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## Article

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# Impact of mixed ownership reforms on firm innovation—empirical evidence from China

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## ABSTRACT

Based on data from Chinese A-share listed companies from 2008–2018, an investigation is carried out upon the impact of mixed ownership reforms and relative control transfers on corporate innovation before and after the occurrence of mixed ownership reforms, and relative control transfers in state-owned and private enterprises, as well as their mechanisms of action. A double-difference propensity score matching method is adopted. It has been found that mixed ownership reforms are more likely to promote innovation in SOEs, particularly in monopolistic industries. A further subsample test reveals that in state-owned enterprises in monopolistic industries, the acquisition of relative control by private shares can amplify the innovation effect of mixed ownership reforms. In private companies in competitive industries, state-owned shares can only fuel innovation if they gain relative control. Reducing agency costs and easing financing constraints are important channels for mixed ownership reform to promote corporate innovation.

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Mixed ownership reform;  
relative control transfer;  
corporate innovation;  
agency costs; financing  
constraints

## 1. Introduction

The introduction of private capital was proposed in the 1990s in China to increase productivity, which formed the beginnings of a mixed ownership reform. The Chinese government officially proposed the mixed ownership economy as a form of realisation of the basic economic system in 2013, and mixed ownership reform has officially become a hot topic of research. A mixed ownership system is an equity structure where state-owned and non-state-owned capital are integrated. It allows not only private shares to participate in state-controlled enterprises, but also state-owned shares to get involved in privately held enterprises, thereby promoting high-quality economic development by combining the strength of state-owned enterprises with the vitality of private enterprises. Consequently, the following problems have emerged: what will be the impact of the participation of state-owned shares and private shares in privately held and state-controlled enterprises respectively in the process of mixed ownership reform? Does it behave differently in different sectors? Besides, what are the mechanisms of their effects? To this end, the study of these issues will help solve the current problems of “mixed but

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not compatible”, and provide theoretical references for further promoting mixed ownership reform.

The existing literature reveals that most studies on mixed ownership reforms have focused on the topic of state-owned enterprises and mixed ownership reforms, which confirms the positive impact of mixed ownership reform on firm performance or productivity (Gupta, 2005; Zhang, Yu, & Chen, 2020). However, the effectiveness of mixed ownership reform cannot be judged by the economic effect alone; the goal of mixed ownership reform is to enhance the competitiveness and innovation of the state-owned economy and to cultivate globally competitive world-class enterprises. Therefore, it has also been further pointed out in the literature that the effect of mixed ownership reform should be linked to corporate innovation (Gao, Hsu, & Li, 2018), with the focus placed on both the nature of equity and equity structure. In terms of the nature of equity, most scholars argue that SOEs not only suffer from a lack of ownership (Chen, 2010), but their complex investment project decision-making mechanism also leads to missed innovation opportunities (Qian & Xu, 1998), even a loss of innovation efficiency in SOEs (Megginson, Ullah, & Wei, 2014). In terms of equity structure, Ferreira, Manso, and Silva (2014) argued that an increase in the proportion of non-state equity can not only reduce agency costs, but also mitigate the tendency to avoid innovation risks within firms by leveraging their innovation resources and political connections, thus incentivising higher levels of innovation. However, there have been some opposite ideas. For instance, Hoff and Stiglitz (2004) argued that the continued increase in private ownership not only leads to more serious problems of encroachment by large shareholders, but even leads to social and economic instability. Besides, Lin, Lin, and Song (2010) further claimed that the degree of equity concentration and enterprise innovation presents an inverted “U” shaped relationship.

It can be observed that the existing literature does have forged the foundation for the study of the innovative effects of mixed ownership reform, but there are still certain shortcomings. First, the existing literature on mixed ownership reform has mostly focused on state-owned enterprises, ignoring the nature of mixed ownership reform as a two-way street and the existence of mixed private enterprises. Secondly, most of the existing literature examines the impact of changes in equity ratios from the perspective of “quantitative changes”, while the impact of “qualitative changes” in equity on corporate innovation has been rarely examined against the context of mixed ownership reform from the perspective of relative control transfer. In view of this, not only the innovation effects of the occurrence of mixed ownership reforms are hereby examined, but also the impact on corporate innovation following the transfer of relative control is explored. Besides, property rights and the nature of the industry are also incorporated into the analytical framework for examining the impact of mixed ownership reforms on firm innovation in a more comprehensive manner.

The marginal contribution of this paper is threefold: First, most of the existing studies consider the impact on firm innovation from the perspective of the nature of firm equity and equity concentration, but relative control transfers are hereby incorporated into the analytical framework in this paper. Not only does it examine the impact of the occurrence of mixed ownership reforms on firm innovation, but the impact on firm innovation after the transfer of relative control is also further examined, which provides a useful addition to the existing literature. Second, the role of industry heterogeneity and firm ownership

heterogeneity in the equity structure of firms has been rarely analysed. This paper, however, analyses more specifically the differences in the impact of firms in different industries and ownership nature on corporate innovation after the occurrence of hybridization and relative control transfer, and further explores the mechanisms of their effects from the perspectives of financing constraints and agency costs. Thirdly, most of the existing literature has explored the impact of mixed ownership reform from the perspective of SOE reform, while only a rather limited proportion of the literature has examined the impact of the nationalisation of private enterprises. Besides, investigations are hereby conducted upon not only the impact of the incorporation of state-owned enterprises into private shares, but also that of the incorporation of private enterprises into state-owned shares, and the integrated analysis of the mixed reform of state-owned enterprises and private enterprises has to some extent improved the credibility of the present findings.

## 2. Theoretical foundations and assumptions

The resource-based view is that equity diversification can lead to special social network resources of heterogeneous shareholders, and that these unique resources can effectively enhance the competitiveness of a company. Mixed ownership reform is essentially about diversifying the equity of a firm (Schiehll, Lewellyn, & Muller-Kahle, 2018). Such an equity diversification may bring different resources to the firm, which in turn provides important implications for firm innovation. For SOEs, the mixed ownership reform may have contributed to corporate innovation in three main ways: First, the mixed ownership reform has helped SOEs improve their corporate governance environment and increase decision-making efficiency. The universal ownership of SOEs makes the problem of owner deficiency serious (Alchian, 1965), and coupled with the existence of long and complex principal-agent chains, the agency costs of SOEs are often too high (Xu, Tihanyi, & Hitt, 2017), thus leading to insufficient incentives for innovation. Mixed ownership reform can reduce the opportunistic behaviour of top management and moral hazard to a certain extent through the introduction of private shares, compensate for the shortcomings of the “one job for all, one job for all” system in state-owned enterprises (Fan, Wong, & Zhang, 2013), help reduce agency costs and improve the level of democracy and science in corporate decision-making (Gupta, 2005). Second, mixed ownership reforms can reduce the policy burden on SOEs and optimise their business objectives. The mainstream view is that the policy burden borne by SOEs is not conducive to more innovative activities based on their value maximisation business objectives (Shleifer & Vishny, 1994). Private shareholders, on the other hand, are naturally “profit-seeking”, the primary goal of which is to maximise profits, often accompanied by a stronger sense of innovation and a desire to achieve higher returns through innovative activities (Wang, Wang, Xu, & Yuan, 2017). Mixed ownership reforms can enable private shares to participate in governance, which leads to checks and balances between shareholders of different nature, thereby leading to more standardised enterprise operations and enhancing the regulatory capacity of SOEs (Bortolotti, 2002). In turn, the resources of SOE will be enriched, their strategic burden will be reduced, and, to some extent, corporate innovation will be further stimulated.

For private firms, problems such as information asymmetry and lack of collateral make it difficult to address R&D investment through internal funding and face stronger financing constraints (Lu & Shi, 2012), limiting the level of innovation of private firms (Megginson et al., 2014). After the mixed ownership reform, the participation of state-owned shares may bring advantages to private enterprises in the following two aspects: on the one hand, the state-owned shares introduced by private enterprises can weaken the problem of credit discrimination arising from information asymmetry, alleviate the financing constraints of private enterprises to a certain extent, and provide more economic resources and development opportunities for private enterprises (Sun & Liu, 2014). On the other, private firms with state-owned shares enjoy a better reputation, and this “halo effect” can reveal the innovative edge of the firm (Meuleman & De Maeseneire, 2012), help private firms to better integrate market resources, and thus promote technological innovation. However, if the control allocation model in the hybrid reform process is unreasonable, the entry of state-owned shares is likely to create obstacles for private enterprises, as state-owned shares themselves bear the dual responsibility of safeguarding the security of state-owned capital and maintaining social stability, often creating a policy burden in the process of enterprise development. In such cases, state-owned shareholders are more likely to reduce their investment in high-risk innovation projects for self-interest motives. The involvement of state-owned shares may then also weaken the innovation potential of private firms and even bring about a “political resource curse” effect. Therefore, mixed ownership reforms are more likely to increase the level of innovation in SOEs, while the negative and positive effects on innovation in private enterprises tend to be entangled and offset each other. Besides, the strength of the two effects depends on the control allocation model under the participation of state-owned shares. Still, only by achieving a reasonable sharing and allocation of control between state-owned and private shares (Zhou, Gao, & Zhao, 2017) can the innovation potential of private enterprises be stimulated. In view of this, Hypothesis H1 is hereby proposed.

H1: Compared to private enterprises, mixed ownership reform is more capable of promoting innovation in state-owned enterprises.

At the initial stage of the mixed ownership reform, the dual objectives of enhancing the efficiency of state-owned enterprises and maintaining the status of public ownership as the mainstay were achieved (Xu, 2011). Taking state-owned enterprises as the main reform target, China set out a reform path based on the nature of its industries, and reformed the property rights of enterprises in competitive industries but not those in monopolistic industries (Guan, Gao, & Tan, 2021). The introduction of mixed ownership reform in 2013 was a sign of the country’s in-depth reform in monopolistic industries. The problem of short-termism and over-consumption of resources by managers of SOEs in monopolistic industries tends to be more serious. Coupled with the long chain of principal and agent in SOEs themselves, this pushes up the agency costs of SOEs. These problems prevent SOEs in monopolistic industries from effectively utilising their available resources to gain more corporate value and significantly reduce their level of innovation. Besides, compared to SOEs in monopolistic industries, SOEs in competitive industries are also exposed to principal-agent problems. However, they are also faced

with greater competitive pressures and lower costs of resource reallocation, so the agency problem is less severe than that faced by SOEs in monopolistic industries (Li, Xia, & Zajac, 2018). Although the absence of monopoly rents reduces the amount of funding available to SOEs in competitive industries, they are still provided with political attributes and government resources will provide some degree of financial support for corporate innovation (Zhang, Zhang, & Zhao, 2003). In this case, there is not much difference between SOEs in competitive industries and those in monopolistic industries in terms of financing (Peng, Tan, & Tong, 2004), indicating that the impact of mixed ownership reform varies across industries, with SOEs in monopolistic industries likely to have lower levels of innovation due to more severe principal-agent problems. In this case, there is more room for the improvement of SOEs in monopolistic industries after the mixed ownership reform. As a result, Hypothesis H2 is hereby proposed.

H2: The occurrence of mixed ownership reforms in monopolistic industries is more conducive to innovation in SOEs than that in competitive industries.

A decentralised shareholding structure can create mutual checks and balances between shareholders of different nature and reduce the cost of supervision of the enterprise. The nature of the shareholding also has a bearing on the effectiveness of the checks and balances. A further increase in the relative control of state-owned shares will enable private enterprises to access government resources and make up for their shortcomings. However, state-owned shares bear a heavier political burden. An increase in the proportion of state-owned shares will increase the “politeness” of the firm, and thus creates a heavier tax burden not conducive to innovation (Chen, 2010). For SOEs, private shares present a relative concentration of control when they further gain relative control, and the management system of SOEs can be improved from both equity checks and balances and top governance perspectives (Megginson, 2017). On the one hand, private share owners enter SOEs through self-funded equity purchases, which is equivalent to achieving “ownership in place”, when, the pursuit of maximum benefits enables private shareholders to monitor and check state-owned shareholders (Lo, Gao, & Lin, 2022), which alleviates the second type of principal-agent problem and thus increases firms’ willingness to innovate. On the other, private shares pursuing economic interests who have gained relative control have more motivation and voice to strengthen the supervision and incentives of SOE executives (Xu et al., 2017), such as strengthening remuneration incentives and improving internal governance. This can not only provide effective supervision over SOE executives and alleviate the first type of principal-agent problem (Zhang et al., 2003), but also effectively motivate firms to actively improve their core competencies, thus promoting corporate innovation. In view of this, Hypothesis H3 is hereby proposed.

H3: For state-controlled enterprises, private shares who have gained relative control in mixed ownership reforms can promote corporate innovation.

The heterogeneity of the industry in which an enterprise operates determines its mode of operation and management. Although state-owned enterprises in competitive industries are faced with principal-agent problems, stronger competitive pressures will force them to reduce



their agency costs and improve innovation to capture the market share. The further acquisition of relative control by private shares fails to qualitatively affect their internal governance mechanisms, and even the excessive concentration of equity can lead to encroachment by major shareholders (Chen, Wan, & Zhang, 2018; Fried, Kamar, & Yafeh, 2020). In particular, private shares pursuing for private interests may lead to the phenomenon of private shareholders encroaching on the interests of other shareholders through collusion when they gain sufficient voice (Liu, Luo, & Wang, 2021), which makes it difficult to exercise a positive effect on corporate innovation. SOEs in monopolistic industries tend to be exposed to more severe principal-agent problems and be subject to a more rigid management systems, while SOEs in monopolistic industries are more capable of controlling the markets and prices by administrative means, and large monopoly profits reduce firms' willingness to engage in innovative activities. Moreover, monopolistic industries have more serious policy burdens of their own, and there is more room for their policy burdens to be reduced after carrying out mixed ownership reforms, and the effects of mixed reforms will be more obvious (Liao, Chen, Jing, & Sun, 2009). Therefore, further acquisition of relative control by private shares in state-controlled enterprises can further improve their corporate governance mechanisms, and can more effectively play a role in promoting corporate innovation through hybrid reform (Rong, Wang, & Gong, 2016). For private firms, whether in competitive or monopolistic industries, they have more reasonable incentives and are managed more efficiently than state-owned enterprises. However, in general, private firms are smaller in the scale than SOEs, are exposed to a significant new entrant disadvantage, and are often resource-constrained and have higher borrowing costs without government backing (Brandt & Li, 2003). Compared with monopolistic industries, private enterprises in competitive industries are also faced with more serious financing constraints due to their greater degree of competition and lack of monopoly profit support, which needs to be compensated by external resources. In this case, further acquisition of control by state-owned shares is not effective for private enterprises in monopolistic industries (Song & Zhang, 2017). In contrast, for private firms in competitive industries, further acquisition of relative control by state-owned shares can compensate for the resources needed for corporate innovation and promote corporate innovation. In view of this, Hypothesis H4a and Hypothesis H4b are thereby proposed.

H4a: For state-controlled enterprises in monopolistic industries, the acquisition of relative control by private shares in mixed ownership reforms can promote corporate innovation.

H4b: For privately held enterprises in competitive industries, the acquisition of relative control by state-owned shares in mixed ownership reforms can promote corporate innovation.

### **3. Research design**

#### **3.1. Data sources and sample selection**

Considering the better reliability and simplicity of obtaining that data from listed companies than non-listed companies, as well as the better capability of listed companies in the case of responding to policy calls to increase their efforts in hybrid reform, data on A-share



listed companies in Shanghai and Shenzhen from 2008–2018 are hereby used for the study. In addition, given that not all listed companies in Shanghai and Shenzhen are innovative companies, this paper selects data from companies in the manufacturing industry. The data are obtained from CSMAR and WIND, and some are supplemented by the web crawling technology. Through screening, 1,782 manufacturing enterprises, including 449 state-owned enterprises and 1,333 private enterprises, are finally selected as research subjects.

### 3.2. Variable description

**Explained variable:** Herein, innovation output is used as the explanatory variable. The number of patent applications perfectly measures a firm's level of innovation output, including invention patents, utility model patents and design patents. Among them, invention patents and utility model patents are more difficult to apply for and better reflect the level of innovation of enterprises. To this end, the total number of invention and utility model patent applications is used to measure corporate innovation ( $Y$ ).

**Explanatory variables:** In this study, the proportion of private (state-owned) equity in state-owned (private) enterprises is used to define the occurrence of mixed ownership reform. The dummy variable *reform* is defined as 1 for a proportion of private (state-owned) equity in state-owned (private) enterprises greater than 10%, while the dummy variable *reform* is defined as 0 for a proportion of private (state-owned) equity in state-owned (private) enterprises less than 10%, and no mixed ownership reform has occurred (Xu, 2011). Regarding the setting of dummy variables for relative control transfer, this paper sets the control = 0 when the proportion of private (state-owned) equity in state-owned (private) enterprises is less than that of the first major shareholder, and control = 1 when the proportion of private (state-owned) equity in state-owned (private) enterprises is greater than that of the first major shareholder.

**Intermediary variables:** Considering the focus of this paper, an examination is conducted over the impact of changes in agency costs brought about by improvements in corporate governance mechanisms after the hybrid reform on firms innovation activities. The ratio of overheads to main operating income is adopted to measure agency costs ( $Z1$ ); According to the existing literature, the measurement of indicators of financing constraints is divided into single-variable and multivariable indicators. The former mainly include dividend payout ratio and cash holding level, while the later cover the KZ index, WW index and SA index. Among them, Hadlock and Pierce (2010) constructed the SA index by taking into account the endogenous interference problem of the KZ and WW indices, and the SA index has been proven applicable by a large number of scholars. Therefore, the SA index is hereby adopted to measure the financing constraints of firms ( $Z2$ ) following Hadlock and Pierce (2010).<sup>1</sup>

**Control variables:** Herein, the effects of firm asset size (*Size*), gearing (*Lev*), growth (*Growth*) and profitability (*Roa*) are controlled using the natural logarithm of a firm's year-end total assets, total liabilities as a proportion of total assets, the growth rate of operating income and net profit as a proportion of total assets (Zhang et al., 2020).

<sup>1</sup>The specific calculation formula is as follows:  $SA = 0.043 \times (\ln size^2) - (0.04 \times age) - (0.737 \times \ln size)$ . Where size is the size of the firm, measured in this paper using total firm assets, and age is the age of the firm.

### 3.3. Model setting

In order to eliminate bias, the propensity score matching method (PSM) approach is hereby used to obtain the net effect of the implementation of the mixed reform policy on firm innovation by matching the experimental group with the control group. The dummy variable reform for mixed reform is taken to be 0 as the control group representing firms that have not undergone mixed ownership reform, and the dummy variable reform for mixed reform is taken to be 1 as the experimental group representing firms having undergone mixed ownership reform. In order to investigate the impact of relative control transfer on enterprise innovation in mixed ownership reform, the sample of enterprises featuring mixed ownership is further screened to obtain 133 enterprises in which relative control transfer occurs in mixed ownership reform as the experimental group, with the dummy variable for relative control transfer set as 1; enterprises with relative control transfer does not occur as the control group, with the dummy variable for relative control transfer set as 0; and Time, as the time dummy variable. The model is set up as follows.

$$Y_{it} = \alpha + \beta_1 \text{reform}_{it} \times \text{Time}_{it} + \beta_2 C_{it} + \varepsilon_{it} \quad (1)$$

$$Y_{it} = \eta + \gamma_3 \text{control}_{it} \times \text{Time}_{it} + \gamma_4 C_{it} + \varepsilon_{it} \quad (2)$$

where, the coefficient  $\beta_1$  of the interaction term  $\text{reform}_{it} \times \text{Time}_{it}$  reflects the policy effect of the experimental group, i.e., the difference in the impact on firm's innovation activities before and after the occurrence of the mixed ownership reform, while the coefficient  $\gamma_3$  of the interaction term responds to the difference in the impact on firm's innovation activities before and after the transfer of relative control in a mixed ownership reform, with  $C_{it}$  as the control variable. Therefore, the focus of this paper is placed on the interaction term coefficients  $\beta_1$  and  $\gamma_3$ .

In this section, two mediating variable machines, i.e., agency cost (Z1) and financing constraint (Z2), are selected for analysis to sort out the mechanism of the impact of mixed ownership reform on firm innovation. The following three models are developed after data standardisation (Cerin, Taylor, & Leslie, 2006).

$$Y_{it} = \alpha + \beta_1 \text{reform}_{it} \times \text{Time}_{it} + \beta_2 C_{it} + \varepsilon_{it} \quad (3)$$

$$Z_{it} = \alpha + \alpha_1 \text{reform}_{it} \times \text{Time}_{it} + \alpha_2 C_{it} + \varepsilon_{it} \quad (4)$$

$$Y_{it} = \alpha + \gamma_0 Z_{it} + \gamma_1 \text{reform}_{it} \times \text{Time}_{it} + \gamma_2 C_{it} + \varepsilon_{it} \quad (5)$$

where, Equation (3) regresses the interaction term on firm innovation and responds to the effect of mixed ownership reform on firm innovation; Equation (4) represents the effect of mixed ownership reform on the mediating variables, and the coefficient of Equation (5) responds to the effect of mediating variables on firm innovation after controlling for the effect of mixed ownership reform, and the coefficient responds to the effect of mixed ownership reform on firm innovation after controlling for mediating variables. A mediating effect is observed when the coefficient  $\beta_1$  of Equation (3), the coefficient of Equation (4) and the coefficient  $\gamma_1$  of Equation (5) are significant.

## 4. Empirical analysis

### 4.1. Propensity score matching (PSM)

The covariates selected for this paper are as follows: gearing (*Lev*), firm asset size (*Size*) (log of total firm assets), firm fixed assets (*Fa*), average wage level (*lwage*) (the ratio of total wages to average annual employment), current assets (*la*) and employment (*staff*) (average annual employment of the firm). Observations from 2013 are selected to calculate the propensity score before kernel matching, and the test results are shown in Table 1. It can be observed that the standard deviations of the covariates are significantly reduced after matching, that after matching are all less than 5%, and the t-statistics becomes non-significant. This indicates that there is no significant difference between the matched treatment and control groups, and that the accuracy of the matching results is ensured.

### 4.2. Results analysis

#### 4.2.1. Mixed ownership reform

The matched data are hereby tested using the double difference method and the regression results are reported in Table 2, where it can be found that the coefficients of the interaction terms are all significantly positive, indicating the significant promotional effect of the occurrence of mixed ownership reforms in enterprises on innovation. Hypothesis H1 is therefore confirmed, which is in line with the findings of Fan et al. (2013).

In order to test whether the impact of mixed ownership reform on enterprise innovation is the same for enterprises of different nature, the overall sample is further divided into a sample of private enterprises and that of state-owned enterprises for testing, and the regression results are reported in Table 3. It can be noticed that the coefficient of the interaction term in the private enterprise sample is not significant, indicating that the occurrence of mixed ownership reform in private enterprises does not have an impact on enterprise innovation. Possibly given that mixed ownership reform has different effects

**Table 1.** Propensity score matching balance test results.

Variables		Average value		Standard deviation (%)	Degree of reduction in standard deviation (%)	T-value
		Processing group	Control group			
<i>Lev</i>	Before matching	0.262	-0.180	46.000		7.050
	After matching	0.262	0.233	3.000	93.400	0.400
<i>Size</i>	Before matching	22.156	21.631	47.600		7.290
	After matching	22.156	22.118	3.500	92.700	0.460
<i>Fa</i>	Before matching	0.070	-0.049	12.500		1.820
	After matching	0.070	0.031	4.000	67.700	0.640
<i>lwage</i>	Before matching	16.947	16.478	28.800		4.420
	After matching	16.947	16.917	1.800	93.600	0.240
<i>la</i>	Before matching	0.074	-0.048	12.600		1.900
	After matching	0.074	0.039	3.600	71.600	0.540
<i>staff</i>	Before matching	0.081	-0.056	15.100		2.220
	After matching	0.081	0.057	2.700	82.000	0.390

**Table 2.** Test results of mixed ownership reform occurring.

Variables	(1) Y	(2) Y
<i>reform</i> × <i>Time</i>	0.055** (0.032)	0.045* (0.031)
<i>Size</i>		0.045** (0.020)
<i>Lev</i>		−0.046*** (0.022)
<i>Growth</i>		0.028*** (0.013)
<i>Roa</i>		−0.007 (0.011)
Obs	10,286	9599

Note: Standard errors are in brackets; \*\*\*, \*\* and \* denote the significance levels of 1%, 5% and 10%, respectively.

**Table 3.** Mixed ownership reform test results.

Variables	A sample of private enterprises		Sample state-owned enterprises	
	(1) Y	(2) Y	(3) Y	(4) Y
<i>reform</i> × <i>Time</i>	0.028 (0.042)	0.011 (0.041)	0.636*** (0.094)	0.822*** (0.143)
Control variables	NO	YES	NO	YES
Obs	6319	5851	3708	3504

Note: Standard errors are in brackets; \*\*\*, \*\* and \* denote the significance levels of 1%, 5% and 10%, respectively.

on private firms in different industries or insufficient participation, it is hereby argued that the innovation effect of mixed ownership reform is not effective in private firms, which needs further discussion. Columns (3) and (4) of Table 3 show that the coefficient of the interaction term is significantly positive in the SOE sample, indicating the efficiency of mixed ownership reform in significantly promoting innovation in SOEs. In view of this, Hypothesis H1 is confirmed.

Given that industry heterogeneity can inspire firms to choose different business management approaches, it has different impacts on firm innovation. Therefore, this paper further examines the impact of the occurrence of hybridization between private and state-owned enterprises in monopolistic and competitive industries on firm innovation, respectively.<sup>2</sup> The empirical results are reported in Table 4, with Columns (1) and (2) indicating interaction terms, which suggests that there is no significant effect of mixed ownership reform on private enterprise innovation in both monopolistic and competitive industries after accounting for industry heterogeneity. Columns (3) and (4) of Table 4 indicate interaction terms, suggesting that the participation of private capital, whether in monopolistic or competitive industries, can to some extent compensate for the shortcomings of state-owned enterprises and thus facilitate corporate innovation. Besides, the coefficient of the interaction term is larger in monopolistic industries compared to that in competitive industries, indicating that mixed ownership reform by SOEs in monopolistic

<sup>2</sup>This article identifies 17 industries as monopolies based on China's administrative approval regulations for market access, including *The Decision of the State Council on Investment System Reform*, *The Catalogue of Government Approved Investment Projects*, and *The Interim Measures for the Approval of Enterprise Investment Projects*.

**Table 4.** Results of the test for the occurrence of hybridisation in different sectors.

Variables	A sample of private enterprises		Sample state-owned enterprises	
	Monopoly Industries	Competing Industries	Monopoly Industries	Competing Industries
	(1) Y	(2) Y	(3) Y	(4) Y
<i>reform</i> $\times$ <i>Time</i>	0.010 (0.052)	0.025 (0.061)	0.608*** (0.064)	0.556*** (0.042)
Control variables	YES	YES	YES	YES
Obs	3609	2242	2311	1193

Note: Standard errors are in brackets; \*\*\*, \*\* and \* denote the significance levels of 1%, 5% and 10%, respectively.

industries has a greater effect on the innovation promoting, which further confirms that mixed ownership reform should be promoted in an orderly manner according to the nature of the industry. Hypothesis H2 is therefore confirmed.

#### 4.2.2. Transfer of relative control

The regression results of the occurrence of relative control transfer on firm innovation in the process of mixed ownership reform are reported in Table 5, where the coefficient of the interaction term is found to be significantly positive, indicating that relative control transfer in mixed ownership reform can promote firm innovation. Besides, the sample is hereby differentiated into a sample of private enterprises and a sample of state-owned enterprises for further examination, and the regression results are reported in Columns (3) to (6) of Table 5, where the interaction term in the private enterprise sample is found to be significant, indicating the significant effect of the transfer of relative control to private enterprises on the promotion of enterprise innovation when they undergo mixed ownership reform. It further suggests that the occurrence of mixed ownership reform does not have a substantial impact on private enterprise innovation due to the insufficient level of state-owned capital participation in private enterprises, which needs to reach a certain level before playing the role of political resources of state-owned capital. The significant positive coefficient of the interaction term in the sample of state-owned enterprises indicates that carrying out mixed ownership reform contributes considerably to corporate innovation for state-owned enterprises, and that further acquisition of relative control by private shares can further amplify the innovation effect of mixed ownership reform. Hypothesis H3 is therefore confirmed.

Based on the previous theoretical analysis, it is hereby argued that state-owned enterprises in monopolistic industries are exposed to more serious principal-agent problems and policy burdens in the case of mixed ownership reform, and that private shares gaining relative control in these enterprises are more capable of improving internal governance mechanisms, enhancing decision-making efficiency and increasing the scope for corporate innovation. Private firms have lower agency costs in both competitive and monopolistic industries, but

**Table 5.** Test results for relative transfer of control.

Variables	Full sample		A sample of private enterprises		Sample state-owned enterprises	
	(1) Y	(2) Y	(3) Y	(4) Y	(5) Y	(6) Y
<i>contro</i> $\times$ <i>Time</i>	0.128*** (0.042)	0.113*** (0.044)	0.121** (0.063)	0.124** (0.066)	1.089*** (0.101)	1.694*** (0.142)
Control variables	NO	YES	NO	YES	NO	YES
Obs	10,286	9599	6319	5851	3708	3504

Note: Standard errors are in brackets; \*\*\*, \*\* and \* denote the significance levels of 1%, 5% and 10%, respectively.

private firms in competitive industries often face tougher market tests (Ishibashi & Matsumura, 2006). When state-owned shares gain relative control, it is tantamount to “endorse” these private firms, which facilitates them to obtain more bank loans and longer loan terms (Sun & Liu, 2014), thus escorting their innovation. In this regard, this section examines the impact on firm innovation of relative control transfers occurring between state-owned and private firms in different industries, and the regression results are reported in Table 6, which reveals that further relative control by private shares in state-controlled enterprises is beneficial to corporate innovation, and that this effect occurs mainly in monopolistic industries. To this end, Hypothesis H4a is confirmed. From the regression results in Columns (1) and (2) of Table 6, further acquisition of relative control by private shares in private enterprises in competitive industries exercises a positive effect on firm innovation. Hypothesis H4b is therefore confirmed. Besides, it is worth noting that from the collated sample, around two-thirds of state-owned and non-state-owned enterprises tend to be absolutely controlled and the nature of their industry has not changed significantly. Thus, the further acquisition of relative control by private shares in monopolistic state-controlled enterprises is effectively equivalent to the acquisition of a corresponding voice, thus enhancing the governance capacity and decision-making efficiency of state-owned enterprises (Bortolotti, 2002) and promoting corporate innovation. Similarly, the relative control of state-owned shares in private firms in competitive industries is tantamount to giving them an “aura” that is less likely to lead to credit discrimination (Sun & Liu, 2014), which in turn has a positive impact on firm innovation.

**Table 6.** Results of the relative control transfer test for different industries.

Variables	A sample of private enterprises		Sample state-owned enterprises	
	Monopoly Industries	Competing Industries	Monopoly Industries	Competing Industries
	(1) Y	(2) Y	(3) Y	(4) Y
<i>control × Time</i>	0.104 (0.082)	0.185** (0.095)	0.564*** (0.045)	0.082 (0.083)
Control variables	YES	YES	YES	YES
Obs	3609	2242	2311	1193

Note: Standard errors are in brackets; \*\*\*, \*\* and \* denote the significance levels of 1%, 5% and 10%, respectively.

### 4.3 Robustness tests

**Replacement of matching method:** In order to verify the reliability of the conclusions, the kernel matching is replaced with one-to-four nearest-neighbour matching in this section to re-match the experimental group, and then the double difference test is performed. The regression results are reported in Columns (1) and (2) of Table 7. The results of the DID test after replacing the matching method and then performing the DID test are basically consistent with those above, indicating the robustness of the present conclusions.

**Replacement of the explanatory variable measure:** To increase the reliability of the innovation indicator. In this section, firm innovation is measured using R&D investment intensity, i.e., the ratio of R&D investment to main business revenue, and the results of the underlying regressions are then tested. The regression results are reported in Columns (3) and (4) of Table 7, and the empirical results continue to support the core findings of this paper.

**Table 7.** Robustness test results.

Variables	(1) Y	(2) Y	(3) Y	(4) Y
<i>reform</i> $\times$ <i>Time</i>	0.374*** (0.091)	0.396*** (0.092)	0.199*** (0.045)	0.078** (0.042)
Control variables	NO	YES	NO	YES
Obs	7023	7023	8659	8659

Note: Standard errors are in brackets; \*\*\*, \*\* and \* denote the significance levels of 1%, 5% and 10%, respectively.

#### 4.4 Further analysis

The regression results of the intermediary effect are reported in Table 8, where it can be found that mixed ownership reform can alleviate the financing constraints and reduce the agency costs of firms. In testing the mechanism of agency cost, the coefficient  $\gamma_1$  of Equation (5) is significant and the coefficient  $\gamma_0$  is significantly negative, indicating the partial mediating role of agency cost. When testing the mechanism of financing constraints, the coefficient  $\gamma_1$  of Equation (5) is significant while  $\gamma_0$  is insignificant, indicating that financing constraints fully mediate the promotion of innovation output by mixed ownership reform. Thus, mixed ownership reform can promote higher levels of innovation by reducing agency costs and alleviating the financing constraints of the firm.

**Table 8.** Intermediary effects.

Variables	(1) Z1	(2) Y	(3) Z2	(4) Y
<i>reform</i> $\times$ <i>Time</i>	-0.885*** (0.022)	0.048* (0.031)	-0.172*** (0.022)	0.105*** (0.035)
Z1		-0.030*** (0.012)		
Z2				-0.004 (0.025)
Control variables	YES	YES	YES	YES
Obs	9559	9559	9559	9559

Note: Standard errors are in brackets; \*\*\*, \*\* and \* denote the significance levels of 1%, 5% and 10%, respectively.

## 5. Conclusions and policy recommendations

Mixed ownership reform is an objective requirement for high-quality economic development in the new era, while enterprise innovation is an effective way to improve the core competitiveness of enterprises. In this case, explorations should be conducted on the impact of mixed ownership reform on enterprise innovation and its mechanism of action to help promote the efficient and orderly development of enterprises. The present conclusions suggest that firstly, mixed ownership reforms are more likely to promote innovation in SOEs, especially in monopolistic industries. Secondly, for state-owned enterprises, the further acquisition of relative control of private shares can amplify the innovative effect of mixed ownership reform, which mainly occurs in monopolistic industries. For private enterprises, the relative control of state-owned shares exercises a more catalytic effect on innovation in private enterprises from competitive industries, suggesting that the innovative effect of the mixed ownership reform of



private enterprises can only be effectively brought into play when state-owned shares are increased to a certain level. Third, the results of the mechanism test indicate that mixed ownership reform can promote corporate innovation by reducing agency costs and alleviating financing constraints. Based on the above findings, the following policy recommendations are hereby proposed for mixed ownership reform.

Firstly, it is suggested to adhere to the direction of mixed ownership reform and enhance the innovation capacity of state-owned enterprises. Compared to state-owned shares, private shares are provided with greater flexibility and willingness to innovate. The participation of private shares in the mixed reform can purify the business objectives of state-owned enterprises and further improve the governance mechanism and incentive mechanism of state-owned enterprises. Therefore, efforts should be made to continuously deepen the mixed reform of SOEs through equity diversification and enhance the decision-making efficiency of SOEs by introducing different types of private shares, which in turn will promote innovation in SOEs.

Secondly, the layout of various types of capital should be effectively optimised and the voice of private shareholders should be strengthened. The present findings show that the further acquisition of relative control by private shares can amplify the innovative effects of mixed ownership reform. This suggests that the key to mixed ownership reform is not a “formal” mix of various capital cross-holdings, but rather a substantive change in the mix through power sharing based on a certain level of voice for private shares, so as to effectively leverage the advantages of each type of capital. It is by giving private shares relative control that the motivation of private shareholders can be mobilised and the agency costs of state-owned enterprises can be effectively reduced, thereby amplifying the innovative effects of the hybrid reform.

Thirdly, it is prudent to promote the entry of state-owned shares into private enterprises and effectively promote innovation in the private sector. The present findings suggest that the acquisition of relative control by state-owned shares is more conducive to innovation by private firms in competitive industries. Therefore, state-owned shares should be targeted at competitive industries and private enterprises with high development potential for effective participation. At the same time, it is also necessary to accurately grasp the proportion of state-owned shares, not only to play the influence of state-owned shares, but also to avoid the “curse of political resources” effect, to really effectively expand the financing channels of enterprises, and to enhance the competitiveness and creativity of private enterprises.

Fourthly, efforts can be made to take full account of the heterogeneity of the industry and promote mixed ownership reform by category. State-owned enterprises in monopolistic industries should continue to be privatised and appropriately liberalised or even cede state control, and inject innovative energy into state-owned enterprises by introducing private capital. For private enterprises, priority should be given to selecting enterprises with a relatively strong degree of competition for reform, and giving sufficient conditions for the introduction of additional state-owned capital to solve key and difficult problems in reform in a timely and effective manner, so that mature and replicable experience can be formed as soon as possible.

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