Review Article

Mixed Ownership Reform of State-Owned Enterprises and R&D Investment

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State-owned enterprise (SOE) reforms may play a vital role in R&D investment. This paper investigates the impact of mixed ownership reform of SOEs in China on R&D investment. Using a large sample of Chinese SOEs for the 2009–2018 period, we find that the reform has a positive effect on R&D investment. The result is robust to a battery of robustness tests and more prominent for firms with non-state-owned large shareholders holding more shares relative to state-owned large shareholders, and for firms with less stress from local officials pursuing political promotion. Furthermore, we find that to compensate for the adverse impact of R&D on the political promotion of the CEO, non-state-owned large shareholders allow the CEO to increase perk consumption. Our study suggests that the ongoing mixed ownership reform in China improves the SOEs’ efficiency.

1. Introduction

SOEs are defined as wholly-owned but managed and operated by the state [1]. SOEs dominate China’s economy [2]. Before the Chinese economic reform in 1978, there were only SOEs in China. Although the government promised non-SOEs to develop after the reform, SOEs are still the most important part of the economy. Due to the ownership, SOEs have a close relationship with the government and easily access resources, such as bank loans [3] and policy support [4], which promotes the development of SOEs. According to the report from the Chinese State-owned Assets Supervision and Administration Commission (SASAC), the revenue of SOEs has an increasing tendency with an annual increase of 5.3% since 2014 and the total assets of SOEs are RMB 233900 billion (about US$32456.3) in 2019 (the data are from the State-Owned Assets Supervision and Administrative Commission: http://www.npc.gov.cn/npc/c30834/202010/8459210b544e4b993e5b46a2e9fa.shtml). SOEs have made great contributions to China’s development. For example, SOEs provide tremendous employment, which helps to maintain social stability. More important, SOEs are one of the forces behind the outstanding success of China’s economy over the last decades [5].

However, SOEs are generally considered to be less efficient, both in productivity and innovation [6]. The state appoints officials to serve as chairman and CEO [7]. In this case, the CEO of an SOE has both the “economic man” and “political man” status and is not a typical professional manager [8]. Since the CEOs are government officials, they temporarily serve in enterprises and generally return to government departments. Political promotion is their main incentive [9], followed by perk consumption [10, 11]. (Salary is important for traditional professional managers [12], but the salary for CEO in SOEs in China is not an important incentive. The salaries of state-owned CEO are limited, usually several times as much as the rank-and-file employees, to maintain the social balance within SOEs [13–15]. The salary of the rank-and-file employees is generally low, so CEO’s salary in SOE is not high. Therefore, salary is not an important incentive in SOE. This makes perk consumption become an important “gray compensation” for CEO in SOE.) R&D activities have a long pay-off period and high risk [16]. However, political promotion is achieved by short-term performance, which makes the CEO have insufficient...
motivation for R&D activities in SOEs. This means that SOEs may have lower R&D investment than non-SOEs.

To improve the efficiency of SOEs and achieve high-quality development of SOEs, the Chinese government has been promoting the reform of SOEs. In 2013, the Third Plenary Session of the 18th CPC Central Committee proposed that mixed ownership should be an important breakthrough in the reform of SOEs and actively promoted mixed ownership reform of SOEs. The main method of the reform is that the government allows non-state-owned shareholders to hold more stocks of SOEs, thus improving the operating efficiency of SOEs. After several years of mixed ownership reform, the State Department of China proposes in its 2020 government report that it will further promote the fourth group of SOEs, namely, 210 firms, to finish mixed ownership reform (the news came from the State-Owned Assets Supervision and Administrative Commission: http://www.sasac.gov.cn/n2588025/n2588119/c14692552/content.html). We know little about whether mixed ownership reform affects corporate R&D investment. In this paper, we investigate the impact of mixed ownership reform on R&D investment in SOEs.

We argue that mixed ownership reform can promote R&D investment in SOEs. In the case of concentrated ownership, large shareholders are widespread and play an important role in corporate governance. Claessens et al. [18] study 8 East Asian countries and find that multiple large shareholders are a common phenomenon. Similarly, Faccio and Lang [19] also find that multiple large shareholders are common in 13 Western European countries. Large shareholders hold more shares and have strong motivation and the ability to participate in corporate governance. Large shareholders can directly use the voting power to elect directors to supervise managers [20] or directly use exit threats to stress managers [21], thus improving managers’ attention to shareholders’ interests. R&D investment is conducive to a firm’s long-term development (Branch, 1974) [22, 23]. When non-state-owned large shareholders enter SOEs, as rational “economic men,” they will ask the CEO to improve R&D investment. Besides, when firms have only controlling large shareholders, firms face the second type of agency problem, namely, the conflict between controlling larger shareholders and small shareholders [24]. Multi-large shareholder ownership can hinder the expropriation of controlling shareholders [25], which make firms have more resources to invest in R&D projects. Finally, external knowledge inflow is important for corporate innovation [26]. Non-state-owned large shareholders may provide innovative knowledge from their enterprises for SOEs, which increases the knowledge base in SOEs, thus promoting R&D investment in SOEs. Therefore, we expect that mixed ownership reform has a positive impact on R&D investment.

To test the impact of mixed ownership reform of SOEs on R&D investment, according to whether an SOE has non-state-owned large shareholders, we divide SOEs into mixed ownership reform and non-mixed ownership reform SOEs. A shareholder, holding more than 10% shares after considering the persons acting in concert, is defined as a larger shareholder. (The existence of the persons acting in concert is a common phenomenon in China, which is a fact that cannot be ignored in the study of Chinese listed firms’ equity structure [15]. China Securities Regulatory Commission requires firms to disclose affiliated relations or belong to the persons acting in concert with the top ten shareholders.) This is because shareholders holding more than 10% shares can convene shareholders meets. Moreover, the “Regulation Opinions on Shareholders’ Meetings of Listed Companies” promulgated in 2000 stipulates that shareholders holding more than 10% of the shares can decide whether to convene a general meeting of shareholders after their proposal, convening the provisional shareholders’ meeting, is rejected by the board of directors (details of the comments can be found on the website of the CSRC: http://www.csrc.gov.cn/pub/shenzhen/xxfw/tzjyzd/ssgs/sszl/ssgsfz/200902/t20090226_95510.htm). An SOE is regarded as experiencing mixed ownership reform when there are non-state-owned large shareholders in a given year. Besides, following Lin et al. [27] and Luo et al. [28], we use R&D expenditure divided by revenue to measure corporate R&D investment.

Using a large dataset of Chinese SOEs for the 2009–2018 period, we find that mixed ownership reform has a positive impact on R&D investment. This evidence is robust to use alternative measures of mixed ownership reform, change the measure of R&D investment, and exclude the sample that controlling shareholder holds more than 50%. In order to reduce the impact of endogenous problems on the research results, we use the Heckman two-step methodology and PSM matching to control endogenous issues. These results show that mixed ownership reform promotes R&D investment.

Based on the availability of data, we only examine whether mixed ownership reform affects R&D investment by improving the supervision of the CEO. We find that mixed ownership reform promotes R&D investment by increasing the CEO’s perk consumption. This is consistent with the reality that political promotion is the most important for the CEO in SOEs, and the improvement of R&D investment adversely affects the CEO’s political promotion. If the supervision of non-state-owned large shareholder makes CEO invest more resource in R&D projects instead of political promotion projects, non-state-owned large shareholders will allow the CEO to increase perk consumption to compensate for the adverse impact of R&D investment on the political promotion of the CEO. The increase in perks means that non-state-owned large shareholders improve supervision for the CEO in SOEs.

The number of shares held by non-state-owned large shareholders relative to state-owned shareholders affects their ability to monitor the controlling shareholder. We use the sharing held by non-state-owned large shareholders divided by the holding held by state-owned large shareholders to measure the ability of non-state-owned large shareholders to supervise state-owned large shareholders. We find that the higher the relative proportion of non-state-owned shareholders in SOEs, the higher the level of R&D investment.
The political promotion of government officials also affects the innovation of SOEs [29, 30]. Chinese central government provides the local government with a large amount of power and discretion in economic reform, which has enabled the local government to control the resources required by firm development [29]. To obtain political promotions, government officials pass on their social tasks and political goals to enterprises, thus affecting enterprises’ decision-making [30], and reducing the R&D investment of SOEs [29]. At the same time, the CEO of SOE and local officials belong to Chinese bureaucracies. In order to maintain good relations in the future, a CEO in SOE has an incentive to accept the interference of local officials. We find that the willingness for political promotion of local officials weak the relationship between mixed ownership reform and R&D investment.

The paper has the following contributions to the existing literature. First, our paper adds to the literature on how government policy affects R&D investment. Prior studies find that government policy plays a vital role in R&D investment, such as government R&D subsidy [31, 32], anti-corruption [33], environmental regulation (Huang et al., 2021), credit policy [34], and industrial policy [35]. This paper examines the effect of mixed ownership reform on R&D investment, which deepens our understanding of how government policy can affect R&D investment.

Second, the paper enriches the literature on the impact of mixed ownership reform on firm operations. Scholars find that mixed ownership reform improves audit quality (Chen et al., 2021) and internal corporate governance [36], promotes total factor productivity [37] and CSR practice [38], and reduces stock price synchronicity [39] and the degree of tax avoidance [40]. Some papers study the impact of mixed ownership reform on corporation innovation [6, 41]. Although the two papers examine mixed ownership reform on corporate innovation, they use R&D investment as the measure of corporate innovation. Therefore, the two papers are closely related to ours. Unlike the two papers, this paper uses a more appropriate measurement of mixed ownership reform and provides the mechanism that mixed ownership reform affects R&D investment.

Finally, this paper enriches the debate about the efficiency of SOEs. At present, most literature indicates that SOEs are inefficient in operation [42–44]. However, some literature believes that the operation of SOEs is effective [45, 46]. Our results show that mixed ownership reform can improve R&D investments, which shows the lack of efficiency of SOEs in R&D investment. The government can consider using mixed ownership reform to improve the innovation ability of SOEs.

2. Hypothesis Development

The CEO of SOEs in China has the dual identities of “political man” and “economic man,” and they are not typical managers [9]. The CEO of SOEs is appointed by the SASAC, and the control market has no effect on their positions. Besides, the CEO’s compensation is strictly limited. In order to maintain the social balance within the SOEs, the salary of the CEO of SOEs is usually a fixed multiple of the company’s employees [15]. This leads to a low salary level for CEOs, and implicit incentives play an important role in the incentive system for CEOs of SOEs [13]. Among them, the most important implicit incentive is a political promotion [8, 9], followed by perk consumption [10, 11]. R&D investment is characterized by high risks and long-term [16]. The failure of R&D not only damages the performance of a company but also makes the CEO of the SOEs lose the possibility of political promotion. At the same time, the benefit of R&D investment has a lag effect and fails to improve the performance of the company in the short term. Due to performance as the key indicator of the political promotion, the characteristics of R&D investment led the CEO of SOEs to have less incentive to improve the company’s R&D investment during their tenure.

The main purpose of mixed ownership reform of SOEs is to introduce non-state-owned large shareholders. Non-state large shareholders are typical “economic men,” and profit maximization is their sole purpose. Non-state-owned large shareholders hold more shares, which makes them capable and willing to participate in corporate governance and effectively supervise the CEO [17]. According to Chinese laws, when a shareholder holds more than 10% share, the shareholder can convene the shareholders’ meetings at any time. Even if the proposal of convening shareholder’s meetings is rejected by the board of directors, they still have the right to convene the shareholders’ meeting. The general meeting of shareholders can also play a greater role in monitoring the CEO of the SOEs because when non-state-owned large shareholders convene a general meeting to query the management of the CEO, it can attract the attention of the SASAC and may have an adverse effect on political promotion. In addition, non-state-owned large shareholders can appoint directors to the board of directors to directly intervene company’s operations and supervise the CEO. R&D investment is conducive to the company’s long-term development [22, 23, 47]. For the long-term development of the company, non-state-owned large shareholders can effectively supervise and intervene R&D investment decisions of the CEO.

Besides, unlike in the U.S., ownership is more highly concentrated in China [7]. High ownership concentration means that the agency problem in corporate governance is the horizontal problem of agency conflict between controlling shareholders and minority shareholders. Due to the large gap between cash flow claims and control rights, controlling shareholders have more incentive to expropriate the benefit of minority shareholders, such as self-dealing, tunneling, and outright theft [48, 49]. Minority shareholders have less incentive to supervise the expropriation of controlling because the benefit of supervision is smaller than the cost. However, scholars argue that multiple large shareholders may monitor the firm and one another, improving corporate governance [25, 50]. Larger shareholders can supervise controlling shareholders by submitting proposals to management [51], negotiating with management [17], and exiting [52]. Although the government is the controlling shareholder of SOEs and does not expropriate corporate resources for private benefit, the government may ask SOEs
to endure public burden, such as more employment. This harms the interest of other shareholders and appropriates resources belonging to minority shareholders. Mixed ownership reform helps to develop an ownership structure with multiple large shareholders, which improves corporate governance. Meanwhile, prior studies argued that better corporate governance stimulates corporate R&D investment [53]. Therefore, mixed ownership reform allows SOEs to invest more resources in R&D projects.

Finally, non-state-owned large shareholders may provide more resources for corporate R&D projects, stimulating R&D investment. In the era of the knowledge economy, no firm can generate all ideas used in the innovation process. To increase innovativeness and improve competition, firms need to promote the inflows of external knowledge and open innovation process [54], Huizining et al., 2011. In mixed ownership reform, innovation knowledge may inflow SOEs from enterprises that are controlled by non-state-owned large shareholders, which increases the knowledge base and stimulate SOEs to invest more in R&D projects. Based on the above analysis, we propose the following assumptions.

**Hypothesis 1.** Mixed ownership reform of SOEs has a positive effect on R&D investment.

The stock share of other large shareholders relative to controlling shareholders is one of the important factors affecting their monitoring ability [55, 56]. A higher stock share of non-state-owned large shareholders means that non-state-owned large shareholders can obtain more benefits from participating in corporate governance in SOEs, increasing the incentive to supervise CEOs. Therefore, in mixed ownership reform of SOEs, the more non-state-owned shareholders hold more shares, the stronger their role in supervising the CEO; thus, the less likely the CEO is to reduce R&D investment for political promotion. Besides, non-state-owned shareholders with more shareholders may hinder the expropriation of controlling shareholders’ public policy, such as stable employment, which reduces SOEs’ burden and makes SOEs have more resources to invest in R&D projects. Finally, holding more shares also stimulates non-state-owned large shareholders to share voluntary more of their own innovation knowledge with SOEs to improve SOEs’ innovation input because more innovation outputs can improve firm performance, thus increasing their investment return in SOEs. Based on the above analysis, we propose the following assumptions.

**Hypothesis 2.** The impact of mixed ownership reform of SOEs on R&D investment is more prominent for firms where non-state-owned large shareholders hold more shares relative to state-owned shareholders.

Government has an important impact on microeconomics development in a market economy led by the government [29]. When the central government delegates a large amount of discretionary power to the local government, the local government officials control administrative and economic resources needed for enterprise development [24]. For political promotion, local officials will transfer their social tasks and political goals to enterprises, which makes the decision-making and development of enterprises subject to the government [30]. The high-risk and long-term characteristics of corporate R&D investment are difficult to meet the short-term goals of local governments. Local governments might force SOEs to reduce or postpone R&D investment and use the funds to invest in fixed assets that provide more employment and have faster economic effects. Wang et al. [29] point out that the promotion pressure of local officials will inhibit the R&D investment of SOEs. In addition, the CEO of SOEs and local officials belong to the Chinese bureaucratic system. In order to maintain good relations in the future, the CEO has an incentive to accept the interference of local officials in the decision-making of enterprises. Therefore, when local officials have a greater willingness for political promotion, the impact of mixed ownership reform on R&D investment will be weakened. Based on this, we propose the following assumptions.

**Hypothesis 3.** The political promotion willing of local officials can weak the role of mixed ownership reform of SOEs in promoting R&D investment.

### 3. Samples and Empirical Methodology

#### 3.1. Sample

We use the data from the 2009–2018 period of Chinese A-share listed SOEs as samples. (Many Chinese listed companies issue two types of shares: A shares and B shares. A shares are priced in RMB and are mainly purchased by Chinese residents. B shares are denominated in foreign currencies (B shares issued by Shanghai listed companies are priced in US dollars, while B shares issued in Shenzhen are denominated in Hong Kong dollars). The main buyers are foreign investors. The use of 2009 as the beginning of the data is because China’s listed companies began to adopt the new accounting standards in 2007, and by 2009, the new accounting standards have been widely adopted. Besides, we also want to exclude the effect of the financial crisis in 2008.) The R&D data come from two databases: the China Securities Market and Accounting Research (CSMAR) and China Research Data Service Platform (CNRDS). (These databases are the most commonly used data by Chinese scholars. Due to the serious lack of R&D investment data in a single database, we merge the R&D investment data of these databases.) Other data come from the CSMAR database, RESSET database, and CNRDS database. Then, we exclude financial services companies (financial companies are excluded because they adopt different accounting standards) and firm-year observations with missing information for variables. Our final sample includes 6371 firm-year observations representing 969 individual SOEs. We also winsorize all continuous variables at 1% and 99% to mitigate the effect of outliers.

The Panel A of Table 1 shows the distribution of the sample in different industries. The industry classification standards come from the China Securities Regulatory Commission’s 2012 industry classification guidelines for listed companies. As shown in Table 1, the manufacturing industry occupies 69.3% of the total sample. This is because
China is a large manufacturing country, and listed companies are mainly concentrated in the manufacturing industry. Panel B reported the changes in mixed ownership reform of SOEs in the sample period. From Panel B, it can be seen that mixed ownership reform of SOEs has gradually increased, especially after 2013. (The reason for the decline in the number of mixed reform state-owned enterprises in 2015 is that China’s stock market fluctuated greatly, the liquidity of private capital fell into difficulties, and state-owned funds entered the stock market to rescue the market.)

3.2. Measurement of R&D Investment (RD). Following Luo et al. [28] and Fu and Jian [57], we use the company’s R&D expenditure divided by revenue to measure the company’s R&D investment (RD).

3.3. Measurement of Mixed Ownership Reform of SOEs (Mixed). First, A shareholder, holding more than 10% shares after considering the persons acting in concert, is defined as a larger shareholder. Then, an SOE is regarded as experiencing mixed ownership reform when there are non-state-owned large shareholders in a given year. The value of the variable Mixed is 1 when an SOE belongs to the sample of mixed ownership reform and otherwise 0. We also use the share of non-state-owned large shareholders scaled by total shares to measure mixed ownership reform in robustness tests (Mixed1).

3.4. Empirical Model. In order to study the impact of mixed ownership reform of SOEs on R&D investment, we construct the following model:

$$RD_{it} = \beta_0 + \beta_1 Mixed_{it} + \gamma Controls_{it} + Industry_{dummies} + Year_{dummies} + \epsilon_{it},$$

where $i$ and $t$ represent a company and the year, respectively. We also control other factors that affect R&D investment. Specifically, we control the size of the company (Size), debt ratio (Lev), return rate (ROA), free cash flow (Cash), fixed asset (Tangi), company’s age (Age), CEO duality (Duality), the proportion of independent directors (Indep), audit quality (Audit), and industry competition (HHI and HHS). At the same time, we also controlled industry fixed effects (Industry_dummies) to control unobservable time-invariant industry-specific characteristics and year-fixed effects (Year-dummies) to control common time trends. (According to the industry classification standard of the China Securities Regulatory Commission, we further subdivide the manufacturing industry into four categories using 2-digit code.) All variables are defined in Table 2.

4. Main Regression and Robustness Tests

4.1. Descriptive Statistics of Variables. Panel A of Table 3 reports the descriptive statistical results of the variables used in our analysis. The median value and maximum value of RD
are 0.0257 and 0.1508, respectively. This shows that R&D investment among SOEs has a relatively large heterogeneity. The average value of mixed ownership reform is 0.2427, indicating that the sample of mixed ownership reform of SOEs accounts for 24.27% of the total sample. The correlation between the variables is reported in Panel B in Table 3. Mixed and RD are positively correlated at the statistical level of 5%, indicating that mixed ownership reform is conducive to the R&D investment of SOEs. In addition, the correlation coefficients between mixed ownership reform and other control variables are not high, indicating that multicollinearity is not a serious problem.

4.2. Main Result. Table 4 reports the estimates of the main regression model (1). In column 1, we only regress R&D on mixed ownership reform. The regression coefficient of Mixed is positive and significant at the statistical level of 1%, suggesting that mixed ownership reform of SOEs promotes R&D investment. In column 2, we control company size (Size), debt ratio (Lev), return rate (ROA), cash flow (Cash), fixed asset (Tangi), and company’s age (Age). The regression coefficient of Mixed is positive and significant at the statistical level of 1%. In column 3, we further control CEO duality (Duality), the ratio of independent directors (Indep), audit quality (Audit), and industry competition (HHI and HHS). The regression coefficient of Mixed is still positive and significant at the statistical level of 1%, which supports Hypothesis 1, indicating that mixed ownership reform of SOEs has a positive effect on R&D investment. It should be noted that in our study, the regression result of the Size is negative and significant at the statistical level of 1%. This is different from the research of Fu and Jian [57]. They take the whole A-share listed companies in China as the research sample and find that the larger the company size, the higher the level of R&D investment. Our paper, however, shows that a larger SOE has a lower R&D investment. This is because SOEs do not aim to maximize profits, and they undertake lots of social and political tasks of the government (Shleifer and Vishny, 1994). When the scale of an SOE is larger, the more social and political tasks are required to undertake by the government, and the more resources invested in R&D investment will be squeezed out, thus reducing a company’s R&D investment.

4.3. Robustness Test. In this section, we conduct the following robustness test. First, we change the measurement of mixed ownership reform. We use the share of non-state-owned large shareholders scaled by total shares to measure mixed ownership reform (Mixed1). As shown in column 1 of Table 5, the coefficient of Mixed1 is significantly positive, which is consistent with the finding in Table 4. Our finding remains valid.

Second, some empirical literature defines shareholders with more than 5% shares as large shareholders and believes that they will have an important impact on corporate governance because shareholders holding more than 5% shares need to be publicly disclosed [21], Chen et al., 2009, and Luo et al., 2013. Therefore, we change the measuring way of mixed ownership reform and define a firm as a sample of mixed ownership reform when there are non-state large shareholders who hold more than 5% of the shares in a given year (Mixed2), and use model (1) to regress. The regression results are shown in column 2 of Table 5. The coefficient of Mixed is positive and statistically significant at 1%, indicating that mixed ownership reform is conducive to R&D investment.

Besides, we change the measure of R&D investment. Specifically, following Kong et al. [58], we use the company’s R&D expenditure divided by total assets to measure R&D investment (RD1). The regression results are shown

| Table 2: Variable definitions. |
|-------------------------------|
| **RD** | R&D expenditure divided by revenue |
| **RD1** | R&D expenditure divided by total assets |
| **Mixed** | It is a dummy variable. On the basis of merging persons acting in concert, if non-state-owned large shareholders with more than 10% of the shares in SOEs, mixed equals 1 and otherwise 0 |
| **Mixed1** | The share of non-state-owned large shareholders scaled by total shares |
| **Mixed2** | It is a dummy variable. On the basis of mergers acting in concert, if non-state-owned large shareholders with more than 5% of the shares in SOEs, mixed equals 1 and otherwise 0 |
| **Size** | The natural logarithm of the book value of total assets at the end of the fiscal year |
| **Lev** | Firm’s debt divided by total assets |
| **ROA** | Net profit divided by total assets |
| **Cash** | Free cash flow divided by total assets |
| **Tangi** | Net fixed assets divided by total assets |
| **Age** | The natural logarithm of the year of company’s establishment plus 1 |
| **Duality** | Dummy variable, if CEO duality person, duality equals 1 and otherwise 0 |
| **Indep** | The number of independent directors divided by the total number of directors |
| **Audit** | Dummy variable, when the company’s financial audit company is the top four audit company this fiscal year, the value is 1 and otherwise 0 |
| **HHI** | The square of HHI |
| **HHS** | Non-state large shareholder’s shareholding divided by state-owned large shareholder’s shareholding |
| **Balance** | The difference fiscal expenditure and fiscal revenue divided by GDP |
| **Promotion** | Corporate management costs minus the sum of executive compensation divided by operating income |
Table 3: Panel A descriptive statistics of variables. Panel A in Table 3 reports the descriptive statistics for mixed ownership reform of SOEs, R&D investment, and control variables. Panel B reports the Pearson correlation matrix. The sample period is 2009–2018. The symbols *, **, and *** denote significance level at the 10%, 5%, and 1% levels, respectively.

| Variable | N  | Mean       | Std        | Minimum | Median | Maximum |
|----------|----|------------|------------|---------|--------|---------|
| RD       | 6371 | 0.0257     | 0.0283     | 0.0001  | 0.0176 | 0.1508  |
| Mixed    | 6371 | 0.2427     | 0.4287     | 0.0000  | 0.0000 | 1.0000  |
| Size     | 6371 | 22.6638    | 1.4242     | 20.0133 | 22.4733| 26.9495 |
| Lev      | 6371 | 0.5124     | 0.2028     | 0.0846  | 0.0397 | 0.9558  |
| ROA      | 6371 | 0.0426     | 0.0664     | −0.1804 | 0.0269 | 0.1865  |
| Cash     | 6371 | 0.0426     | 0.0664     | −0.1385 | 0.0397 | 0.2321  |
| Tangi    | 6371 | 0.2575     | 0.1751     | 0.0085  | 0.2191 | 0.7444  |
| Age      | 6371 | 22.6638    | 1.4242     | 20.0133 | 22.4733| 26.9495 |
| Duality  | 6371 | 0.0973     | 0.2964     | 0.0000  | 0.0000 | 1.0000  |
| Indep    | 6371 | 0.3692     | 0.0540     | 0.3125  | 0.3333 | 0.5714  |
| Audit    | 6371 | 0.0973     | 0.2964     | 0.0000  | 0.0000 | 1.0000  |
| HHI      | 6371 | 0.0927     | 0.0664     | −0.1385 | 0.0397 | 0.6721  |
| HHS      | 6371 | 0.0279     | 0.0974     | 0.0003  | 0.0012 | 0.4517  |

Panel B

|          | RD   | Mixed | Size  | Lev  | ROA  | Cash | Tangi | Age   | Duality | Indep | Audit | HHI | HHS |
|----------|------|-------|-------|------|------|------|-------|-------|---------|-------|-------|-----|-----|
| RD       | 1    |       |       |      |      |      |       |       |         |       |       |     |     |
| Mixed    | 0.032** | 1     |       |      |      |      |       |       |         |       |       |     |     |
| Size     | −0.216*** | 0.146*** | 1     |      |      |      |       |       |         |       |       |     |     |
| Lev      | −0.276*** | −0.031** | 0.391*** | 1     |      |      |       |       |         |       |       |     |     |
| ROA      | 0.053*** | 0.045*** | 0.030** | −0.427*** | 1     |      |       |       |         |       |       |     |     |
| Cash     | −0.060*** | 0.030** | 0.098*** | −0.173*** | 0.380*** | 1     |       |       |         |       |       |     |     |
| Tangi    | −0.208*** | −0.019 | 0.088*** | 0.112*** | −0.186*** | 0.245*** | 1     |       |         |       |       |     |     |
| Age      | −0.206*** | −0.080*** | 0.180*** | 0.213*** | −0.155*** | −0.029*** | 0.045*** | 1     |         |       |       |     |     |
| Duality  | 0.008 | 0.0120 | −0.060 | −0.002 | 0.002 | 0.0110 | −0.0100 | 0.0120 | 1         |       |       |     |     |
| Indep    | −0.023 | 0.044*** | 0.183*** | 0.067*** | −0.044*** | −0.025** | −0.050** | 0.0130 | 0.030** | 1     |       |     |     |
| Audit    | −0.085*** | 0.226*** | 0.421*** | 0.090*** | 0.072*** | 0.100*** | 0.0200 | 0.049*** | 0.0180 | 0.119*** | 1   |     |     |
| HHI      | 0.047*** | 0.0120 | 0.044*** | −0.051*** | 0.053*** | 0.041*** | −0.143*** | −0.139*** | −0.028** | 0.0120 | 0.0160 | 1   |     |
| HHS      | 0.112*** | 0.001 | −0.030*** | −0.075*** | 0.052*** | 0.030*** | −0.134*** | −0.139*** | −0.025** | −0.0130 | −0.006 | 0.958*** | 1   |
in column 3 of Table 5. The coefficient of Mixed is positive and significant at a statistical level of 5%, indicating that mixed ownership reform of SOEs has a positive effect on R&D investment. Meanwhile, when controlling large shareholders holding stock shares of more than 50%, they have absolute control over the company. Under such circumstances, the introduction of non-state-owned large shareholders to play the role of the monitor is weak [15]. We exclude the sample of state-owned large shareholders total holding more than 50%. The regression results are shown in column 4 of Table 5. The coefficient of Mixed is positive and statistically significant at 5%, which is consistent with our Hypothesis 1.

Moreover, the previous analysis that the relationship between mixed ownership reform and corporate R&D is significantly positive may be caused by the existence of endogenous issues, such as sample selection bias or sample self-selection bias. We use the Heckman two-stage estimation methodology and propensity score matching (PSM) to control potential endogenous problems. First, to solve the existing sample selection bias, following Ben-Nasr et al. [59], we use the average value of mixed ownership reform of other companies in the industry this year as the instrumental variable of mixed ownership reform of individual companies. This is because mixed ownership reform of an SOE is generally related to mixed ownership reform in the same industry, but mixed ownership reform of other SOEs in the industry does not directly affect the individual company’s R&D investment. The regression results of Heckman’s two-step method are shown in column 5 of Table 5, and the coefficient of Mixed is positive and statistically significant at 1%, indicating that mixed ownership reform is conducive to R&D investment. At the same time, the regression coefficient of inverse Mills (Imr) is not significant, which shows that the sample used in this paper has not an obvious sample selection problem. To solve the problem of sample self-selection, we used propensity score matching to match the samples. The methodology can make the corporate characteristics of mixed ownership reform and non-mixed ownership reform not significantly different. We perform a 1:1 nearest matching based on a set of firm characteristics. Specifically, in the calculation of the probability of the first stage of mixed ownership reform, we use some factors that might affect a firm’s mixed ownership reform, including the company size, debt ratio, return ratio, free cash flow, fixed asset, and company age. Panel B of Table 6 presents the results of variable matching. We can find that there is no significant difference in the characteristics of mixed ownership reform and non-mixed ownership reform after matching. Based on sample matching, we use model (1) to examine the relationship between mixed ownership reform and R&D investment. As shown in column 6 of Table 5, the coefficient of Mixed is positive and significant at a statistical level of 5%, indicating that mixed ownership reform is conducive to R&D investment.

5. Further Analysis

In this section, we analyze the impact of mixed ownership structure and political promotion on the relationship between mixed ownership reform and R&D investment, respectively.

5.1 The Impact of the Relative Proportion of Non-State-Owned Large Shareholders Holding Shares. The shareholding proportion of non-controlling large shareholders relative to the controlling shareholder is the most important condition for non-controlling large shareholders to play a monitoring role in corporate governance [55]. In mixed ownership reform of SOEs, the greater the proportion of non-state-owned large shareholders, the stronger their ability to supervise the CEO. We use the shares of non-state-owned large shareholders divided by the shares of state-owned large shareholders to measure the relative proportion of non-state-owned large shareholders’ stock
We replaced the Mixed in the model (1) with the variable Balance for regression. The regression results are shown in column 1 of Table 7. The regression coefficient of Balance is positive and significant at a statistical level of 1%, suggesting that the greater the relative proportion of non-state-owned shareholders in mixed ownership reform, the stronger the impact of mixed ownership reform on R&D investment, which supports our Hypothesis 2.

| Variables | Unmatched Mean | Matched Mean | %Bias | | | t | p |
|-----------|----------------|--------------|-------|----------|---------|----------|----------|
| Size      | U 23.032       | 22.546       | 31.7  | 96.9     | 11.81   | 0.000    |
|           | M 23.036       | 23.051       | -1.0  | -0.26    | 0.797   |          |
| Lev       | M 0.50111      | 0.51977      | -7.3  | 87.1     | -2.51   | 0.012    |
|           | U 0.50084      | 0.50275      | -0.9  | -0.26    | 0.796   |          |
| ROA       | M 0.03398      | 0.02838      | 10.4  | 69.9     | 3.6     | 0.000    |
|           | U 0.03404      | 0.03572      | -3.1  | -0.89    | 0.374   |          |
| Cash      | M 0.04603      | 0.04144      | 6.9   | 94.7     | 2.36    | 0.018    |
|           | U 0.04615      | 0.04639      | -0.4  | -0.10    | 0.919   |          |
| Tangi     | M 0.25154      | 0.25945      | -4.5  | 67       | -1.55   | 0.122    |
|           | U 0.2518       | 0.24919      | 1.5   | 99.1     | -6.39   | 0.000    |
| Age       | M 2.4074       | 2.5317       | -17.6 | 99.1     | -6.39   | 0.000    |

Panel B matching balance results
5.2. The Impact of Political Promotion of Local Government Officials. Political promotion of local government officials will affect the decision-making of SOEs [30]. We use the government financial pressure of the prefecture where the state-owned enterprise is located to quantify the political promotion intention. (A prefecture is an administrative division, ranking below a province and above a county in the Chinese administrative structure. A prefecture is larger than a “city” in the usual sense of the term. It is an administrative unit comprised of a main central urban area (usually with the same name as the prefecture) and its larger surrounding rural area, containing many smaller cities, towns, and villages [60].) This is because the economic growth as the main indicator of political promotion assessment makes the scale of local government public expenditure tend to be expansionist [29]. Larger fiscal expenditures for political promotion will bring greater financial pressure, which makes the local government’s financial pressure become a better indicator of political promotion. We use fiscal expenditure and fiscal revenue difference divided by GDP to measure the willingness for political promotion of local officials (Promotion). We use model (2) to examine the impact of the political promotion willing of local government officials on the relationship between mixed ownership reform and R&D investment:

\[
RD_{it} = \beta_0 + \beta_1\text{Promotion}_{it} \times \text{Mixed}_{it} + \beta_2\text{Mixed}_{it} + \beta_3\text{Promotion}_{it} + \gamma\text{Controls}_{it} + \text{Industry\_dummies} + \text{Year\_dummies} + \epsilon_{it}.
\]

The regression results are shown in the second column of Table 6. On the basis that the coefficient of Mixed is significantly positive, the coefficient of Mixed × Promotion is negative and statistically significant at 1%, indicating that the
political promotion incentives of local officials have a negative on the relationship between mixed ownership reform on R&D investment, which is consistent with our Hypothesis 3.

6. Mechanism Tests

In this section, we explore possible economic mechanisms through which mixed ownership reform affects R&D investment. In theoretical analysis, we point out that mixed ownership reform can affect R&D investment by supervising the CEO, reducing the expropriation of controlling shareholders and increasing innovation knowledge inflow. However, investigating these channels is challenging in our setting, because not all channels are easily observable and measurable. For example, the controlling shareholders of SOEs expropriate firms’ resources to achieve policy burden and provide innovation knowledge for SOEs. Hence, we only provide suggestive evidence that mixed ownership reform affects R&D investment by supervising the CEO to advance understanding of the channel.

The CEO in SOE has the dual status of “economic man” and “politician man.” As government-appointed officials, political promotion is their main incentive, followed by perk consumption [9, 11, 13]. The characteristics of a company’s R&D investment will adversely affect the political promotion of the CEO. Because the CEO is appointed by the government and the position is stable, the supervision behavior of the non-state-owned large shareholders cannot be a threat to the CEO position. Moreover, CEO compensation is strictly restricted by the government. If the supervision of non-state-owned large shareholders makes CEO invest more resource in R&D projects instead of political promotion projects, non-state-owned large shareholders will allow CEO to increase perk consumption to compensate for the adverse impact of R&D investment on the political promotion of the CEO. The increase in perks means that non-state-owned large shareholders improve supervision for the CEO in SOEs. Following Luo et al. [11], we use the company management costs minus the sum of executive compensation divided by revenue to calculate the perk consumption of the CEO (Perk). Following Ye et al. [61], we first use model (3) to examine the impact of mixed ownership reform on the CEO perk consumption. Then, we use model (4) to test the impact of perk consumption on R&D investment. If the value of coefficient or statistical significance of Mixed in the model (4) is lower than that in column 3 of Table 4, non-state-owned large shareholders influence R&D investment by improving the perk consumption level of the CEO in mixed ownership reform, which also suggests that mixed ownership reform improves R&D investment by increasing supervising for CEO:

$$\text{Perk}_{it} = \beta_0 + \beta_1 \text{Mixed}_{it} + \gamma \text{Controls}_{it} + \text{Industry}_d, \text{Year}_d + \epsilon_{it},$$

$$\text{RD}_{it} = \beta_0 + \beta_1 \text{Mixed}_{it} + \beta_2 \text{Perk}_{it} + \gamma \text{Controls}_{it} + \text{Industry}_d, \text{Year}_d + \epsilon_{it},$$ (3)

In mode (3), the control variables are the same as the model (1). The regression result of the model (3) is shown in the first column of Table 7. The regression coefficient of Mixed is positive and significant at 1% of the statistical level, suggesting that mixed ownership reform of SOEs CEO’s perk consumption. (Executive compensation is the company’s normal management expenditures, which obviously do not belong to perk consumption. When calculating perks, these items should be subtracted.)

The control variables in the model (4) are the same as those in the model (1). In column 2 of Table 6, based on the coefficient of Perk is significantly positive, the value of the coefficient of Mixed is smaller compared to that in column 3 of Table 4 and is significant, indicating that non-state-owned large shareholders affect R&D investment by increasing CEO’s perk consumption. This also suggests that mixed ownership reform improves R&D investment by increasing supervising for CEO.

7. Discussion

7.1. Conclusion. This paper examines the impact of mixed ownership reform of SOEs on R&D investment. Using Chinese 2009–2018 A-share listed SOEs, we find that mixed ownership reform is conducive to R&D investment. After changing the measurement method of R&D investment, using alternative measurements of mixed ownership reform, and excluding the sample of controlling shareholders holding more than 50%, the relationship between mixed ownership reform and R&D investment remains stable. Moreover, we find that the higher the relative shareholding proportion of non-state-owned large shareholders strengthens the impact of mixed ownership reform on R&D investment. However, the political promotion willing of local officials will weaken the impact of mixed ownership reform on R&D investment. To control the impact of possible endogenous issues on the results, we use the Heckman two-stage estimation and PSM matching to deal with sample selection errors and sample self-selection bias, respectively. Finally, we find that the non-state-owned large shareholders will allow the CEO to increase perk consumption to compensate for the adverse impact of R&D investment on the CEO’s political promotion, indicating that mixed ownership reform promotes R&D investment by improving the supervision of the CEO.

7.2. Policy Implication. The evidence provided in this paper should be of interest not only for scholars, but also for policymakers given the fact that mixed ownership reform can promote R&D investment in SOEs. To stimulate R&D investment, the government can consider the following advice:

1. Deepen mixed ownership reform in SOEs. R&D investment is the most important factor affecting corporate innovation that drives economic development and improves firm competition. To
stimulate R&D investment, the government may expand the scope of mixed ownership reform, such as zombie companies. Meanwhile, the government also should strengthen the supervision of the reform because SOE reforms usually cause a great loss of state capital, which is adverse to improving the development quality of SOE.

(2) Design more perfect compensation contracts for CEO in SOEs. Compensation is one of the important incentive tools to stimulate CEO effort. However, to keep income equality internal, SOEs do not pay enough salary to CEOs, which makes perks become implicit incentives. In mixed ownership reform, non-state-owned shareholders allow CEOs to increase perks to compensate for the adverse impact of R&D investment. Without efficient supervision, CEOs may use perks to appropriate firms’ assets. Therefore, the government may consider designing market-oriented compensation contracts and improving the tolerance of income gaps in firms.

(3) Reduce the intervention for SOEs by local government. Political promotion may induce local officials to focus on the short-term economic growth and ask firms to invest in some projects that quickly obtain returns which might crow out R&D investment. To reduce the intervention for SOEs by local government, the central government can reduce the weight of economic growth in officials’ political promotion.

7.3. Limitations and Further Research Directions. Notably, this study provides limited methods to correct endogenous issues. Although the two methods used in this paper can alleviate the concern that endogenous issues, missing important variables that affect the enforcement of mixed ownership reform and R&D investment may bias the research finding. Besides, R&D investment is key input of innovation. However, we know little about the result of R&D investment. This paper does not provide further research on innovation output. Finally, mixed ownership reform may affect R&D investment by several mechanisms. This paper only provides one mechanism that mixed ownership reform affects R&D investment by improving supervision for CEO in SOEs. This shortcoming is another direction for further research.

Data Availability
The data used to support the finding of this study are available from the corresponding author upon request.

Conflicts of Interest
The authors declare that they have no conflicts of interest.

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