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# The Effects of De-Capacity Policy on Steel and Coal Firms' Profitability: Evidence from China's Listed Companies

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**Abstract:** Chinese overcapacity in the steel and coal industry has been on the rise since 2013, which leads to the misallocation of resources and decreases in production efficiency. In 2015, the Chinese central government adopted a series of de-capacity policies to resolve excess capacity and improve corporate profitability. However, there is scant evidence on the impacts of de-capacity policies on the firm profitability. Based on the data from Chinese listed companies in the steel and coal industry, this study constructs the difference-in-difference (DID) method to investigate the effects of the de-capacity policy on the profitability of listed companies in the steel and coal industry empirically. The results show that the de-capacity policy significantly increases the return on equity (ROE) of the experimental group, which is higher than that of the control group by 12.4%. That is partially because of the improvement in gross profit margin, management efficiency, and return on manpower due to the de-capacity policy. This study offers new evidence on the efficiency of China's de-capacity policy toward the steel and coal industries through data at the enterprise level.

**Keywords:** difference-in-difference; de-capacity policy; profitability; overcapacity industry; steel companies; coal companies



**Citation:** Tian, Y.; Ding, L.; Yang, B.; Peng, F. The Effects of De-Capacity Policy on Steel and Coal Firms' Profitability: Evidence from China's Listed Companies. *Energies* **2022**, *15*, 4377. https://doi.org/10.3390/en15124377

Academic Editors: Paweł Dziekański, Piotr Prus and Mansoor Maitah

Received: 21 May 2022
Accepted: 13 June 2022
Published: 15 June 2022



## 1. Introduction

The coal and steel industries have played a vital role in China's eye-catching economic growth and experienced a golden decade after 2000. However, with the slowdown in China's growth, the demand for steel and coal industries has declined dramatically, but the supply capacity has remained excessive. This has led to an overcapacity problem in the coal and steel industries [1,2]. Overcapacity has the characteristics of low-capacity utilization and heavy losses, which considerably impact the transformation of the economy and the optimization and upgrading of industry structure [3,4]. Overcapacity has become a source of prominent contradictions, causing several problems in China's economic operations. In this context, China has implemented a series of policies to tackle overcapacity and improve the profitability of the coal and steel industries. In particular, the Chinese government proposed supply-side structural reforms in 2015 to achieve high-quality development. The de-capacity policy, the first task in the supply-side structural reform, is responsible for actively resolving excess capacity, solving the unfavorable situation of vicious competition, and actively transforming and upgrading production technology and products. To achieve the goal of de-capacity policy in the steel and coal industries, the government has adopted a series of measures such as prohibiting the construction of new projects, comprehensively cleaning up and rectifying illegal production capacity, promoting enterprise mergers and reorganization, expanding domestic effective demand, consolidating and expanding the international market, and breaking through core key technologies [4,5]. These measures are taken to enhance the profitability of companies.

The changes in the capacity of raw coal and steel, return on equity (ROE), and return on assets (ROA) are shown in Figure 1. The capacity of raw coal has continued to rise since

2010, from 3.435 billion tons in 2010 to 3.874 billion tons in 2014, an increase of 12.78%, and fell to 3.747 billion tons in 2015, which further dropped to 3.411 billion tons in 2016, down to the level of 2010. With the de-capacity and the transformation of the domestic economy, starting in 2017, raw coal production began to rise slowly, but as of 2018, it was still far below the peak level before the de-capacity policy. The output of steel has shown an upward trend since 2010, from 802.8 million tons in 2010 to 1.125 million tons in 2014, an increase of 40%. Since 2015, the increase in production capacity has been suppressed. The output remained unchanged, and the steel output in 2017 was 80 million tons lower than the peak in 2014. Meanwhile, the ROE of steel and coal companies continued to decline in 2010. By 2014, ROE and ROA fell to 1.53% and 3.74%, respectively. In 2015, the ROE and ROA of the steel and coal industries were both negative, resulting in large-scale losses. However, after 2015, the ROE and ROA of the two industries increased, turning losses into profits.

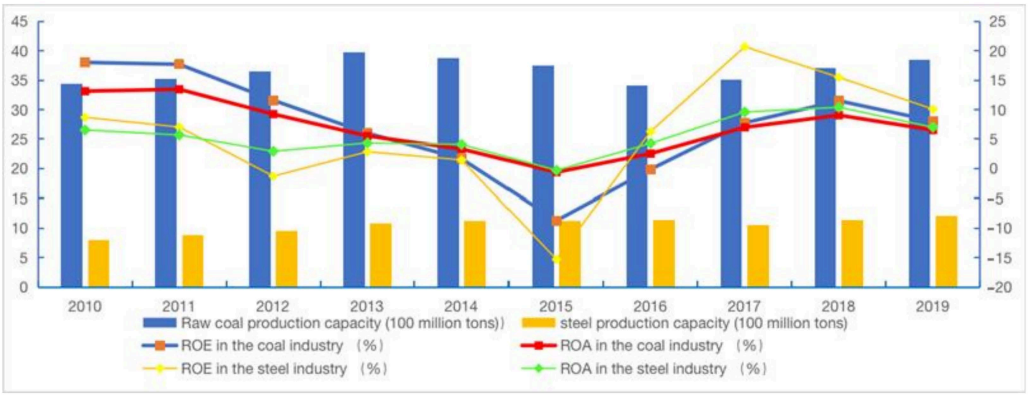


**Figure 1.** Changes in production capacity, ROE and ROA in the steel and coal industries.

Moreover, from the comparison of coal and steel industries (treatment group) and other industries (control group), it can be seen from Figure 2 that since 2010, the ROE and ROA of steel and coal companies have been lower than those of other companies. It was not until 2015 that the ROE and ROA of steel and coal companies increased rapidly. In 2016, they turned losses into profits, and the gap with other companies gradually narrowed. In 2017, the ROE surpassed other companies. Since 2018, the ROE and ROA of steel and coal companies have fluctuated around 10%, slightly higher than that of other companies. In addition to the ROA, ROE and total industrial capacity of the steel and coal industry, in 2013, the coal industry employed 5.3 million employees. As of 2020, the number of employees in the coal industry is only 2.85 million, a decrease of 46.23%. Meanwhile, between 2016 and 2019, the Chinese government reportedly provided resettlement guarantees for more than 280,000 workers who quit the steel industry. Moreover, in 2013, the fixed asset investment in the steel industry and coal industry was about CNY 670 billion and CNY 500 billion, respectively, which together accounted for 2.62% of the country's total fixed asset investment. In comparison, the fixed asset investment in the computer and electronic equipment industry accounted for only 1.60% of the country's total fixed asset investment.

In this case, this study focuses on the effect of the de-capacity policy and attempts to explore the following core, but not yet well answered, questions: Does the de-capacity policy really help improve the profitability of enterprises in the steel and coal industries? If so, what is the mechanism that affects corporate profitability? There are many challenges in answering the above two questions, with endogenous problems being the most important one. Specifically, the choice of the de-capacity policy industry is not completely random; the industries affected by the policy and other industries themselves have different characteristics, such as production and management cycle differences, which may influence enterprise performance and bias the regression results; that is, the estimated results are not entirely derived from the de-capacity policy itself. To solve this problem, this study uses the de-capacity policy carried out in 2015 as a quasi-natural experiment and uses

the difference-in-difference (DID) approach, which is a key method to evaluate the policy effect, to alleviate the errors caused by unobservable factors in the empirical analysis results and study the impacts of the de-capacity policy on the profitability of steel and coal corporations.

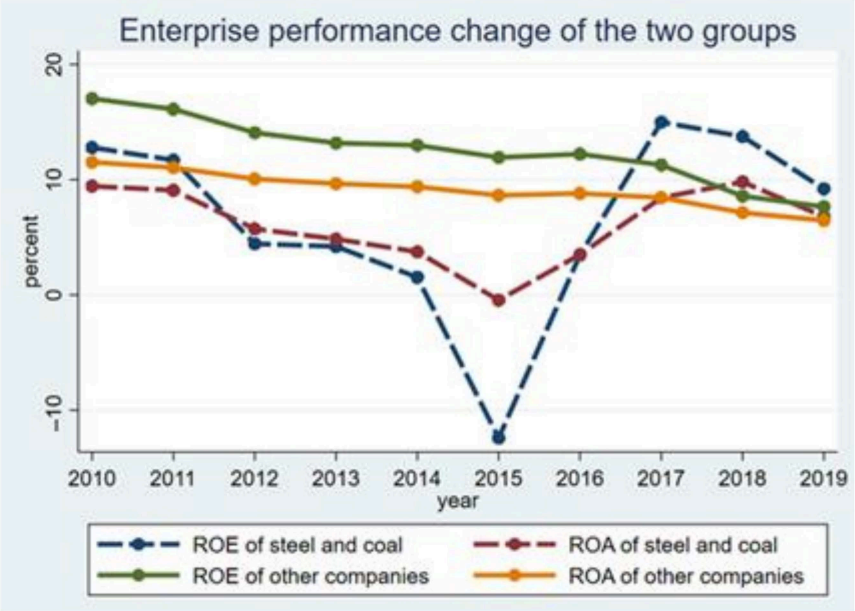


**Figure 2.** Changes in ROE and ROA of the two groups.

This study finds that the de-capacity policy has a significant improvement effect on the profitability of enterprises in the steel and coal industries. Furthermore, mechanism analysis shows that the de-capacity policy has reduced the company's period costs, including management, expenses, and sales expenses, and has improved the rate of return on manpower and gross profit margin. The aforementioned results demonstrate that the de-capacity policy has achieved the original objective of policy design, effectively improving the profitability of the over-capacity companies. This study also analyzed heterogeneity based on ownership and region, and the results show that the impact of the de-capacity policy on corporate profitability is not significantly different between state-owned and non-state-owned enterprises and between eastern, central, and western enterprises. The results provide empirical evidence for the evaluation of the policy effect of the de-capacity policy, thereby providing useful insights for the Chinese economy to shift from high-speed growth to high-quality development.

This study is closely related to the three threads of the literature on overcapacity in recent years. The first concerns the adverse impact of overcapacity on the economy. The supply of the steel and coal industry in China exceeds the demand, and vicious competition reduces the efficiency of resource allocation and enterprise profit [6,7]. Overcapacity has had a negative impact on economic development, employment, and social stability. Some scholars believe that if overcapacity is not resolved, then the price of industrial products will continue to fall. As a result, the efficiency of enterprises will not be enhanced, so economic growth will be difficult to sustain [8,9].

The second is about the reasons of overcapacity. There are three reasons for overcapacity: market, government, and market–government dual factors [4,6,10,11]. Market factors are mainly reflected in the following two aspects. First, to prevent potential competitors from entering the industry, companies generally build entry barriers by lowering prices and expanding market shares and often maintain excess capacity [12,13]. Second, to reduce the long-term operating costs caused by production fluctuations, some companies often maintain a certain amount of excess capacity [14]. Government factors are mainly manifested in the fact that due to the unreasonable economic growth mode of China, the government often

overinvests in stimulating economic growth, which eventually leads to overcapacity [2,15]. The overcapacity caused by the market–government dual factor manifests in short-term overcapacity and long-term overcapacity. Short-term excess energy production is due to market factors, while long-term overcapacity comes from government intervention in the market. Short-term overcapacity can be resolved through market mechanisms. Long-term overcapacity is difficult to resolve through market mechanisms [8,16].

The third is the effect evaluation of the de-capacity policy, which is complementary to this study. These studies use methods such as regression discontinuity and descriptive statistics to evaluate the overcapacity policy from the perspectives of capacity utilization and total factor productivity. Wang et al. (2019b) concluded that the de-capacity policy affects highly efficient companies by investigating the Chinese coal companies under the background of the de-capacity policy [17]. Hao et al. (2019) found that the de-capacity policy has a significant effect on coal production capacity in the central and southwestern regions [8]. Moreover, although existing studies have analyzed the production efficiency of overcapacity companies, they have not focused on the impact of the de-capacity policy on the firm performance of overcapacity companies. Zhang et al. (2022) used the DID method to study the impact of the de-capacity policy on the economic benefits and green efficiency of the coal industry, but also believed that further measures were needed to reduced production capacity under the background of carbon neutralization [18].

Compared to the literature, the contributions of this study are primarily reflected in the following two aspects: First, from a methodological point of view, one of the difficulties in the evaluation of policy effects lies in the endogenous problems that are commonly faced. The current literature seldom conducts policy effect evaluations based on effectively solving endogenous problems. This study constructed corporate and year-level panel data from 2010 to 2019, adopted an overcapacity policy as a quasi-natural experiment, built a difference-in-difference model at the individual and time levels, and conducted a series of robustness tests, which had better alleviated endogenous problems. Second, in recent years, there has been plenty of literature on the evaluation of overcapacity policies; however, few studies have examined and decomposed the impact mechanism of overcapacity policies on the performance of enterprises in overcapacity industries. Based on relevant literature, this study uses panel data of A-share listed companies of steel and coal from 2010 to 2019 to comprehensively examine the impact of the overcapacity policy on corporate profitability and its mechanism.

The remainder of this paper is organized as follows. Section 2 constructs the data, econometric model, and identification strategy; Section 3 reports the empirical results and tests a series of key issues that affect the effectiveness of the model, then reports the results of the heterogeneity analysis; Section 4 examines and decomposes the transmission mechanism of the de-capacity policy affecting enterprise performance; and Section 5 summarizes the article and proposes policy recommendations.

## 2. Background

In recent decades, especially since China's accession to the WTO, the scale of China's economy has grown rapidly. However, rapid economic growth relies on an extensive economic growth mode, which is dominated by investment and export. This will lead to increasingly prominent structural irrationality, overcapacity, serious environmental pollution and many other problems. In particular, overcapacity has the characteristics of low utilization rate of production capacity and wide losses, which greatly affect the transformation of economic development mode and the optimization and upgrading of economic structure. Overcapacity has become a prominent contradiction and the root of many problems in China's economic operation. Against this background, in 2015, the Central Economic Work Conference proposed to focus on five major tasks. As the first of the five tasks in the supply-side structural reform, reducing overcapacity emphasizes solving the unfavorable situation of vicious competition caused by oversupply of products, and actively transforming and upgrading production technologies and products. As far

as the steel and coal industries are concerned, in February 2016, the State Council issued the "Opinions on Resolving Overcapacity in the Coal Industry and Realizing Development from Difficulties", pointing out that the coal industry will further reduce its production capacity by about 500 million tons and carry out a production capacity of about 500 million tons. Cut and restructure. In the same month, the State Council also issued the "Opinions on Resolving Overcapacity in the Iron and Steel Industry and Realizing Development from Difficulties", pointing out that the iron and steel industry will further reduce its production capacity by 100 million tons to 150 million tons. In order to achieve the goal of reducing production capacity in the steel and coal industries, the government has adopted a series of measures such as strictly prohibiting the construction of new production capacity projects, comprehensively cleaning up and rectifying illegal production capacity, promoting corporate mergers and reorganizations, expanding domestic effective demand, consolidating and expanding international markets, and breaking through core key technologies.

## 3. Methodology and Data

### 3.1. Difference-in-Difference Model

Whether the de-capacity policy has effectively improved the performance of enterprises in the steel and coal industries and promoted the high-quality development of the industry is the question examined in this study. To solve common endogenous problems, this study utilizes supply-side structural reform as a quasi-natural experiment to conduct DID. The first layer of difference is at the enterprise level, that is, the difference between steel and coal enterprises affected by policy and other industry enterprises that are not affected by policy; the second layer of difference is from the time level, that is, the difference between the years before and after the policy impact. Empirically, we treat the steel and coal listed enterprises as the experimental group, while other enterprises are treated as the control group. According to the relevant literature [19], the general DID model with a two-way fixed effect is described as follows:

$$Dependent_{it} = \alpha + \beta_1 treat_{it} + \beta_n control_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (1)$$

where the subscripts $i$ and $t$ represent the firm and year, respectively, and $lnDROE_{it}$ represents the dependent variable. The important one is the interactive $treat_{it}$, which defines whether firm $i$ is affected by the de-capacity policy in year $t$. When $treat_{it} = 1$, it means that the enterprise $i$ belongs to the enterprise affected by the de-capacity policy in year $t$; when $treat_{it} = 0$, it means that the enterprise i does not belong to the enterprise affected by the de-capacity policy in year $t$. Its coefficient $\beta_1$, the key coefficient of concern, is the DID estimator, which measures the effect of the de-capacity policy in 2015 on the profitability of steel and coal enterprises. According to the related literature [20], this study chose the firm size, leverage, growth ability, liquid, main business ratio (MBR) as control variables. $\mu_i$ represents the fixed effect of the individual, which controls the time-invariant, unobserved individual characteristics that shape the dependent variable across individuals, such as company culture. $\gamma_t$ represents the time fixed effect, which controls the nationwide shocks and trends that may affect the dependent variable over time, such as the macroeconomic situation in that year. Detailed descriptions of the variables are presented in Table 1.

### 3.2. Data

In this study, we selected the steel and coal companies listed on the Chinese Shenzhen and Shanghai Stock Exchange from 2010 to 2019 as a research sample using the Wind database, which is a listed company information disclosure website assigned by the China Securities Regulatory Commission and contains detailed financial data of listed firms. During the processing, some companies were eliminated because too many data were missing, while missing data for some years were supplemented by the linear interpolation method. Three companies listed after 2015 were removed from the datasheet to evaluate the

effect of the de-capacity policy because the de-capacity policy was implemented at the end of 2015. Additionally, some firms were eliminated because they are special treatment firms. Finally, a total of 67 listed companies in China's steel and coal industry were collected in this study. According to the Guidelines on Industry Classification of Listed Companies issued by the China Securities Regulatory Commission, this study selects the steel listed companies and coal and expense fuel companies as the steel and coal firms. Available information began in 2010. As mentioned earlier, steel and coal companies have been affected by the de-capacity policy since late 2015. Therefore, we limit our dataset from 2010 to 2019 to evaluate the effect of the policy effect precisely. The descriptive statistics for each variable are presented in Table 2.

**Table 1.** Definitions of variables.

| Variable | Meaning | Definition |
|---|---|---|
| ROE | Return on equity | Net profit/total assets |
| $G_i$ | Dummy of groups | If is a steel or coal enterprise, then $G_i = 1$; otherwise $G_i = 0$ |
| $D_t$ | Dummy of years | If the year is after 2015, then $D_t = 1$; otherwise $D_t = 0$ |
| $Treat_{it}$ | Policy dummy | If $G_i \cdot D_t = 1$, then, $Treat_{it} = 1$; otherwise, $Treat_{it} = 0$ |
| liquid | Solvency | Current assets/current liabilities |
| leverage | Financial | Total liabilities/total assets |
| MBR | Main business ratio | Main business profit/total profit |
| growth | Growth ability | Year-on-year growth rate of operating income |
| size | Firm size | Nature logarithm of total assets (100 million CNY) |
| Expense | Management efficiency | Nature logarithm of period cost (100 million CNY) |
| ROP | Technological innovation | Return on manpower |
| GPM | Gross profit margin | Gross margin/operation revenue |

**Table 2.** Descriptive statistics.

| Variable | Obs | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| ROE | 33,627 | 12.05 | 16.94 | −197.76 | 199.35 |
| liquid | 33,626 | 2.68 | 4.11 | 0.04 | 204.74 |
| leverage | 33,627 | 0.42 | 0.20 | 0.01 | 1.10 |
| MBR | 33,627 | 0.81 | 6.46 | −871.01 | 433.12 |
| growth | 32,265 | 0.25 | 2.95 | −1.31 | 367.53 |
| size | 33,627 | 3.25 | 1.51 | −5.34 | 10.22 |
| expense | 32,872 | 0.79 | 1.36 | −4.39 | 7.45 |
| ROP | 32,026 | 1.60 | 6.68 | −97.54 | 732.79 |
| GPM | 33,607 | 0.32 | 0.23 | −24.50 | 1.15 |

## 4. Results

In this section, the empirical results of DID are reported; secondly, the regression results of the parallel trend test, the placebo test and the results after taking into account the benchmark influence factors are reported to enhance the credibility of the research method; thirdly, the results of four different robustness tests are reported to further enhance the reliability of the research results; finally, two heterogeneity analyses are conducted to explore whether the policy effects differed significantly between different ownerships and regions.

### *4.1. Empirical Results*

This study uses a de-capacity policy as a quasi-natural experiment to identify how a firm's profitability changes. Benchmark regression results show that the de-capacity policy has a significant positive effect on ROE of steel and coal enterprises. The regression results are reported in Table 3, wherein columns (1)–(4) represent the results of the pooled regression model, individual fixed effect model, two-way fixed effect model, and two-way fixed effects model with control variables, respectively. In this study, the regression coefficients of $Treat_{it}$ in the four columns are strong in terms of statistical significance.

**Table 3.** DID estimates of the effectiveness of the de-capacity policy.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | **ROE** | **ROE** | **ROE** | **ROE** |
| Treat | −1.703 | 6.426 ** | 13.05 *** | 12.04 *** |
| | (1.083) | (2.300) | (2.323) | (2.285) |
| growth | | | | 0.195 |
| | | | | (0.109) |
| liquid | | | | −0.261 *** |
| | | | | (0.0514) |
| leverage | | | | −7.293 *** |
| | | | | (2.019) |
| MBR | | | | 0.00565 |
| | | | | (0.0120) |
| lnsize | | | | −1.607 *** |
| | | | | (0.448) |
| cons | 12.07 *** | 12.00 *** | 21.46 *** | 28.66 *** |
| | (0.0927) | (0.0182) | (0.335) | (1.311) |
| Individual effect | NO | YES | YES | YES |
| Year effect | NO | NO | YES | YES |
| N | 33,627 | 33,627 | 33,627 | 32,264 |
| $R^2$ | 0.000 | 0.001 | 0.091 | 0.094 |

Standard errors are clustered at the firm level. **, and *** indicate statistical significance at the 5%, and 1% levels, respectively.

Using the estimated value in column (4) for explanation and analysis, this study ascertained that the average improvement effect of the de-capacity policy on corporate performance is about 12.04%. This is roughly consistent with the conclusions of existing studies [18]. This means that compared with the control group, the de-capacity policy has increased the ROE of steel and coal companies by an average of approximately 12.04%. The average ROE of the experimental group companies after 2015 was 10.36%, which is an increase of 53.28% compared to before 2015, indicating that the contribution of the de-capacity policy was approximately 22.60%.

### *4.2. Discussion*

The rationality of the DID approach is based on a series of empirical assumptions. To ensure the accuracy and robustness of the results, this section conducts a series of robustness tests on its important recognition hypotheses.

#### 4.2.1. Parallel Trend Test

To verify whether the ROE of the experimental and control groups have a parallel growth trend before the de-capacity policy, we conducted an event study by introducing a parametric specification. Annual changes in firm performance before and after the de-capacity policy are estimated as follows [21]:

$$Dependent_{it} = \alpha + \sum_{k=-3}^{k=3} \beta_k \cdot Dummy_{i,t0+k} + \mu_i + \gamma_t + \varepsilon_{it} \quad (2)$$

Here, the dummy variable $Dummy_{i,t0+k}$ jointly represents the interactive term of the three periods around the de-capacity policy, and $t_0$ denotes the year when the de-capacity policy was implemented ($t_0 = 2015$ *in this case*). In particular, the series of dummy variables is $Dummy_{i,t0+k} = 1$ if $t - t_0 = j$, with $j = -3, -2, -1, 0, 1, 2, 3$. The parameter $\beta_k$ measures the performance difference between the experimental and control groups in the first year of the policy. If the trend in time is calmer, then it is said to be consistent with the parallel trend hypothesis, and vice versa. The results of this trend test are shown in Figure 3.

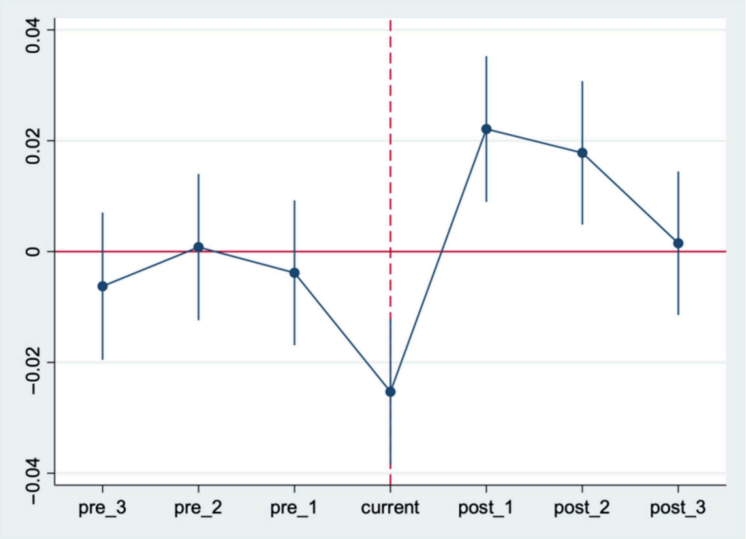


**Figure 3.** Results of parallel test.

As shown in Figure 3, the value of the experimental group is relatively flat and not significant, indicating that there is no significant difference between the experimental group and the control group before the policy occurs, and it begins to rise significantly, indicating that the capacity removal policy has significantly improved the performance of the experimental group enterprises.

4.2.2. Placebo Test

Another concern regarding the DID approach is that unobservable factors affect the estimated results. Different enterprises have diverse characteristics. Although the two-way fixed effect has been added to control the impact of factors that do not change with time and individuals on corporate performance, there may still be some factors that may have different effects with time or individual changes, thus resulting in errors in the estimation results. These effects are beyond the control of the model. Although this study controls a series of financial indicators, such as the current ratio and asset–liability ratio, it cannot control all variables, especially unobservable variables. Therefore, to prove that it is a de-capacity policy, and not other external factors, that led to the improvement in corporate performance, this study utilized two indirect placebo tests. The logic is to find an error variable that will not theoretically affect the explained variable to replace the core independent variable, so its regression coefficient should not be significant. If the wrong variable has a statistical impact on the explained variable, that is, the regression coefficient is significant, it proves that the estimation model in this study is wrong, indicating that other characteristic factors will affect the estimation results. The specific analysis process is as follows.

The de-capacity policy was introduced in 2015, so corporate performance should not be affected or only slightly affected in other years. If the year in which the policy occurred is changed, and the regression result of DID remains unchanged, then we can suspect that other unobservable factors that change over time have affected the estimation results. Table 4 shows the results of the placebo test that advanced the policy shock year from 2015 to 2012.

As shown in Table 4, the regression coefficients of Treat are significant in columns (1) and (2). However, after the time fixed effect and control variables were included, the regression coefficients of Treat were not significant in columns (3) and (4). This demonstrates that the measures for de-capacity have no statistical impact on firms' performance, which is in accordance with the expectations of the placebo test. The aforementioned results further enhance the credibility of the research methods and conclusions.

**Table 4.** Placebo test.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | **ROE** | **ROE** | **ROE** | **ROE** |
| Treat | −7.169 *** | −5.299 *** | 2.645 | 1.398 |
| | (0.929) | (1.520) | (1.541) | (1.539) |
| growth | | | | 0.196 |
| | | | | (0.110) |
| liquid | | | | −0.258 *** |
| | | | | (0.0512) |
| leverage | | | | −7.230 *** |
| | | | | (2.020) |
| MBR | | | | 0.00598 |
| | | | | (0.0118) |
| lnsize | | | | −1.749 *** |
| | | | | (0.451) |
| cons | 12.15 *** | 12.13 *** | 21.43 *** | 28.94 *** |
| | (0.0927) | (0.0211) | (0.335) | (1.321) |
| Individual effect | NO | YES | YES | YES |
| Year effect | NO | NO | YES | YES |
| N | 33,627 | 33,627 | 33,627 | 32,264 |
| $R^2$ | 0.002 | 0.001 | 0.087 | 0.090 |

Standard errors are clustered at the firm level. *** indicate statistical significance at the 1% levels, respectively.

With reference to relevant literature, this study used an indirect placebo test [22,23]. According to Equation (1), the following expression can be obtained:

$$\hat{\beta} = \beta + \gamma \cdot \frac{cov(Treat_{it}, \varepsilon_{it}|W)}{var(Treat_{it}|W)} \quad (3)$$

where $W$ includes all other control variables and fixed effects, and $\gamma$ is the influence of non-observed factors on the explained variable. Because it is randomly generated, $\beta = 0$; if this wrong estimation variable has an impact on the result, that is, $\hat{\beta}$ is not zero, it proves that the previous estimation equation in this study is wrong, indicating that other characteristic factors will affect the estimation result. Specifically, this study makes the impact of the de-capacity policy on corporate performance random, and then makes the random process repeat 500 times, resulting in 500 random $\hat{\beta}$. Figure 4 shows that the $\hat{\beta}$ generated in 500 random processes is concentrated around 0, so $\gamma = 0$ can be inversely deduced, which proves that the unobserved characteristics barely affect the estimation results. This means that the previous estimation results are robust and in accordance with the expectations of the placebo test.

#### 4.2.3. Consider the Impact of Benchmark Factors

The ideal situation of the DID method is that the experimental and control groups are randomly selected. However, in practice, ensuring that sample selection is completely random is difficult. Similarly, the performance of the experimental group will also be affected by the geographical location and the existing economic level, resulting in a deviation in the estimation. To control for the influence of these benchmark factors, the interaction between these benchmark factors and the linear trend of time was added to the regression as the control variable [24]. The regression results, which are included in the benchmark variables, are listed in Table 5.

Specifically, this study uses two binary dummy variables as proxy variables for the benchmark factors and then adds the interaction terms of these two dummy variables and the trend term as control variables in the regression models. The two dummy variables are EAST and CAPITAL. EAST represents whether companies are located in the eastern province. CAPITAL represents whether companies are in municipalities directly under the central government. Columns (1) to (4) in Table 6 show that after controlling for the

intersection of benchmark variables and trend items, the regression coefficient of Treat is still significant at the 1% level. This shows that, after considering the inherent regional differences, the regression results are still robust.

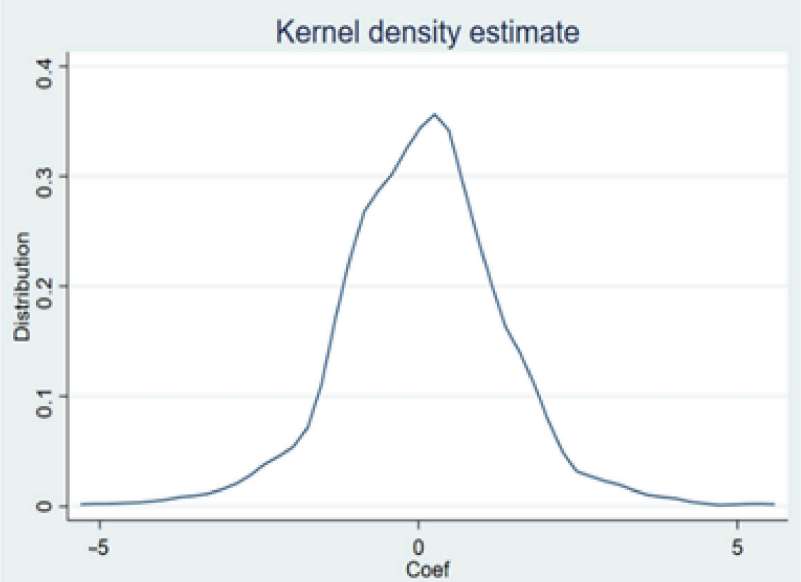


**Figure 4.** Results of Placebo test.

**Table 5.** Regression results with benchmark factors.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | **ROE** | **ROE** | **ROE** | **ROE** |
| Treat | 9.763 *** | 11.57 *** | 9.764 *** | 11.60 *** |
| | (2.291) | (2.301) | (2.294) | (2.305) |
| EAST * Trend | −1.016 *** | −0.369 *** | −1.054 *** | −0.415 *** |
| | (0.0775) | (0.0961) | (0.0827) | (0.0997) |
| CAPITAL * Trend | | | 0.151 | 0.215 * |
| | | | (0.0981) | (0.0998) |
| growth | 0.206 | 0.195 | 0.207 | 0.195 |
| | (0.114) | (0.109) | (0.114) | (0.108) |
| liquid | −0.232 *** | −0.265 *** | −0.230 *** | −0.263 *** |
| | (0.0474) | (0.0515) | (0.0471) | (0.0512) |
| leverage | −5.992 ** | −7.303 *** | −6.005 ** | −7.336 *** |
| | (1.983) | (2.017) | (1.983) | (2.015) |
| MBR | 0.00331 | 0.00588 | 0.00339 | 0.00601 |
| | (0.0121) | (0.0123) | (0.0122) | (0.0124) |
| lnsize | −2.863 *** | −1.538 *** | −2.880 *** | −1.549 *** |
| | (0.390) | (0.447) | (0.390) | (0.447) |
| cons | 27.56 *** | 28.57 *** | 27.60 *** | 28.62 *** |
| | (1.248) | (1.307) | (1.247) | (1.305) |
| Individual effect | YES | YES | YES | YES |
| Year effect | NO | YES | NO | YES |
| N | 32,264 | 32,264 | 32,264 | 32,264 |
| $R^2$ | 0.082 | 0.095 | 0.082 | 0.095 |

Standard errors are clustered at the firm level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

**Table 6.** Robustness test of replacement dependent variable.

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | **L.ROE** | **DROE** | **lnDROE** | **ROE2** | **ROA** |
| Treat | 4.436 ** | 8.354 *** | 0.0137 *** | 11.64 *** | 4.706 *** |
| | (1.560) | (1.502) | (0.00236) | (2.320) | (0.828) |
| growth | −0.124 ** | 0.268 * | 0.000450 * | 0.201 | 0.0956 |
| | (0.0376) | (0.117) | (0.000197) | (0.118) | (0.0530) |
| liquid | −0.0462 | −0.223 *** | −0.000414 *** | −0.261 *** | −0.161 *** |
| | (0.0340) | (0.0513) | (0.0000922) | (0.0532) | (0.0321) |
| leverage | −10.78 *** | −0.881 | −0.00620 | −5.869 ** | −5.336 *** |
| | (1.666) | (1.925) | (0.00336) | (2.024) | (0.779) |
| MBR | 0.0825 * | −0.0947 * | −0.000158 * | 0.00487 | 0.00479 |
| | (0.0417) | (0.0402) | (0.0000662) | (0.0125) | (0.00477) |
| lnsize | 1.242 ** | −1.888 *** | −0.00252 *** | −2.049 *** | −1.595 *** |
| | (0.390) | (0.400) | (0.000666) | (0.519) | (0.298) |
| cons | 22.66 *** | 1.005 | 6.399 *** | 28.65 *** | 20.52 *** |
| | (1.066) | (1.115) | (0.00189) | (1.457) | (0.812) |
| Individual effect | YES | YES | YES | YES | YES |
| Year effect | YES | YES | YES | YES | YES |
| N | 29,787 | 29,787 | 29,787 | 32,264 | 32,264 |
| $R^2$ | 0.099 | 0.017 | 0.017 | 0.093 | 0.135 |

Standard errors are clustered at the firm level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

#### 4.2.4. Other Robustness Tests

To further ensure the reliability of the research conclusions, other robustness tests were conducted in this study. First, a robustness test was conducted by replacing the explained variable, and the corresponding results are listed in Table 6. Second, a robustness test was conducted by changing it to a more similar control group, and the corresponding results are shown in Table 7.

**Table 7.** Robustness test of replacement control group.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | **ROE** | **ROE** | **ROE** | **ROE** |
| Treat | 0.750 | 6.426 ** | 8.709 *** | 8.559 *** |
| | (1.100) | (2.301) | (2.377) | (2.283) |
| growth | | | | 2.310 |
| | | | | (2.121) |
| liquid | | | | −0.195 ** |
| | | | | (0.0658) |
| leverage | | | | −22.62 *** |
| | | | | (4.196) |
| MBR | | | | 0.0139 ** |
| | | | | (0.00531) |
| lnsize | | | | −1.085 |
| | | | | (1.134) |
| cons | 9.613 *** | 9.361 *** | 17.57 *** | 30.06 *** |
| | (0.213) | (0.102) | (0.791) | (3.609) |
| Individual effect | NO | YES | YES | YES |
| Year effect | NO | NO | YES | YES |
| N | 5976 | 5976 | 5976 | 5773 |
| $R^2$ | 0.000 | 0.006 | 0.066 | 0.098 |

Standard errors are clustered at the firm level. **, and *** indicate statistical significance at the 5%, and 1% levels, respectively.

In this section, the lag period of the weighted return on equity (ROE), the difference in the weighted return on equity (DROE), the logarithm of the difference in weighted return on equity (lnDROE), average return on equity (ROE2), and return on total assets (ROA) are regressed as new dependent variables. As shown in Table 6, all regression coefficients are significant, which further shows that the regression results are robust.

Similar to most of the DID research framework, the sample selected in this study is from most of the enterprises listed on the Shanghai and Shenzhen Stock Exchange, and all the enterprises except the experimental group were used as the control group. To make the treatment group and the control group more similar, this study further restricts the control group to Energy II and Material II industries to which the treatment group enterprises belong, and the regression results are reported in Table 7.

As shown in Table 7, except for the slight decrease in the regression coefficient, the regression coefficient of $Treat_{it}$ is still significantly positive at the 1% level, indicating that the estimated results are not affected by the choice of the control group. These results further enhance the credibility of the research methods and conclusions.

### *4.3. Heterogeneity Analysis*

To explore the impact of the de-capacity policy on corporate performance under different ownership and geographic regions, this study conducted two heterogeneity tests. The regression results are presented in Tables 8 and 9.

**Table 8.** Results of ownership heterogeneity.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | State-Owned | | Non-State-Owned | |
| | ROE | ROE | ROE | ROE |
| Treat | 1.769 | 10.45 *** | −1.772 | 10.28 ** |
| | (1.377) | (2.803) | (1.559) | (3.368) |
| growth | | 0.388 | | 0.179 |
| | | (0.578) | | (0.103) |
| liquid | | −0.417 * | | −0.243 *** |
| | | (0.181) | | (0.0514) |
| leverage | | −27.03 *** | | −2.075 |
| | | (3.675) | | (2.323) |
| MBR | | −0.0211 | | 0.0121 |
| | | (0.0311) | | (0.0138) |
| lnsize | | 2.647 *** | | −1.935 *** |
| | | (0.556) | | (0.579) |
| cons | 7.744 *** | 16.76 *** | 13.79 *** | 31.04 *** |
| | (0.149) | (2.137) | (0.113) | (1.426) |
| Individual effect | NO | YES | NO | YES |
| Year effect | NO | YES | NO | YES |
| N | 9677 | 9591 | 23,859 | 22,586 |
| $R^2$ | 0.000 | 0.069 | 0.000 | 0.135 |

Standard errors are clustered at the firm level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Columns (1) and (2) are samples of state-owned enterprises, and columns (3) and (4) are samples of non-state-owned enterprises. Columns (2) and (4) add time fixed effects, individual fixed effects, and control variables based on columns (1) and (3), respectively. Columns (2) and (4) show that the de-capacity policy has a significant effect on the performance of state-owned and non-state-owned enterprises. The seemingly unrelated regression results of the regression coefficients between groups show that there is no significant difference between the performance improvement effect of state-owned enterprises and non-state-owned enterprises because of the de-capacity policy ($p$ = 0.7544).

**Table 9.** Results of region heterogeneity.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | **Eastern Region** | | **Central Region** | | **Western Region** | |
| | **ROE** | **ROE** | **ROE** | **ROE** | **ROE** | **ROE** |
| Treat | −0.759 | 12.46 ** | −0.266 | 11.60 *** | −3.838 | 10.60 * |
| | (1.443) | (4.094) | (1.833) | (2.875) | (3.085) | (4.104) |
| growth | | 0.333 * | | 0.819 | | 0.0366 |
| | | (0.169) | | (0.468) | | (0.0356) |
| liquid | | −0.201 *** | | −0.550 ** | | −0.434 ** |
| | | (0.0481) | | (0.182) | | (0.155) |
| leverage | | −2.741 | | −21.87 *** | | −18.75 ** |
| | | (2.166) | | (5.366) | | (6.761) |
| MBR | | 0.0112 | | −0.0283 | | −0.0000658 |
| | | (0.0128) | | (0.0293) | | (0.0799) |
| lnsize | | −2.270 *** | | −1.080 | | 1.609 |
| | | (0.506) | | (1.176) | | (1.202) |
| cons | 12.82 *** | 29.16 *** | 10.21 *** | 31.91 *** | 9.820 *** | 22.85 *** |
| | (0.105) | (1.429) | (0.231) | (3.707) | (0.325) | (3.954) |
| Individual effect | NO | YES | NO | YES | NO | YES |
| Year effect | NO | YES | NO | YES | NO | YES |
| N | 24,431 | 23,331 | 5487 | 5340 | 3709 | 3593 |
| $R^2$ | 0.000 | 0.117 | 0.000 | 0.087 | 0.000 | 0.059 |

Standard errors are clustered at the firm level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Columns (1) and (2) are samples from the eastern region, columns (3) and (4) are samples from the central region, and columns (5) and (6) are samples from the western region. Columns (2), (4), and (6) add time fixed effects, individual fixed effects, and control variables based on columns (1), (3), and (5), respectively. Columns (2), (4), and (6) show that the overcapacity reduction policy has a significant effect on the corporate performance of steel and coal companies. The seemingly unrelated regression results of the regression coefficients between groups show that there is no significant difference in the effect of the de-capacity policy on the performance improvement in the eastern, central, and western enterprises ($p$ = 0.9147). In summary, the impact of the de-capacity policy on corporate performance is not heterogeneous in terms of ownership and geography, which shows the universality of the de-capacity policy across the country.

## 5. Discussion

The above discussion shows that the de-capacity policy has significantly improved the performance of the target industry. However, what are the variables that make the de-capacity policy affect firm performance? Based on the implementation details of the de-capacity policy and the related literature, this study comprehensively investigates the specific mechanisms by which de-capacity policy affects the performance of the experimental group in terms of profitability, management efficiency, and human return [25,26].

First, a de-capacity policy may improve corporate performance by enhancing the profitability of the industry. On the one hand, the overcapacity policy encourages the withdrawal of outdated production capacity and eases the contradiction of oversupply, thereby promoting the steady recovery of product prices; on the other hand, the overcapacity policy encourages enterprises to adopt new technologies and new equipment to develop new products to achieve transformation and upgrading. To verify this mechanism, this study used the gross profit margin as a proxy variable for profitability.

Second, a de-capacity policy may enhance corporate performance by improving management efficiency. On the one hand, the overcapacity reduction policy has alleviated the unreasonable and excessive intervention of the local government, so that companies that accept preferential policies such as tax reductions and exemptions must improve

quality and efficiency to maintain competitiveness; on the other hand, the overcapacity reduction policy has eased the optimization of resource allocation. The vicious competition in the industry has improved the efficiency of corporate management, which is reflected in the financial indicators; that is, management expenses, financial expenses, and sales expenses as period costs have been controlled and reduced. To verify this mechanism, this study adopted period cost as a proxy variable for management efficiency.

Finally, a de-capacity policy may improve corporate performance by increasing the rate of return on human input. The overcapacity reduction policy has eased the vicious competition in the industry and fostered the transformation and upgrading of the industry. Therefore, companies have the ability and motivation to retrench redundant staff and improve the quality of personnel, thereby improving corporate performance. To verify this mechanism, this study adopts the rate of return on human investment as a proxy variable for human returns.

To further test and quantify the results of the above-mentioned mechanisms, this study adopted the methods of Heckman et al. (2013) and Gelbach et al. (2016) to quantify the mechanism and decompose it using the following formula [27,28].

$$ROE_{it} = \alpha + \beta_1 treat_{it} + \beta_n control_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (4)$$

$$lnM^j_{it} = \alpha + \gamma^j treat_{it} + \beta_n control_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (5)$$

$$ROE_{it} = \alpha + \rho treat_{it} + \sum_j \delta^j lnM^j_{it} + \beta_n control_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (6)$$

In Equations (4)–(6), $i$ represents the enterprise, $t$ represents the year, and $j$ represents the mechanism variable; $M^j_{it}$ represents the mechanism variable $j$ of enterprise $i$ in year $t$. The other variables and coefficient settings are consistent with Equation (1).

$$\beta_1 = \rho + \sum_j \gamma^j \cdot \delta^j \quad (7)$$

Gelbach (2016) established Equation (7). The effect explained by mechanism $j$ is $\gamma^j \cdot \delta^j$, and the remaining unexplained part is $\rho$. Therefore, the proportion of the effect explained by mechanism $j$ is $\gamma^j \cdot \delta^j / \beta_1$.

The regression results are presented in Table 10. In summary, the mechanism analysis results show the following. First, the overcapacity policy has significantly reduced the period cost, which means that management efficiency has been enhanced, thereby improving corporate performance; second, the overcapacity policy has significantly boosted the rate of return on human input, thus fostering the improvement in enterprise performance; finally, the overcapacity reduction policy has advanced the gross profit margin of the experimental group enterprises. The corresponding quantitative analysis results were as follows: The explanation ratio due to the change in management efficiency was 3.12%, the explanation ratio caused by the change in the return on human investment was 20.62%, and the explanation ratio caused by the gross profit margin was 4.44%, which explained 28.18% of the total effect. This result shows that the above-mentioned three aspects of mechanism investigation have strong credibility and explanatory power.

**Table 10.** Results of mechanism analysis.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | **lnexpense** | **lnexpense** | **ROP** | **ROP** | **GPM** | **GPM** |
| Treat | 1.633 *** | −0.213 *** | −0.233 ** | 1.197 *** | −0.118 *** | 0.0534 *** |
| | (0.0830) | (0.0360) | (0.0896) | (0.153) | (0.00716) | (0.00890) |
| growth | | 0.000135 | | 0.0242 | | 0.000323 |
| | | (0.00116) | | (0.0123) | | (0.000287) |
| liquid | | −0.0157 *** | | −0.00836 | | 0.000187 |
| | | (0.00338) | | (0.00850) | | (0.000416) |
| leverage | | 0.745 *** | | −2.424 *** | | −0.129 *** |
| | | (0.0477) | | (0.258) | | (0.0167) |
| MBR | | −0.000205 | | 0.000447 | | −0.000206 |
| | | (0.000285) | | (0.000989) | | (0.000447) |
| lnsize | | 0.658 *** | | 0.476 *** | | 0.00109 |
| | | (0.0118) | | (0.0677) | | (0.00567) |
| cons | 0.778 *** | −1.773 *** | 1.603 *** | 2.293 *** | 0.317 *** | 0.382 *** |
| | (0.00749) | (0.0406) | (0.0377) | (0.211) | (0.00127) | (0.0226) |
| Individual effect | NO | YES | NO | YES | NO | YES |
| Year effect | NO | YES | NO | YES | NO | YES |
| N | 32,872 | 31,544 | 32,026 | 32,007 | 33,607 | 32,256 |
| $R^2$ | 0.012 | 0.724 | 0.000 | 0.018 | 0.002 | 0.011 |

Standard errors are clustered at the firm level. **, and *** indicate statistical significance at the 5%, and 1% levels, respectively.

## 6. Conclusions

### *6.1. Conclusions*

The overcapacity of China's coal and steel industry has gradually drawn attention from scholars. In recent years, the Chinese government has implemented a series of measures to solve the problem of overcapacity. The core goal of the de-capacity policy for the steel and coal industries is to improve firm performance and capacity utilization to achieve sustainable development. However, the existing literature lacks relevant analysis on whether the performance of steel and coal companies has improved. This study evaluates the policy effect of the de-capacity policy on improving the corporate performance of steel and coal enterprises through a difference-in-difference approach. Based on the above discussion, we draw the following conclusions [29].

First, this study found that China's de-capacity policy has significantly improved the performance of steel and coal companies and promoted the high-quality development of the industry. However, it was also found that the effect of the de-capacity reduction policy demonstrated a rapid weakening trend, and there was no significant difference compared with the control group in 2018.

Second, this study found that the mechanism of the impact of China's de-capacity policy on improving firm performance is derived from the improvement in management efficiency, gross profit margin, and return on human investment.

Third, this study found that the de-capacity policy is not heterogeneous in terms of ownership and region, indicating that the effect of the policy is not significantly different due to differences in ownership or region.

### *6.2. Policy Implications*

Based on the above conclusions, the authors propose the following policy implications to enhance the performance of China's steel and coal companies and promote the supply-side structural reform of the steel and coal industry [30].

First, the Chinese government should continue to advance and continuously expand supply-side structural reforms. At the same time, new reform measures should be formulated and introduced in a targeted manner to ensure that the reform effect will not be abandoned

halfway. In general, the government can continue to deepen the policy effect by encouraging technology innovation, and recommending enterprise mergers and reorganizations.

Specifically, the government can encourage enterprises to carry out technological innovation through targeted subsidies. This is beneficial for companies to enhance market competitiveness by improving quality rather than lowering prices, and provides favorable conditions for further reductions in employees. Meanwhile, the government should guide enterprises to carry out mergers and acquisitions, that is, to allow large-scale advantageous enterprises to merge small-scale enterprises with no advantages. This is conducive to giving full play to the advantages of scale and technology, thereby improving the average productivity of the entire industry.

Second, the Chinese government should avoid excessive government intervention in the steel and coal industry and insist that the market plays a decisive role in resource allocation. Appropriate information disclosure is conducive to alleviating information asymmetry in the steel and coal markets, thereby reducing irrational investment and government intervention. Concurrently, the government should also focus on macro-control and policy guidance to avoid vicious competition and disorderly development in the industry to promote high-quality economic development.

Finally, the Chinese government should promote enterprise human capital accumulation and technological innovation in steel and coal companies. As the main body of the market, enterprises play an important role in accumulating human capital and promoting technological innovation. Therefore, the government should take corresponding measures to compensate for the positive externalities of enterprises.

**Author Contributions:** Y.T.: Conceptualization; Data curation; Writing—original draft; Writing—review and editing; L.D.: Data curation; Software; Writing—review and editing; B.Y.: Methodology; Supervision; F.P.: Conceptualization; Writing—review and editing. All authors have read and agreed to the published version of the manuscript.

**Funding:** This study was supported by the foundation of the Sichuan Philosophy and Social Sciences Key Research Base-Social Development and Risk Control Research Center Project (SR20A09), the Fundamental Research Funds for Central Universities of Sichuan University (skbsh2020-05, 2020Ziyan-gongguan05), and the Foundation of Sichuan Provincial Social Science "13th Five-Year Plan" (SC20TJ029).

**Institutional Review Board Statement:** Not applicable.

**Data Availability Statement:** Data available in a publicly accessible repository that does not issue DOIs. Publicly available datasets were analyzed in this study. This data can be found here: [https://www.wind.com.cn/], accessed on 17 November 2020.

**Conflicts of Interest:** The authors declare that they have no competing interest.

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