In summary, it is necessary to analyze the changes in the

traditional energy industry under the double carbon constraint and provide them with new measures to optimize the industrial structure. The implementation of the dual-carbon goal in the coal industry needs to be considered in an integrated manner and adapted to local conditions. It is crucial to explore the fluctuations of the coal industry under the double carbon constraint, and to find out the factors affecting the fluctuations of the coal industry and the linkages between them, in order for the coal industry to meet the next challenges. In this paper, from the perspective of national development strategy, we study the factors influencing the volatility of coal industry development under the double carbon constraint in four aspects: price, cost, production, and revenue, and provide relevant basis for the adjustment of national energy policy.

2. Analysis of factors affecting the volatility of coal industry development

2.1. Analysis of Coal Price Influencing Factors

The value of coal is subject to many constraints, including coal mine costs, international coal transportation prices, macroeconomic policies of countries around the world, global coal prices, coal stocks, the rise in the price of alternative resources, etc., because there are commodities have prices, and the most fundamental reason affecting the world commodity prices is the issue of supply and demand, with the introduction of various environmental protection measures in recent years, the price of coal as a non-clean resource will also be subject to Therefore, this article focuses on the supply and demand situation of the world coal industry and the policy measures to study the main reasons affecting the supply and demand situation and price changes in the world coal industry.

1)Supply and demand

(1) Coal mine production capacity is the most important reason for coal supply and demand, it is the core of supply side to determine coal supply and demand. At present, due to the excessive production of coal in China, it is easy to cause overcapacity, and also easy to lead to the downward movement of coal prices.

(2) The net import of coal is another element to reflect the supply level of coal, which is by directly reflecting the supply of coal, thus affecting the price of coal products.

(3) Coal demand is a fundamental factor on the supply and demand side that governs the direction of coal prices, and determines coal price trends on a larger scale. High coal consumption will cause a tight market supply, which will lead to higher coal prices; conversely, the market is depressed, and coal prices will fall.

2) Cost factors

Coal production costs directly affect the supply side of coal. Coal production costs are mainly divided into mining costs and transportation costs, production costs rise, coal companies can hardly afford, will inevitably share the risk to consumers by increasing the price of coal, and this leads to an increase in prices.

3) Industry concentration

Industrial concentration refers to the degree of dominance of a few enterprises in a certain industry in the market in terms of production volume, sales volume, total assets, etc. Coal industry concentration, is another important factor affecting the price of coal, and play an important role in the role of coal supply and demand factors. With too many coal producers, in a highly fragmented market structure, any coal company is a

passive recipient of market prices, and the high or low price of coal is determined entirely by supply and demand. On the contrary, under a completely monopolistic market structure, the only coal enterprise will be the dominant price taker, while under a fully competitive market structure, coal prices face a certain degree of uncertainty [1].

4) Other energy prices influence

Coal, oil and natural gas have become the main components of China's economy and the world's energy structure, and to some extent, the three may be substitutes for each other. Especially with the increasing global climate change issues, optimize the energy consumption structure, reduce human dependence on coal resources, has become an important initiative in energy conservation. Therefore, as the traditional coal alternative products such as oil, natural gas and other new energy products price changes, will also have an important impact on global coal prices.

5) The impact of government policies

In order to promote economic development and energy conservation and emission reduction, improve the urban atmosphere, China has introduced various aspects of environmental protection preferential policies, but with the expansion of China's regulatory scope, coal prices have been greatly affected, especially at present, China's environmental protection capacity has reached or even close to the upper limit, so the price of coal by China's energy conservation and emission reduction preferential policies and carbon emission reduction measures are also more influential.

Supply and demand is the main factor affecting coal prices, coal prices are below cost period, coal mines into losses, naturally will reduce investment, supply reduced to a certain extent, there will be an oversupply, prices rise; coal prices are above cost period, investors profitable, naturally increase investment, supply increased to a certain extent, there will be more than demand, prices fall [2].

2.2. Analysis of Coal Cost Influencing Factors

At all times, risk management is the core of enterprise management, for coal enterprises, cost reduction is to reduce risk, coal cost issues have always been the most important issue in the industry, especially after the introduction of the double carbon policy, the coal industry is in urgent need to find a new way out, so it is urgent to analyze the cost impact factors and find ways to reduce costs and increase efficiency. The main factors that affect the cost of coal are

1)Natural factors

Coal belongs to natural factors, and coal mining belongs to underground work. The storage depth of coal in the underground, the surrounding geological environment, etc. will have an impact on the mining of coal. In the actual operation, we need to carry out reasonable mining according to different situations, such as the use of machinery, the construction of safety measures in the mine, etc. Machinery and equipment is an important power in the operation, so the use of machinery and equipment determines the work intensity and efficiency of workers, if less equipment is used or the equipment used is not advanced enough, it will increase the intensity of labor and affect the efficiency of material utilization, so that the final cost of mining will increase, and the cost of high efficiency machinery and equipment will also increase [3]. And as the mining depth increases, problems such as pressure, temperature, gas, and gushing water in the mine also require the implementation of appropriate measures, and the cost of building a safe working environment in the

mine increases accordingly. And these problems will also have a corresponding impact on the surrounding environment, which will make the subsequent environmental management, compensation and other costs increase.

2) Technical factors

Under the goal of "double carbon", the integration of life-cycle green mining with information technology and intelligence is an important driving force to achieve green and efficient mining. The use of intelligent working face mining, the integration of ground settlement data, and the application of new technologies and equipment can establish a sound green low-carbon cycle development system and reduce energy and material consumption. Use intelligent working face monitoring information, use big data to monitor coal mining disasters, and promote green and low-carbon construction and safe and efficient production side by side. In order to solve the surface collapse, waste rock tailings environment broken ring, filling mining technology is a good technology is highly affirmed, can further liberate the "three under mining (under the building, under the road, underwater)" coal pressure problem, not only can make difficult to mine coal guess out, but also can reduce impact ground pressure and other underground power disaster, and play an important role in coal gangue and other solid waste disposal. The coal gangue and other solid waste disposal plays an important role. However, the filling mining technology has many processes and high requirements, and the production cost increases accordingly, and the production efficiency decreases [4].

3) Social factors

Social factors mainly include local industrial policies, tax policies and the price of raw materials and labor required in coal mining, because these are unavoidable, so it is difficult to reduce the cost of enterprises by improving these factors. And the environment after mining or accidents in mining of the enterprise will also be widely concerned by the society, and need to invest a lot of money in safety and environment.

4) Transportation cost

The transportation of coal in China is mainly based on railroad transportation (direct railroad and combined railroad and water transportation), supplemented by road transportation. From 2019 onwards, the adjustment policies of railroad freight rates for whole trucks of various road bureaus have been launched continuously, and although the freight rates of some national and local railroads have been reduced, most of them are less than expected and have limited impact on the market, while the rates and miscellaneous railroad charges of different railroads are different, such as spot loading charges, delay charges and over-ton freight charges. Because the coal mining place is generally remote, the transportation distance to all parts of the country is long, and the loss in the transportation process will also make the cost increase. Therefore, the price of coal has been high and remains the largest part of the cost of coal [5].

5) Labor cost

Under the "double carbon" policy, in order to achieve carbon neutrality and environmental protection, as well as to achieve the competitiveness and sustainable development of coal enterprises, enterprises insist on introducing high-tech talents and management talents to upgrade their mining technology and management ability, and realize intelligent, unmanned and green mining. In the current distribution of talents in the market, there is a shortage of intelligent, information technology and other coal high-quality talents,

and coal enterprises in special production environments have been facing a shortage of talent loss, which has an impact on the upgrading of enterprise equipment, maintenance, technical services, etc. This year, the talent training programs of each coal enterprise came out one after another, and each university cooperated with each other to deeply implement the strategy of strengthening enterprises with talents, and increase the introduction and training programs of each enterprise's management, professional and technical and high technology talents to provide talents and intellectual support for the high-quality development of the enterprise [6].

6) Environmental Costs

The environmental management cost of Chinese coal enterprises increases with the increase of mining years, and the environmental pollution is serious. With the national strategy of sustainable development and green development, enterprises pay more attention to environmental management, and the cost of management has increased greatly. And the environmental management cost as long as it includes ex ante environmental cost, ex post environmental cost and ex post environmental cost. The ex-ante environmental cost is the cost of protecting and preventing the ecological environment from being damaged, and directly avoiding environmental pollution and environmental accidents from the source to a certain extent, such as making corresponding protection measures for the surrounding environment by early survey. The environmental cost in the matter is mainly in the coal opening, the management of ventilation, dust, gas and water resources in the mine, and the construction of a good underground coal mining environment. Using the self-recovery ability of the surface ecosystem, supplemented by artificial measures, the damaged ecosystem is gradually restored or the ecosystem is made to develop in the direction of a virtuous cycle to create a pleasant surface ecological environment [7]. And the ex-post environmental cost is simply the cost of repairing the damaged environment after the completion of coal mining, such as surface collapse, landslide, and restoration of green vegetation. The research and development of various environmental management technologies and the cost of environmental management lead to increased costs.

In terms of coal cost, the cost of coal has been increasing year by year in recent years. The double carbon target mainly affects the three aspects of labor cost, mining technology cost and environmental management cost. Coal companies promote green mining technology, promote intelligent and mechanized unmanned mining, introduce a large number of talents to innovate technology, fully implement the policy of pollution prevention and good management of the environment affected by mining.

2.3. Coal production

The study of coal production is one of the important directions to further analyze the influencing factors of coal industry development volatility.

Due to the implementation of the national policy of carbon neutrality and carbon peaking, how to green development and green production increase in the coal industry has become an urgent problem for the coal industry in the new period. At present, the optimization and transformation of China's coal industry has achieved certain results, but the problems of energy supply security, insufficient succession industries, and lack of fundamental technical support for the industry still need to be solved. Factors affecting the amount of fluctuations

in coal production are mainly the following six indicators:

1) Coal prices

In recent years, China's various types of coal prices are rising, of which, anthracite lump coal prices change the most, the price of coke rose the least. Affected by the rising prices, coal production is also climbing. Some studies show that, in general, coal prices can affect coal production, but coal production cannot affect coal prices.

2) Production capacity

Production capacity has a significant positive impact on coal production. Coal cost, coal reserves and mine investment jointly determine production capacity. From the perspective of coal cost, excessive cost will affect coal production, the higher the cost, the lower the production capacity and thus the lower the production. From the perspective of coal mineable reserves, coal mineable reserves are influenced by coal reserves and coal mining rate. The factors affecting coal reserves and resources are mainly geological conditions, mining technology and market demand, etc. The size of mining rate is directly related to the production capacity and annual mining volume of the mine. Finally, analyzed from the aspect of mine investment, mine construction investment is a part of fixed asset investment, the size of both investments is mainly influenced by the loan volume, the loan volume of coal enterprises is mainly influenced by the government's interest rate, monetary policy, environmental protection policy and the loan rate.

3) Gross Domestic Product

Since the founding of the People's Republic of China, China's economy has continued to develop and GDP has been climbing, GDP growth has driven coal production to increase, and GDP and coal production basically move in the same direction. There is still a long-term equilibrium relationship between coal production and economic growth, and from the theoretical perspective of China's economic growth and energy, China's high economic growth is inextricably linked to high energy consumption, and the energy consumption grows while the economic growth rate increases [8].

4) Coal supply and demand relationship

There are about 5000 mines in China and the supply of coal is large. Due to the structural transformation and upgrading of the coal industry implemented by the state, China's raw coal production began to decline in 2014 and fell to the lowest point in the past decade in 2016, after which it began to rise gradually, and by 2022, the coal supply protection policy continues to take effect, the release of advanced production capacity is basically completed, coal production has increased significantly, and supply and demand tend to be balanced. At the same time, China's coal consumption is also increasing, in 2022, China's total annual energy consumption of 5.41 billion tons of standard coal, of which, coal consumption accounts for 56.2% of total energy consumption. From the current data of coal supply and total consumption, supply and demand are close to balance, therefore, coal companies should review the situation, control production and accurately grasp the market demand.

5) Technology level

Coal industry to break the key core technology problems on the road to high precision still need to work. In the short term, the level of technology will not change greatly, thus not affecting the current coal production. However, in the long run, the improvement of technology level will bring about the reduction of coal production cost and the improvement of production efficiency, thus increasing coal production.

6) Industrial structure

Based on the current development of China, the proportion of the secondary industry, especially the industrial sector, is relatively large, thus determining the larger demand for energy consumption in China, especially for coal. The energy consumption index of the secondary industry is much larger than that of the primary industry and the tertiary industry. With the introduction of the double carbon target, China's industrial structure is further transformed and upgraded, coal enterprises start to green transformation, the tertiary industry keeps growing, and the increase of the proportion of tertiary industry has a great impact on coal consumption, which will reduce coal production.

2.4. Coal Profit

Under the influence of the "double carbon" policy, the volatility of coal industry profits gradually emerges, high energy-consuming industries are facing production restrictions or environmental reforms, and the coal industry is also facing a tight supply-demand balance. We study coal profits as one of the influencing factors of coal industry and explore its relationship with national or regional economic level, coal production capacity, coal supply, coal demand, coal price, etc. The study by Zhao Li and Li Gang also showed that both coal profits and their influencing factors have a long-term equilibrium relationship before and after the capacity reform, and, after the reform, coal profits growth is affected by various factors, and the prediction error on coal profits growth increases [9]. Therefore, the research related to the influencing factors of coal profits has certain reference value and significance.

1) Cost of coal

According to the formula for calculating profit: profit = total sales price of the product - cost. In this formula, the factors affecting profit include the total price of the product and the input cost. Coal is a commodity with relatively low unit value, and the proportion of distribution costs such as transportation and storage is large. Usually, the distribution costs such as transportation and storage costs will account for more than 31% of the selling price, and the increase of coal-related costs increases the cost of coal, and the increase of coal costs erodes the profitability of coal enterprises. In recent years, the country is making efforts to minimize its impact by upgrading science and technology and building more railroad lines. In addition, environmental costs and mining costs also fluctuate due to factors such as the gradual reduction in the number of coal mines requiring more searching for new mines and the gradual intelligence and automation of mining, which have an impact on the cost of coal and thus affect the fluctuating changes in coal profits.

2) Coal price

The price of coal directly determines the level of profitability of the coal industry [9], 60%-70% of the production cost of coal is composed of fixed costs, therefore, in the case of falling coal prices, coal companies will not easily limit production. Therefore, when coal prices fall, it is difficult for the coal industry to reduce variable costs by reducing production and thus keep profits unchanged. At this time, the imbalance between supply and demand will lead to a further decline in coal prices, causing more coal companies to fall below the break-even point [10], which will inevitably cause fluctuating changes in coal profits in such a situation.

Based on the coal market and using it as a basis, Xie Ying proposed a cost-profit model for thermal power plants and

used the model to conduct a tariff sensitivity analysis of the changes in cost-profit of thermal power plants under different proportional increases in coal prices: with the government setting the feed-in tariff, the increase in coal prices further compresses the profitability of thermal power plants and even

results in losses phenomenon. When the coal price increased by 20%, the return on assets of the thermal power plant was 1.68%, which was close to zero, and when it increased by 33%, a loss was incurred [11]. This shows that coal prices directly affect the level of coal profits.

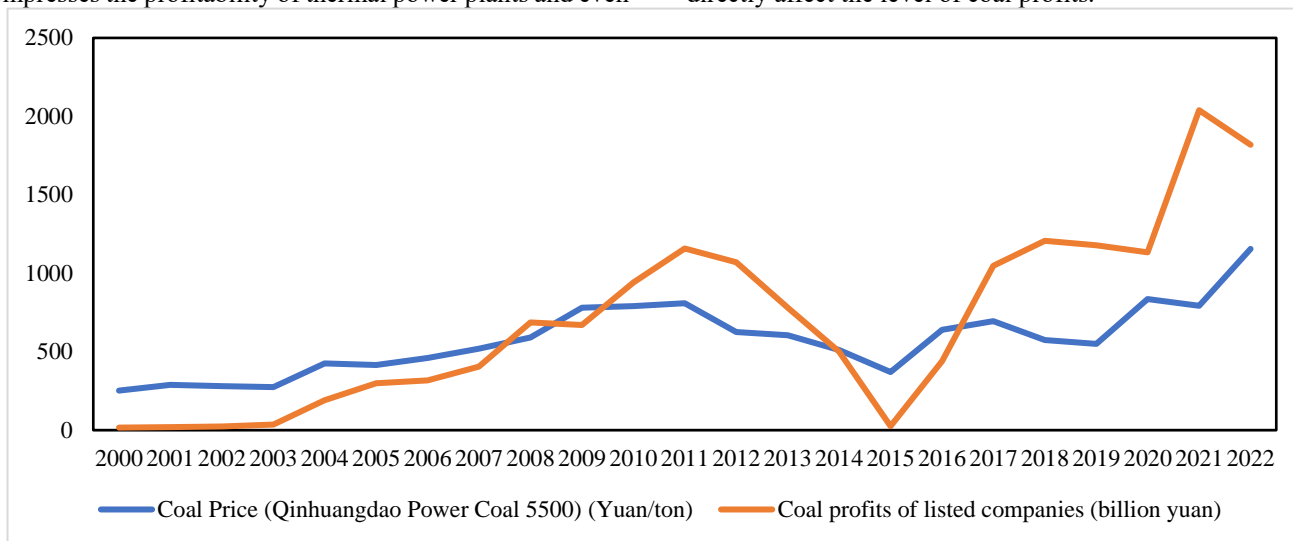


Figure 1. Coal price and coal profit comparison from 2000-2022

3) Coal demand

In the performance forecast of the first half of 2022, the demand of coal market is gradually rising and the price is also rising, which makes the performance of many listed companies in the coal industry, such as Jinjiang Control Coal and Shanxi Coking Coal, to get substantial growth.

The power industry is the most consumed industry among the four major coal-using industries in China. Although new energy sources such as natural gas are being developed gradually and the trend is great, but because its price is too high and still rising due to the disturbance of many factors, coupled with the difficulty of mining or not abundant enough, the national demand for coal will even rise instead of fall, making coal profits fluctuate and change as a result.

4) Economic level (GDP)

There is a certain correlation between the GDP growth rate and the profitability of coal enterprises. However, there is a big gap between the GDP growth rate and the profit of the coal industry from 2014-2016, which is mainly because of the serious overcapacity of coal in that year, which led the coal industry into an industry-wide loss [10].

5) Product structure

In the case of similar input costs, which product has higher price and lower cost, the corresponding profit will be bigger, and vice versa, the profit will be smaller, the change of product structure directly affects the value of the product, and then has an impact on the price and even profit of the product. It can be seen that the structure of the product directly affects the profit of the enterprise.

6) Freight and labor cost

Due to the continuous changes in traffic conditions, special circumstances and human resources, prices and other factors, resulting in changes in the cost of coal sales process, the coal industry profits fluctuate.

7) Research investment

The increase in research investment increases profits and has a larger regression coefficient for the same unit of measure. On the one hand, the increase in research investment accelerates the optimization of technology and makes products more competitive, and on the other hand, technology

has a diffusion effect, which improves the productivity and profitability of the whole industry.

In addition, it is found that there are relatively few studies on the influence factors of coal profitability, and there is no literature on coal profitability under the double carbon constraint. Therefore, this study is of practical significance to analyze the volatility of coal industry through price, cost and profit factors in the context of "double carbon".

3. Policy Recommendations

There are many factors affecting the development of China's coal industry, and the relationship is very complex. We extract the most critical factors affecting the development of China's coal industry, and make suggestions for the future development of the coal industry.

First, accelerate green low-carbon technology research and development, and continue to promote the optimization and upgrading of industrial structure. Over the past ten years, China's structural reform measures to promote in-depth, the problem of excess coal production capacity has been a breakthrough, but the contradiction between coal supply and demand still exists, China still needs to accelerate the optimization of industrial structure, stabilize coal prices and improve production capacity. The traditional energy industry is in urgent need of highly skilled personnel and high precision technology, and the government should continue to implement the strategy of promoting coal through science and education and strengthening coal with talents, and accelerate the construction of ecological civilization in mining areas.

Second, pay attention to environmental management issues, adhere to sustainable development and green development. With the release of the "double carbon" policy, environmental issues are becoming more and more important to the development of enterprises, and the cost of environmental management is a major factor in the rising cost of coal. Enterprises should adhere to the "early prevention, diligent control, full treatment" approach, do not "first pollution, then treatment", in order to minimize the cost of environmental management.

Thirdly, optimize coal production capacity and product structure, carry out supply-side reform in coal production sector, solve the problems of overcapacity, improve intelligent management system, keep pace with the times, liberate labor and save resources. And to optimize the coal product structure, improve the quality of the product itself, improve the coal coking capacity and the entry rate, and try to reduce the situation that too much coal is eliminated in the screening due to unqualified, so as to increase the revenue.

Fourth, to strengthen the monitoring and early warning of coal market, especially the long-term supply and demand forecast and early warning capability of coal market, to establish a flexible system to reduce the recurrence of under-capacity and over-capacity, and to actively play the role of the market in resource allocation to improve the imbalance of supply and demand in coal market.

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