

Article

De-Capacity Policy Effect on China's Coal Industry

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Abstract: Overcapacity in China's coal industry has serious negative impacts on the rational allocation of coal resources and stable operation of the national economy. Since 2016, the Chinese government has implemented a series of de-capacity policies to optimise coal production capacity. Timely policy effect assessment is of great significance to the government to guide high-quality development of the coal industry. This paper first reviews the dilemma encountered by China's coal industry prior to 2016, and then analyses the progress and effect of coal industry de-capacity. The main results are as follows: (1) The capacity reduction is mainly distributed in the central and southwestern regions. Most of the coal mines are state-owned, and there is a prominent worker resettlement problem. (2) The capacity optimisation policy has accelerated the implementation of the overall spatial planning of China's coal supply. China's coal production centre has shifted from the central and eastern regions to the west, and the industry's high-quality development pattern has taken shape. (3) China's coal industrial profitability has constantly been improving, industry concentration has increased significantly, and coal mining has become safer. (4) Due to the regional heterogeneity, the de-capacity policy effect has significant differences in coal production capacity and employee reduction in various regions. Finally, regarding the optimisation of China's coal production capacity, some policy implications are given.

Keywords: coal industry; overcapacity; de-capacity; energy policy; China

1. Introduction

In 2016, China's ensured reserves of coal were 249.23 billion tons, ranking third in the world [1]. China's abundant coal resources are distributed across all provinces except Shanghai. China's coal resources are concentrated in northern China. In southern China, the coal resources are mainly distributed in the Guizhou, Yunnan, and Sichuan provinces (Figure 1). Due to the abundant coal resources and the shortage of other energy sources, China has been the largest coal producer and consumer in the world for many years [2]. In the past 10 years, China has produced more than 40% and consumed about 50% of the world's coal (Figure 2), China plays an important role in the world's coal production and consumption system [3].

Coal is China's basic energy source and an important raw material [4]. As one of the main industries of the national economy, China's coal industry is wide-ranging and employs many workers. It is vital to the country's economic development and social stability. In recent years, affected by such factors as slowing economic growth and energy structure adjustment, coal demand growth was significantly below expectations, supply capacity has remained excessive and supply and demand have fallen seriously out of balance, resulting in a general decline in corporate profits, chaotic market competition and increased safety production hazards. It has adversely affected economic development, employment and social stability. China's overcapacity problem was mainly structural rather than

cyclical. If the structural contradiction of overcapacity was not resolved, the price of industrial products would continue to decline, the efficiency of enterprises would not be improved, and economic growth would be difficult to sustain. Therefore, at the end of 2015, both the Political Bureau of the Communist Party of China (CPC) Central Committee and the Central Economic Working Conference named the cutting of overcapacity—or, de-capacity—as one of the five major tasks in 2016 [5].

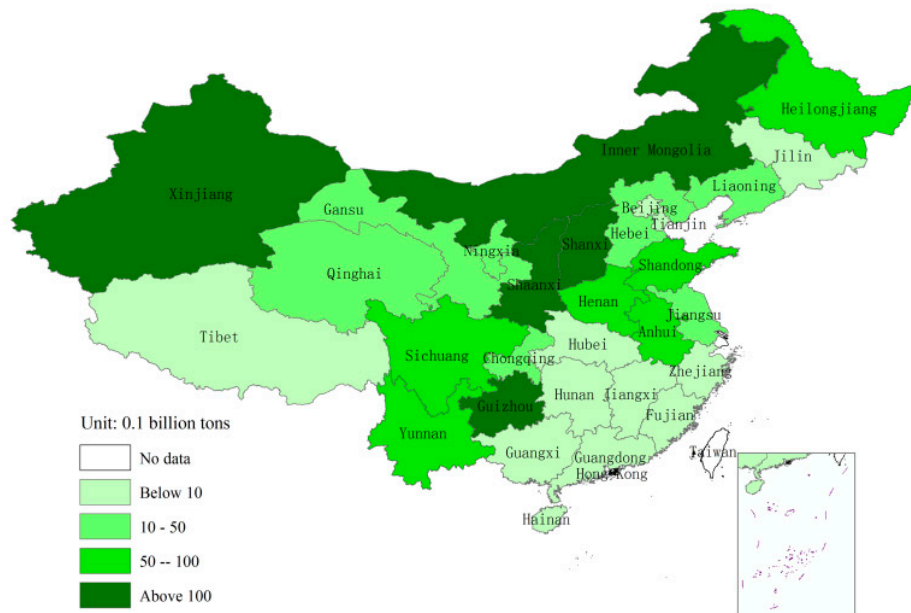


Figure 1. China’s ensured reserves of coal by province (2016).

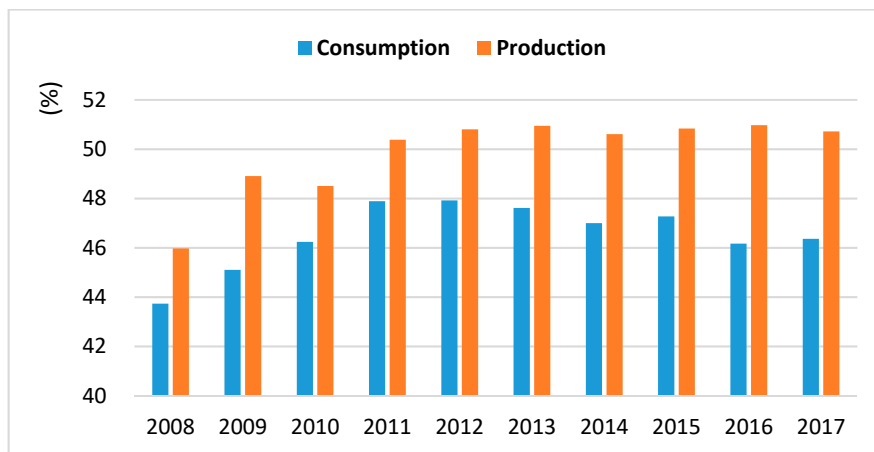


Figure 2. China’s share of coal production and consumption in the world.

In recent years, China has issued a series of policies on how the coal industry could reduce excessive capacity and promote high-quality development. High-quality development refers to a new development pattern in China that focuses more on economic quality. It is a shift from extensive development to intensive development, reflecting the Five Major Development Concepts of “innovation, coordination, green, openness and sharing”. On 5 February 2016, the State Council issued the Opinions on Resolving the Overcapacity Problem of the Coal Industry to Realise Development by Extricating the Coal Industry from Difficulties (the Opinions). The Opinions clearly put forward the overall de-capacity target for the coal industry: on the basis of the elimination of backward coal capacity in recent years, the coal industry will make a further capacity reduction of about 500 million tons and have about 500 million tons of capacity reduced and restructured, with a substantial compression of

coal capacity and moderate reduction of the quantity of coal mines within three to five years from 2016 for an effective solution to the overcapacity of the coal industry, balanced market supply and demand, an optimised industrial structure and substantial progress in transforming and upgrading [6]. At present, China's coal industry supply-side reform has been in effect for three years. What changes have occurred in China's coal industry? Timely assessment of the subsequent effect of de-capacity policy on coal industry and proper responses to them can not only accelerate the supply-side reform and promote high-quality development of coal industry, but also provide experience and policy implications for other countries to deal with overcapacity.

This paper is a part of the preliminary work of the Key Consulting Projects of China Academy of Engineering "China's Strategy of Coal Mine Safety and Abandoned Mine Resources Development and Utilization". Such consulting projects usually do not deliberately emphasize the use of quantitative models, but need to analyse the problem with detailed and the latest data, consider the possible impacts or changes of the policy from as many aspects as possible, summarize the achievements and identify the problems that need to be further resolved. The core part of this research report will be reported to the relevant departments of the State Council in the form of "Academician Opinions" for government decision-making. Therefore, we finished this paper in the form of a case study.

The rest of this paper is designed as follows. Section 2 reviews the existing literature related to excess capacity. Section 3 describes the policy background and China's coal de-capacity progress since 2016. Section 4 studies the de-capacity policy effect on the coal market, spatial distribution of coal production, coal enterprises and the regional differences of the policy effect. Section 5 summarises the main conclusions and policy implications.

2. Literature Review

2.1. Excess Capacity and Its Causes

Coal production capacity, that is, the ability to produce coal, is the total amount of coal that can be produced with the given resources and technical level of all fixed assets that coal enterprises participate in during a certain planning period [7]. Capacity utilisation ratio (CUR) is the ratio of actual output to design production capacity, reflecting whether the production resources of the enterprise can be effectively utilized [8]. Excess capacity ratio (ECR) is a concept that is opposite to the CUR; thus, $ECR = 100\% - CUR$. Referring to the U.S. criteria, the reasonable range of ECR is 5%–10%. Overcapacity occurs when the ECR exceeds the threshold of 10%, while under capacity occurs when ECR is below the threshold of 5% [9].

Overcapacity is a common phenomenon in a market economy. China is a socialist country. Compared with the developed market economy in Europe and America, China's market economy is not yet a complete market economy. However, China did not fully copy the Soviet model and established the socialist market economy with Chinese characteristics, which makes the market play a decisive role in resource allocation and gives full play to the role of the government. Since China's transition from a planned economy to a market economy in the late 1990s, there have been three overcapacity cycles: the first cycle (1998–2001), the second cycle (2003–2006) and the third cycle (since 2009) [10]. Meanwhile, China's coal industry has shifted from a shortage of production capacity to overcapacity, and the cycle is basically in line with the national overcapacity cycle [11]. The characteristics of China's coal overcapacity cycle can be summarised as long-lasting timespans, repeated occurrences, complex causes and serious impacts [12]. Therefore, overcapacity always brought about vicious competition, severe waste of resources, imbalance between supply and demand, plunging coal prices and overall financial loss of coal enterprises [13]. If this problem cannot be solved in a timely and effective manner, it will not only affect the high-quality development of the coal industry, but also hinder the optimisation of China's energy structure and the prosperity and stability of the national economy [14,15].

Correct identification of the causes is the prerequisite and basis for addressing overcapacity. Overcapacity usually can be attributed to the rigidity of capacity and the fluctuation of demand [16]. Accordingly, this paper reviews the present literature from the supply side and the demand side.

(1) Causes from the supply side

‘Wave phenomenon’ of enterprise investment. For a developing country like China in a rapid development stage, enterprises in this country are more willing to invest in industries with mature technologies and existing product markets [17]. Due to the latecomer advantage, it is easy for enterprises to have a consensus on new and promising industries. They are prone to the ‘wave phenomenon’ in investment, and a large amount of money is concentrated in a few industries. Consequently, these over-invested industries will experience overcapacity and related problems [18].

Entry deterrence strategy of existing enterprises. In a perfectly competitive market, the manufacturer is the price taker and faces a horizontal demand curve. For a competitive enterprise that aims to maximise profits, the upward-sloping marginal cost curve is its supply curve. In the long-term equilibrium, when the fully competitive manufacturer determines its output at the level of marginal cost equal to the price, it maximises profit. At this point, the marginal cost is equal to the average cost, price and marginal benefit in a perfectly balanced position with zero profit. At this moment, the production quantity of the representative enterprise is the output that corresponds to the tangency point of the marginal cost, average cost and price; there is no surplus production capacity [8]. However, in the imperfect competitive market, the existing enterprises and the new entrants have a game of interests. The former will curb the latter by maintaining a certain excess capacity and reducing the expected returns [19–21]. Although China’s large coal enterprises are basically state-owned enterprises, there are also many small private coal mines. There is a certain degree of game between private enterprises. In the late 1990s in particular, China’s small coal mines boomed “everywhere”. In order not to allow more new entrants to enter the market to share the benefits, they adopt the entry deterrence strategy and even vicious competition, resulting in the waste of coal resources and the destruction of the ecological environment, along with an over-supply and overcapacity in coal production [14,22].

Factor hoarding behavior of enterprises. Rational enterprises will maintain excess capacity when faced with uncertain demand in the future [23,24]. On the one hand, it takes about five to 10 years for a coal mine to go from investment to commercial operations. If the coal enterprises closes some mines when they have excess capacity and the demand in the future surges, they cannot build new capacity and increase production in such a short time, and thus they will miss the profits of maintaining excess capacity. On the other hand, industries such as coal, which have high sunk costs, need to pay large costs to adjust production factors. When the market demand is slack, enterprises are likely to sell the equipment below the present value after depreciation, but they need to purchase the equipment at the original price when demand surges [11].

Improper government intervention. Unlike other fully developed market economies, government intervention is an important cause of overcapacity in China. In response to the global financial crisis in 2008, the Central Government launched a 4 trillion RMB investment plan and other stimulus policies, bringing huge demand to the steel, cement, non-ferrous metals and other industries. However, overinvestment in these industries adds to the burden of digesting excess capacity in the coming years [25]. Besides, due to the gross domestic product (GDP)-oriented performance evaluation system, local government officials have strong incentives to intervene in corporate investment and use various preferential policies (such as low land prices, tax breaks and low power prices) to attract investment, thereby increasing fiscal revenue and relieving employment pressure to show their political achievements [26–28]. Eventually, this kind of blind investment behavior will lead to overcapacity in the entire industry.

(2) Causes from the demand side:

In theory, the growth of capacity input does not necessarily lead to overcapacity. Only when product demand does not catch up with the growth of capacity input does the overcapacity problem occur [29]. The demand side causes of overcapacity are mainly reflected in the following aspects.

Relationship with the economic cycle. In general, when the economy is in a recession, shrinking demand may lead to an increase in surplus capacity in most industrial sectors [30]. Because of the cognitive bias of enterprises, impulse investment occurs when the economy is overheated, while delaying investment when the economy is depressed, which leads to the synchronisation of production capacity and the economic cycle. When the overheated economy recedes into depression, conditions for overcapacity will eventually be formed [31].

Coal savings from demand-side management. The term ‘demand-side management’ (DSM) refers to technologies, actions and programmes on the demand-side of energy metres that seek to manage or decrease energy consumption, in order to reduce total energy system expenditures or contribute to the achievement of policy objectives such as emissions reduction or balancing supply and demand [32]. With reference to this definition, over the years, China has strengthened coal demand-side management to improve coal utilization efficiency and thereby reduce coal demand. Specific actions or projects include: supporting and promoting emerging clean and efficient coal-fired power generation technologies such as the integrated gasification combined cycle (IGCC) [33,34], replacing direct coal burning in households with natural gas and electricity [35,36], energy-saving renovation of existing buildings [37], and technical transformation of industrial furnaces [38].

2.2. De-Capacity Policy and Policy Effect

China’s coal overcapacity is a joint outcome of oversupply and insufficient demand but given the country’s economic transformation, energy structure optimisation and environmental constraints, it is not realistic to tackle the overcapacity issue simply by stimulating coal demand. Overcapacity is a common phenomenon and sometimes cannot be handled by simple market self-regulation [31]. For this reason, the mandatory elimination of backward production capacity by administrative means has become a commonly used regulatory tool for the Chinese government to optimise production capacity.

China has issued a series of coal de-capacity policies since 2016, but little research has been done to evaluate the policy effects. In the few related studies, Xu [39] analysed the effectiveness of the de-capacity policy from a national perspective and concluded that the coal industry’s operating conditions were improved after de-capacity, but this was largely the result of the redistribution of interests among the industries, and at the expense of raising the cost of other industries, it squeezed the profit margin of other industries. Deng et al. [40] measured the CUR of China’s steel industry and used breakpoint regression to evaluate the de-capacity policy. They found the implementation of the de-capacity policy has solved the problem of overcapacity in the steel industry to a certain extent, but the de-capacity policy has only played a relatively good effect when it was first introduced, and the effect has declined in the long run. Shi et al. [13] explored the unintended consequences and causes of China’s coal capacity cut policy using an extended version of the KAPSARC Energy Model (KEM) of China and found full and partial compliance with the de-capacity policy results in a significant gap between supply and demand, and the policy was technically infeasible, even allowing for a significant increase in coal prices and economic costs. Yang et al. [41] summarised the effect of supply-side reform policies in the coal industry from the aspects of coal price, coal inventory, capacity structure, supply and demand pattern, etc.

2.3. Comments in the Literature and Possible Academic Contributions

Previous studies on overcapacity have mainly focused on the causes and the measurement of overcapacity. Because some scholars have carried out a detailed summary, this paper does not list the literature on overcapacity measurements [40,42,43]. Since 2016, China's coal industry has made great efforts to cut excess capacity, but there has been relatively little research on the effect of the coal de-capacity policy. The possible contributions of this paper entail two aspects. (1) This paper analyses the overall goal completion and the spatial distribution characteristics of production capacity reduction since 2016, as well as the classification of closed mines. This is expected to deepen the understanding of China's energy policy and provide a reference for the formulation of differentiated employment and training policies for these miners. (2) This paper comprehensively discusses the effect of the de-capacity policy on China's coal industry from three aspects: coal market, spatial distribution of coal production and coal enterprises, and then presents the regional policy effect differences due to regional heterogeneity. Objectively evaluating the policy effect is the premise of using market-based means to optimise production capacity and the basis for ensuring the high-quality development of China's coal industry.

3. Policy Background and De-Capacity Progress

3.1. Policy Background

3.1.1. Severe Overcapacity

The period from 2002 to 2012 was called the 'Golden Decade' of China's coal industry. During this period, a large amount of funding entered the coal industry, and China's coal production capacity increased rapidly. According to the data from the China National Coal Association, China's coal production capacity in 2015 was about 5.7 billion tons, among which the normal and updated production capacity accounted for 3.9 billion tons, the new and expanded 1.5 billion tons and the discontinued 308 million tons [44]. Apart from the 308 million tons that were discontinued and the 700 million tons that had not yet been produced, China's effective coal production capacity was about 4.7 billion tons in 2015, much higher than the coal output of 3.7 billion tons, and the coal production capacity was seriously excessive.

3.1.2. Low Market Demand

Since China's coal consumption reached a historical peak of 4.24 billion tons in 2013, coal demand has been sluggish due to factors such as economic downturn, environmental constraints and energy structure adjustment. In 2014, China's coal consumption was 4.12 billion tons, 2.88% lower than the previous year. In 2015, the coal demand of high-energy-consuming downstream industries such as electricity, steel, building materials and chemicals was significantly weakened to 1.84 billion tons of coal used in the power industry, down 6.2% year-on-year; 627 million tons of coal used in the steel industry, down 3.6% year-on-year; 525 million tons of coal used in the building materials industry, down 8% year-on-year; and the 253 million tons used by the coal industry itself, down 8.4% year-on-year [45]. In addition, the unit energy consumption of coal-fired power decreased from 378 g/kWh in 2003 to 316g/kWh in 2015. For these reasons, China's coal consumption in 2015 continued to drop to 3.97 billion tons, a decrease of 3.64%.

3.1.3. More Coal Enterprises Suffered Financial Losses

Since 2011, due to the deteriorating market environment, the profitability of coal enterprises has declined and the losses have become increasingly heavy. In 2015, the total profit of China's coal industry was 44.1 billion yuan, a decrease of 390.1 billion yuan compared with 434.2 billion yuan in 2011, a drop of 89.84%. By the end of 2015, there were 2027 loss-making enterprises in the coal industry, an increase of 1,182 compared with 2011; the proportion of loss-making enterprises was

31.52%, an increase of 20.42% over 2011 (see Table 1 for details). In 2015, 20 of the 38 listed coal enterprises suffered losses, with a loss rate of 52.63%.

Table 1. Enterprises operating situation in China’s coal industry during 2011–2015.

Year	Total Enterprises	Loss-Making Enterprises	Loss Rate (%)	Total Profit (hundred million yuan)
2011	7611	845	11.10	4342
2012	7790	1290	16.56	3555
2013	7975	1788	22.12	2370
2014	7098	1929	27.18	1268
2015	6430	2027	31.52	441

Data source: [45].

3.2. De-Capacity Progress

3.2.1. Overall Goal Completion

From Table 2, according to incomplete statistics, China eliminated 620 million tons of backward coal production capacity during the period from 2016 to 2018. Capacity eliminated means the mining facilities and equipment being physically demolished and, in general, the closed coal mine will not restart. The target of eliminating 500 million tons in three to five years from the Opinions had been achieved by the end of 2017. Specifically, in 2016, China planned to cut 250 million tons and finished at 290 million tons; in 2017, it planned to reduce 150 million tons and cut 250 million tons; in 2018, it planned to eliminate 150 million tons, and from January to July, a production capacity of 80 million tons was eliminated. More than half of the 2018 annual plan was completed, and the work of coal capacity reduction progressed smoothly [46].

Table 2. Completion of China’s coal de-capacity target (hundred million tons).

Year	2016	2017	2018	Total
Plan target	2.5	1.5	1.5	5.5
Actual completion	2.9	2.5	0.8 *	6.2

Note: The data with* denotes the January-July 2018 data. Data source: [47].

3.2.2. Spatial Distribution of De-Capacity

As can be seen from Figures 3 and 4, the province with the largest coal de-capacity in China during 2016–2018 was Shanxi with a total reduction of 69.2 million tons over three years. Overall, the overcapacity withdrawn is concentrated in the central and southwest regions. The intensity of de-capacity in most coal-producing provinces weakened between 2016 and 2018. At the same time, the advanced production capacity was gradually released, indicating that the focus of China’s coal industry’s de-capacity work has gradually shifted from the backward capacity cut to structural capacity adjustments.

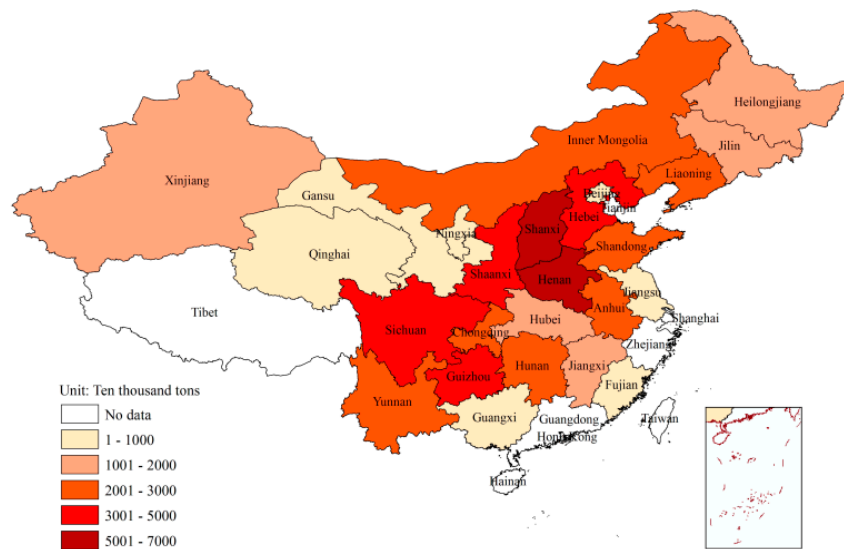


Figure 3. Spatial distribution of coal capacity cut in China.

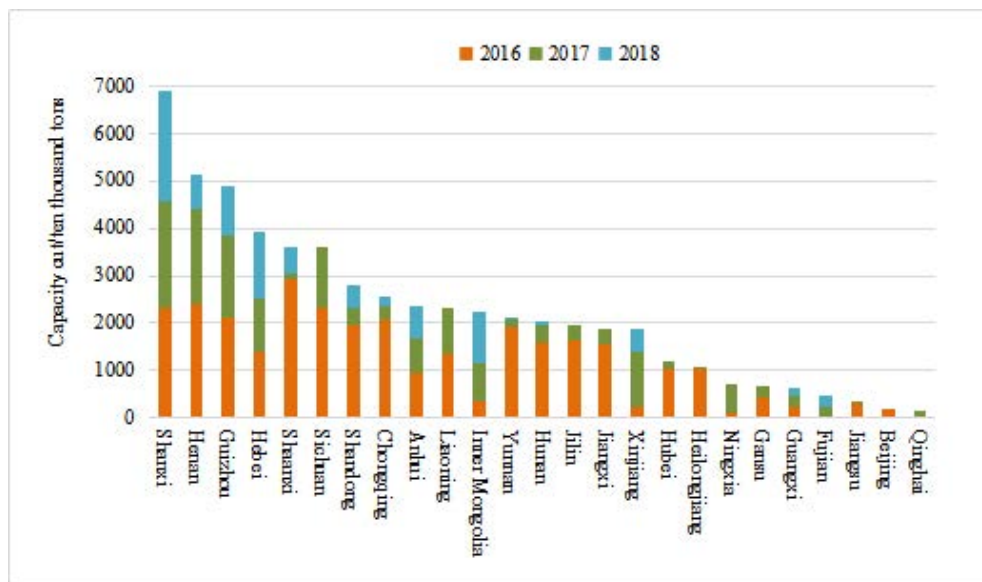


Figure 4. Provincial annual coal capacity cut in China.

3.2.3. Classification of Closed Mines

As shown in Table 3, state-owned coal mines accounted for 81% of capacity elimination in 2016, and the rest were private or collective mines. Among the state-owned mines, capacity reduction of the large and medium mines accounted for 36%, and the small-scale mines below 300,000 tons accounted for 45%. Most of China’s state-owned coal mines, especially the large and medium resource-exhausted mines, have a long mining history, redundancies in their workforces and many social functions, resulting in insolvency and heavy burdens.

Table 3. China’s closed coal mines in 2016.

Mine Property	Mine Scale	Quantity Proportion (%)	Capacity Proportion (%)
State-owned	Large and medium	13	36
	Small-scale (< 300 kt)	60	45
others	—	27	19

Data source: [48].

4. Policy Effect

4.1. Effect on Coal Market

According to the relationship between the coal de-capacity policy and the coal market, the policy effect on the coal market can be divided into three stages: the policy effect-taking stage, the market rebound stage, and the market adjustment stage [49]. The Bohai-Rim Steam-Coal Price Index (BSPI) is the core indicator of China's coal price system and the vane of the coal price, which reflects the total supply and demand level of coal in the country extremely. Therefore, we analyzed the impact of de-capacity policy on China's coal price using BSPI. The corresponding coal price changes are shown in Figure 5.

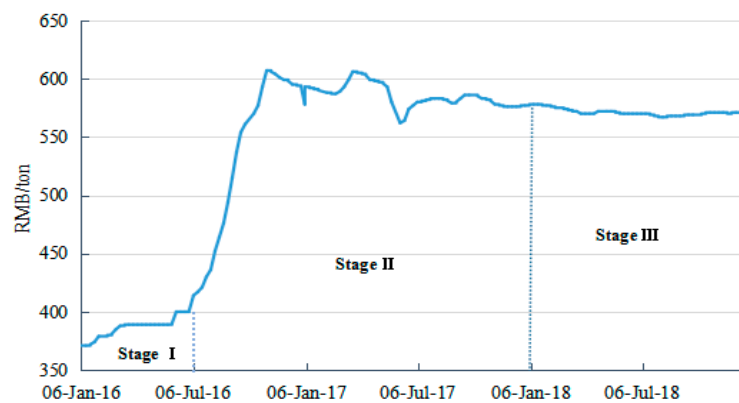


Figure 5. Bohai-Rim Steam-Coal Price Index (BSPI). Data source: [50].

Policy effect-taking stage (Stage I): In the first half of 2016, various ministries and commissions under the Central Government successively launched de-capacity and related policies. Subsequently, local governments responded positively and reduced the coal backward production capacity. In Stage I, the coal production of enterprises above a designated size fell sharply, coal supply was at a low level and the coal supply and demand relationship gradually became balanced. With the implementation of the de-capacity policy, coal supply continued to decline, coal prices rose as expected and the coal price index lagged the implementation of the policy, which rose steadily.

Market rebound stage (Stage II): Starting from the second half of 2016, with the continuous implementation of coal de-capacity work, China's coal production capacity was effectively reduced, and the coal market gradually recovered and rebounded. In Stage II, the coal production of enterprises above the designated size oscillated slightly, and the coal market was basically balanced. Advanced production capacity was released to a certain extent, the balance index of coal supply and demand was basically in normal fluctuations. Affected by the de-capacity policy, coal supply continued to decline, and coal prices rose across the board. Later, with the release of high-quality production capacity, coal prices fell and levelled out.

Market adjustment stage (Stage III): The coal de-capacity work has made remarkable achievements and China's coal market is in a healthy and stable state. The focus of coal de-capacity has been transformed into systematic and structural optimisation from simply capacity reducing since 2018. In Stage III, there was a tight supply in the coal market, while high-quality production capacity continued to be released in an orderly manner, railway transportation was strengthened and coordinated, and the relationship of coal supply and demand developed in a fundamentally balanced direction. In general, the coal production capacity adjustment promotes a stable coal price within a range of normal fluctuations.

4.2. Effect on Spatial Distribution of Coal Production

According to the similarity of geological conditions, the consistency of basic characteristics of coal mine disasters and the principle of administrative division, China's main coal production areas are subdivided into five regions, namely: Jin-Shan-Meng-Ning-Gan, East China, South China, Northeast China and Xin-Qing [51]. The specific division is shown in Figure 6.

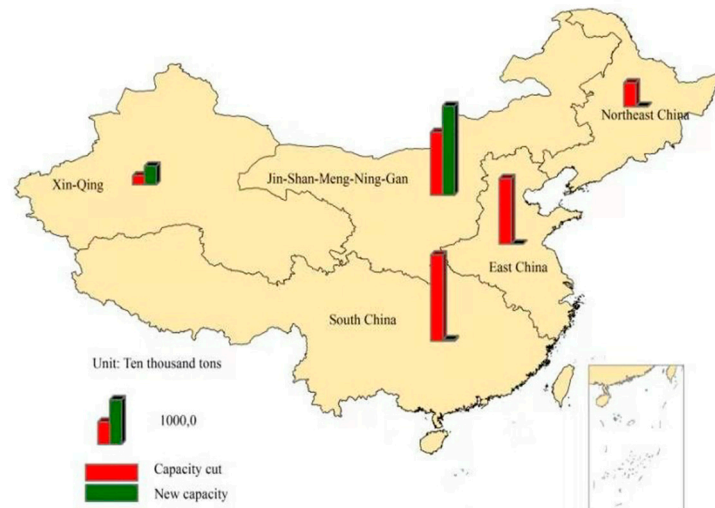


Figure 6. China's five main coal production areas.

Over half of China's sustainable coal production capacity is distributed in Jin-Shan-Meng-Ning-Gan and Xin-Qing, which will be the main battlefields for coal exploitation in China. As can be seen from Figure 4, this round of coal capacity reduction is mainly distributed in southern China where mining conditions are poor and the eastern part of the country, which has a long history of mining. Comparatively, the reductions in Xin-Qing and Jin-Shan-Meng-Ning-Gan were relatively small. From January 2016 to March 2018, China approved 45 coal mines (including renovation and enlargement) with a total capacity of 246.7 million tons, mainly distributed in Shanxi, Shaanxi, Gansu, Ningxia and Xinjiang [52]. There is 'less production capacity reduction and more increase' in western China and 'more capacity reduction and less increase' in central and eastern China, which objectively accelerates the implementation of China's coal overall layout 'controlling the east, stabilising the centre and developing the west'. The centre of China's coal production has shifted from the central and eastern regions to the west, especially Jin-Shan-Meng-Ning-Gan and Xin-Qing in the country's northwest.

4.3. Effect on Coal Enterprises

(1) Significant enhancement in coal enterprises' profitability

China's coal prices rebounded rapidly in July 2016. After September, as some advanced production capacity was released to increase the coal supply, coal prices fell sharply after November before returning to a reasonable level. In this context, China's coal industry, which once suffered overall loss, later ushered in a big turnaround. In 2016, China's coal mining and washing industry achieved a total profit of 109.09 billion yuan, a year-on-year increase of 223.6% [53]. In 2017, with coal prices at a high level, the main business income of coal enterprises above a designated size was 2.54 trillion yuan, a year-on-year increase of 25.9%, and profits totalled 295.93 billion yuan, a year-on-year increase of 290.5% [54]. In the first three quarters of 2018, with coal prices at a still higher level, the coal mining and washing industry achieved a total revenue of 1.79 trillion yuan, a year-on-year increase of 5.8%, and total profits reached 232.75 billion yuan, a year-on-year increase of 14.5% [55].

(2) Rapid increase in industry concentration

With the mergers and acquisitions of coal enterprises, the number of coal mines in China decreased from 9,700 at the end of 2015 to around 7,000 in 2017 and then to about 6,500 in 2018. The concentration of China's coal industry has further increased over the years. CR_8 of China's coal market is calculated by summing the coal output of the top8 firms, dividing that sum by the total coal output of China. In 2016, CR_8 of China's coal market was 36.41% and rose to 38.50% in 2017. In 2018, it exceeded 40% for the first time, reaching 41.90% (see Table 4 for details). At the same time, the international competitiveness of China's coal enterprises had obviously been enhanced. Among the top 30 global coal enterprises, Chinese companies accounted for 21 seats in 2017 [56].

Table 4. Output (TOP8) and CR_8 in China's coal industry (unit: 10,000 tons).

Rank	2016		2017		2018	
	Group	Output	Group	Output	Group	Output
1	Shenhua Group	43,149	Shenhua Group	44,072	China Energy Group	51,200
2	China Coal Group	13,323	China Coal Group	16,368	China Coal Group	19,000
3	Shandong Energy Group	13,050	Shandong Energy Group	14,139	YANKUANG Group	16,100
4	Shaanxi Coal Chemical Industry Group	12,593	Shaanxi Coal Chemical Industry Group	14,010	Shaanxi Coal Chemical Industry Group	16,000
5	Datong Coal Mine Group	11,786	YANKUANG Group	13,511	Shandong Energy Group	14,500
6	YANKUANG Group	11,415	Datong Coal Mine Group	12,700	Datong Coal Mine Group	13,700
7	Shanxi Coking Coal Group	9151	Shanxi Coking Coal Group	9609	Shanxi Coking Coal Group	10,000
8	Jizhong Energy Group	8009	Yangquan Coal Industry Group	8200	Shanxi Jinneng Group	8081
	China's coal output	336,398	China's coal output	344,500	China's coal output	354,610
CR_8		36.41%		38.50%		41.90%

(3) Safer coal mining

With the continuous advancement of supply-side reforms, many small-scale coal mines with poor mining conditions have been shut down one after another. Coal mining in China has become increasingly safe and efficient. In 2016, the number of coal mining accidents and related deaths in China reached a 'double decline', down 29.3% and 10% respectively year-on-year with major accidents and deaths down by 37.1% and 39.5% respectively. The death rate per million tons was 0.156, down 3.7% year-on-year [57]. In 2017, there were 219 accidents and 375 deaths in coal mines in China, which was a decrease of 30 and 151 persons, down 12% and 28.7% respectively. The death rate per million tons was 0.106, a decrease of 32.1% year-on-year [58]. In 2018, the safety of China's coal mines continued to improve. The death rate per million tons was 0.093, down 12.3% year-on-year, and fell below 0.1 for the first time [59].

4.4. Regional Differences of Policy Effect

The de-capacity policy directly affected the coal production and the number of employees in China. Due to the regional heterogeneity, including resource reserves, the contribution of the coal industry to local GDP and policy compliance, there are obvious differences in various regions. It can be seen from Table 5 that in 2016, among the 25 coal-producing provinces in China, except for Xinjiang's coal production growth of 5.59% and Guangxi's growth of 1.66%, coal production in various regions has declined by varying degrees. Among them, Shanxi had the largest coal production reduction, with a reduction of 136.36 million tons. Qinghai had the smallest coal production reduction, with a reduction of 0.29 million tons. The largest reduction rate occurred in Jilin was 36.08%, and the smallest reduction rate occurred in Shaanxi was 1.92%. At the same time, except for an increase of 3200 employees in Guangxi, the coal industry in various regions also experienced different levels of employees reduction. Shandong had the maximum employees reduction of 89,500 and the Qinghai had the minimum employees reduction of 1800 persons. In order to avoid the social problems caused by the massive unemployment of coal employees, local governments and enterprises have to resettle them properly, which is the basic preconditions for the orderly progress of de-capacity.

Table 5. Contribution of the coal industry to local gross domestic product (GDP) and policy effect differences in 2016.

Region	Contribution to Local GDP (%)	Production Reduction (1000 tons)	Production Reduction Rate (%)	Employees Reduction (1000 persons)	Employees Reduction Rate (%)
Shanxi	32.02	13636.23	14.10	3.00	3.13
Inner Mongolia	18.37	6398.17	7.03	1.39	6.37
Ningxia	14.87	906.48	11.37	0.83	12.83
Guizhou	13.36	354.35	2.06	2.48	9.92
Shaanxi	11.78	1010.10	1.92	2.13	9.94
Gansu	3.47	145.34	3.30	0.53	7.43
Henan	3.14	1649.18	12.13	3.45	7.54
Hebei	2.75	952.73	12.81	0.35	1.85
Anhui	2.69	1168.56	8.72	3.57	13.00
Sichuan	2.53	241.64	3.77	2.52	12.44
Shandong	2.43	1402.53	9.86	8.95	18.98
Yunnan	2.26	597.57	11.53	1.03	11.46
Xinjiang	2.24	-851.62	-5.59	1.03	18.33
Heilongjiang	1.66	660.65	10.08	0.69	3.52
Jilin	1.44	950.38	36.08	0.94	12.11
Chongqing	1.41	1124.82	31.58	3.44	27.09
Hunan	1.22	771.42	21.68	3.42	27.74
Liaoning	0.91	582.65	12.26	0.66	4.43
Qinghai	0.90	29.16	3.57	0.18	23.08
Jiangxi	0.67	713.94	31.44	1.77	25.73
Fujian	0.38	207.04	13.01	0.72	19.00
Guangxi	0.31	-7.05	-1.66	-0.32	-36.78
Jiangsu	0.25	550.99	28.71	1.15	16.04
Hubei	0.19	266.01	30.94	0.89	38.20
Beijing	0.08	132.48	29.43	0.30	28.57

Note: The coal production and employees reduction rate is compared with the 2015. The “-” indicates an increase compared with 2015.

5. Conclusions and Policy Implications

5.1. Conclusions

This paper first reviews the dilemma of China’s coal industry pre-2016 without the de-capacity policy, and then analyses the progress of China’s coal de-capacity, including the completion of the overall target and the spatial distribution of the capacity cut. On this basis, we explore the de-capacity policy effect and regional differences. This study draws the following conclusions.

- (1) The target of the Opinions to eliminate 500 million tons in three to five years had been achieved as of the end of 2017, with Shanxi as the province with the largest coal de-capacity during the period of 2016 to 2018. Overall, the capacity withdrawn was concentrated in the central and southwest regions, most of which belonged to state-owned coal mines and the resettlement of workers was a prominent problem. The intensity of de-capacity in most coal-producing provinces had been weakened from 2016 to 2018. At the same time, advanced production capacity was gradually released, indicating that the focus of China’s coal industry de-capacity work had gradually shifted from simple capacity cut to systematic and structural capacity optimisation.
- (2) According to the relationship between the coal de-capacity policy and coal market, the policy effect on the market can be divided into three stages. In the policy effect-taking stage, with the implementation of the de-capacity policy, coal supply started to decline, and coal price increased as expected; In the market rebound stage, affected by the de-capacity policy, coal supply continued to decline and coal price rose across the board. Later, with the release of high-quality production capacity to a certain extent, coal prices fell then stabilised. In the market adjustment stage, the de-capacity work was transformed into systematic and structural de-capacity, which promoted the stability of the coal market and the fluctuation of coal prices within the normal range.

- (3) There is ‘less production capacity reduction and more increase’ in western China and ‘more capacity reduction and less increase’ in central and eastern China. The centre of China’s coal production has shifted from the central and eastern regions to the west, the high-quality industrial development pattern of ‘structural de-capacity and systemic capacity optimisation’ was initially formed.
- (4) With the development of de-capacity work and the rational return of coal prices, the profitability of coal enterprises has been enhanced significantly, while the pace of mergers and acquisitions has improved the industrial concentration. At the same time, the international competitiveness of China’s coal enterprises has been significantly enhanced, and the level of safety production has continued to improve.
- (5) Due to regional heterogeneity, including resource reserves, the contribution of the coal industry to local GDP and policy compliance, there were obvious differences in various regions. Regional heterogeneity was likely to cause local governments and coal enterprises to respond differently to the de-capacity policy issued by the Central Government of China, resulting in varied regional coal production capacity and employee reductions.

5.2. Policy Implications

- (1) Avoid improper government intervention in coal production.

Excessive local government intervention is the main reason for overcapacity in China’s coal industry, and local government behavior is subject to the performance evaluation system and financial restraint mechanism. Therefore, we can suppress excessive investment of the local governments and the large enterprises from the following two aspects to alleviate overcapacity. On the one hand, the performance evaluation system of local officials should be improved from only GDP assessment to a comprehensive assessment also including ecological environment and people’s livelihoods. On the other hand, a set of effective restraint and incentive mechanisms should be set up to regulate the behavior of local governments, state-owned banks and state-owned large enterprises, and to prevent local governments from giving too many preferential policies to stimulate the economy.

- (2) Explore market-based means to cut excess capacity.

The concept “socialist market economy”, introduced by Deng Xiaoping, has survived the test of time, and China is well on its way to catching up with the world’s largest economy. For some people, socialism and markets are still mutually antithetical. It was more so at the time when Deng introduced it to the world, sharply divided as it was between the ideological poles of state-driven socialist planning systems and market-driven economic frameworks. The remarkable aspect of the “socialist market economy” is in its effort to reconcile what used to seem irreconcilable [60]. De-capacity policy, as an administrative tool for dealing with overcapacity, has achieved the expected effects in the past three years. However, the market is the most effective means of allocating resources. In the long run, marketisation is the fundamental way to eliminate the coal excess capacity. In the process of further coal production capacity optimisation, it is recommended to apply the quota system to the overall de-capacity target decomposition, which can give full play to the decisive role of the market in allocating coal resources and lead to benign development in China’s coal industry.

- (3) Continuously optimise the coal capacity and reuse the abandoned mine resources.

The focus of China’s coal capacity optimisation should shift gradually from quantitative targets to qualitative targets. In accordance with the principles of marketisation and legalisation, China should continue to actively and steadily promote the resettlement of staff and the disposal of assets and liabilities. At the same time, it is necessary to provide guidance for the ecological restoration and treatment of different kinds of closed or abandoned mines, foster the continual and substituted industries and form some new economic growth points.

Compared with the previous research, this paper is characterised by systematically studying the implementation effect of China’s coal industry capacity optimisation policy from the three aspects of coal market, spatial distribution of coal production and coal enterprises, and proposes the avoidance of

improper government intervention, the use of market-oriented means, and the continuous promotion of coal capacity optimisation. As China's coal capacity optimisation is in the transformation stage of 'total capacity cut to structural and systematic capacity cut', de-capacity policy is only an administrative measure taken at a specific stage to regulate industry development. It is the fundamental way to achieve high-quality development through market means. Further research is needed to assess the impact of China's de-capacity policy using quantitative models and exploring the application of the quota system in China's coal industry capacity optimisation target. Moreover, the miners' resettlement and the development and utilization of abandoned mine resources (such as industrial plants, equipment, underground space, etc.) should also be a concern.

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