

Promote or inhibit: State-owned equity participation and family firms' innovation investment



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ABSTRACT

Targeting A-share listed family firms on the Shanghai and Shenzhen Stock Exchange, this study focuses on the special situation of state-owned equity participation in non-state-owned enterprises. Specifically, we explore the relationship between state-owned equity participation, intergenerational succession in family firms, and innovation investments. The results reveal a prominent “double-edged sword” effect of state-owned equity participation on family firms; that is, there is a reversed U-shaped relationship between shareholding proportion and innovation investment. To some extent, the intergenerational succession of family firms moderates the reversed U-shaped relationship. Moreover, the double-edged sword effect of state-owned equity is more prominent in family businesses that are created by the entrepreneur from scratch. Compared to existing research arguing for the linear relationship between state-owned equity participation and innovation investment by enterprises, we reveal the impact of the excessive supervision effect arising from the increase in state-owned equity holdings on family firms' innovation. This study confirms the double-edged sword effect of state-owned equity participation in family firms and further explores the influence of intergenerational succession and the heterogeneity of family firms on such an effect. By revealing the double-edged sword effect of state-owned equity holdings, this study enriches the research on the participation of private enterprises in mixed-ownership reform.

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Introduction

Since the Third Plenary Session of the Chinese Communist Party's 18th National Congress, the mixed-ownership reform has gradually attracted academic attention. A mixed-ownership economy is essential for furthering reform of the socialist economic system. If a mixed-ownership economy develops, efforts must be made to realize cross-shareholding and the integration of capital of different ownership types (Luo & Qin, 2019; Jiang & Kim, 2020). It remains to be proven whether mixed-ownership featuring state-owned equity participation contributes to the sound and steady development of family businesses. To date, family businesses have grown to be the most important component of non-state-owned enterprises in China. By the end of 2020, the number of listed family businesses in China had

reached 1230, accounting for 36.5% of listed companies and 65.3% of non-state-owned enterprises in China's A-share market.

The outbreak of COVID-19 in 2020 caused a persistent recession in the global economy, presenting serious challenges and uncertainties to China's economic and social development (Huang & Liu, 2022). To respond to this challenging external environment, the Central Committee of the Communist Party of China proposed a new development vision of “dual circulation.” In recent years, China's family enterprises have reached a critical stage of succession. In the context of innovation-driven strategy, the family business must face the dual tasks of inheritance and innovation. According to data released by the China Stock Market and Accounting Research (CSMAR), from 2007 to 2019, investment for innovation by family businesses in China accounted for 4.84% of operating revenue on average, which is lower than that of non-family businesses (5.67%) during the same period. Scholars also found that investment in innovation by family businesses is lower than that by other enterprises (Chrisman & Patel, 2012; De Massis et al., 2013; Wu & Chen, 2014; Chen et al., 2018a;

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Kim et al., 2022). The ownership and management of most family businesses tend to be concentrated. Because of the credit discrimination practiced by financial institutions, family businesses have limited access to financing options (Si et al., 2021). The lack of equity checks, balance mechanisms, and insufficient innovation investment will affect the long-term development of enterprises and pose a challenge to China's economic and social upgradation and transformation (Du et al., 2022).

So far, most of the discussions on the reform of mixed ownership have focused on the phenomenon that state-owned enterprises introduce non-state-owned capital (Zhang et al., 2020; Yuan et al., 2022). For research on equity participation by the state in private enterprises, the primary focus is on the positive effects of state-owned capital. It is argued that state-owned equity participation can, (i) successfully accelerate the pace of family businesses to be able to compete globally (Xu et al., 2020), (ii) moderate the financing constraints of private enterprises, and, (iii) improve their risk-taking capability (Li & Xiao, 2017; Yu et al., 2022; Li et al., 2021, 2022), effectively improving enterprises' performance and overcoming the inadequate market allocation of private enterprises (Hao & Gong, 2017; Du et al., 2022; Zhao & Mao, 2022). However, scholars have not reached a consensus on the effect of state-owned equity participation on technological innovation in family businesses. Some argue that it can spur family businesses to scale up their innovation investments (Luo & Qin, 2019; Deng & Wang, 2020; Wei & Zhao, 2021). Others argue that it inhibits the technological innovation of private enterprises (Bai et al., 2018). Owing to the limitations in sample selection, the proportion of state-owned enterprise shareholding appears low. For example, the highest proportion of state-owned enterprise shareholdings in family businesses listed between 2009 and 2016, sampled by Luo and Qin (2019), remained at only 12.34%. The proportion in Deng and Wang's (2020) research remained at 14.47%. In the study by Bai et al. (2018), this proportion reached 25%. However, the subjects investigated covered all private enterprises including family businesses. Consequently, this conclusion is not completely applicable to family businesses. According to our statistics, as mixed-ownership reform proceeds, the proportion of state-owned capital in family businesses has risen to 20.1%. Does this mean that a higher proportion of state-owned capital in family businesses is beneficial? Once the state-owned equity holding proportion surpasses a certain range, state-owned equity participation tends to expand the principal-agent chain and leads to the absence of owners. In this context, controlling shareholders will display rigid and increasingly conservative behaviors and a lack of initiative, thus creating an excessive supervision effect (Li et al., 2017; Yang et al., 2018; Bai et al., 2018; Nguyen et al., 2022; Xiao et al., 2022). Thus, the holding proportion of state-owned equity is likely to produce a reversed U-shaped impact on innovation investment. The exploration of non-linear relationships plays an important role in guiding family firms' innovation endeavors. Unfortunately, this double-edged sword effect has not received the attention that it deserves. Existing studies still show the relationship between the two as being chaotic, with contradictory differences. Researchers maintain that the two have a simple linear relationship (Bai et al., 2018; Luo & Qin, 2019; Deng & Wang, 2020; Zhao & Mao, 2022). We find it essential to discuss whether the positive effect of state-owned equity is subject to certain conditions; that is, whether the positive effect will be maintained, as the state-owned equity holding proportion increases, and whether the excessive supervision effect will arise and affect enterprises' innovation investment. If the above reasoning holds, we can determine the relationship between state-owned equity participation and family firms' innovation investment and identify the threshold for the positive effect of state-owned equity participation and the excessive monitoring effect.

Among the empirical studies on state-owned equity participation in family firms, few considered the contextual factors affecting innovation investment (Song et al., 2014; Yao et al., 2019; Zhang et al.,

2022b). Because excessive equity participation by the state may inhibit innovation investment by enterprises, do the latter take effective measures to limit such potential negative impacts? Currently, Chinese family firms are entering a critical period of intergenerational succession. Whether a family firm maintains robust development depends on whether its intergenerational succession proceeds smoothly. The accumulation of children's human capital is determined by investment by their parents and the government, which, in turn, affects innovation investment by family businesses (Huang et al., 2021a). Family business successors can capitalize on unique tacit knowledge and social capital to expand their resources, which will contribute to the increase in innovation investment (Amore et al., 2021; Zybura et al., 2021). However, in the course of a power handover, some predecessors are sometimes reluctant to release their control, which could cause tension between predecessors and next-generation successors. Given the further increase in agent costs and the risky nature of innovation, family firms have to reduce their R&D investment (Yan et al., 2021; Zhu et al., 2021). Thus, existing research on the relationship between intergenerational succession and innovation investment has failed to reach a consensus. In this context, it is very important to explore the mechanism by which intergenerational succession affects both, the positive impact and excessive supervision effect of state-owned equity participation, on innovation investment. Meanwhile, as there is heterogeneity between family firms (Zulficar et al., 2021; Ye et al., 2022), there is an obvious difference in corporate governance and organizational behavior between family firms that are restructured from state-owned enterprises and those that are independently founded. This study argues that it is necessary to consider the impact of state-owned equity participation on different types of family firms.

To compensate for this inadequacy, this study uses a sample of A-share family firms, collected from 2007 to 2019, as the research object to focus on the following three key questions:

- How does state-owned equity participation affect innovation investment by family firms? Does a double-edged sword effect exist?
- Does intergenerational succession moderate the non-linear relationship between the shareholding ratio and innovation investment?
- How does the non-linear effect of state-owned equity participation on innovation investment vary among different types of family firms?

Our contributions are threefold. First, our conclusions pose a challenge to the single explanatory mechanism of a linear relationship between the shareholding proportion and innovation investment. We find that the positive effect of state-owned equity declines with an increase in its proportion in total equity holding of a firm. Meanwhile, we find that the negative effect caused by excessive supervision increases, thus weakening family firms' innovation investment and capability to withstand risks. This study reveals the double-edged sword effect of state-owned equity participation and addresses the controversies noted in existing studies. We attempt to determine the optimal proportion of state-owned equity holdings, and identify critical points that may contribute to the existing non-linear curves, thereby expanding research horizons. Second, this study explores the contextual factors affecting the relationship between equity participation by the state and innovation investment. We thoroughly analyzed the moderating role of intergenerational succession in the reversed U-shaped relationship. Our finding is an important supplement to existing research on intergenerational succession in the context of complicated equity structures. Third, we conduct an in-depth analysis of the impact of state-owned equity participation in different types of family firms. We further tested the positive role of family firm heterogeneity in moderating the relationship between state-

owned equity participation and innovation investment. This finding enriches the literature on the motivation of private enterprises to introduce state-owned capital and has implications for governmental departments managing state-owned capital.

Literature review and research hypotheses

State-owned equity participation

Owing to equity structure adjustments, mixed-ownership reform can integrate the advantages of state-owned capital and private capital to ultimately create value collectively. Whether the governance mechanism of a company under mixed ownership can make a difference is contingent on the company's internal power allocation (Hong & Gui, 2021; Zhang et al., 2022a). To a certain extent, equity composition plays a decisive role in a company's property, resource allocation capability, and decision-making (Jiang & Kim, 2020). The equity structure of family businesses is characterized by concentrated ownership and control by the dominant shareholder (Xu et al., 2020; Tobak & Nabradi, 2020). Recent years have witnessed diversification of equity players in family businesses in the wake of the deepening of mixed-ownership reform.

When state-owned capital, with a unique political background, becomes a shareholder in family businesses, the government and enterprise will form a political connection (Zhao & Mao, 2022; Wei & Zhao, 2021). Different scholars have different views on the effect of state-owned equity on the family business. Scholars in favor of the positive effects of state-owned equity tend to argue from the perspectives of financing convenience, resource acquisition, policy support, and industrial barriers. Song et al. (2014) and Zhang et al. (2022a) found that private businesses involving state-owned capital can gain access to larger credit amounts and longer credit terms. Kusnadi et al. (2015) find that state-owned equity, as a type of political capital, plays a positive role in helping private businesses access high-barrier industries. Yao et al. (2019) maintain that there is an intrinsic connection between state-owned equity and the government. In the case of an imperfect institutional environment, the participation of state-owned equity can protect the property rights of private businesses from infringement. State-owned equity could effectively cushion the impacts caused by policy uncertainties and improve the earning capacity of an enterprise (Chen et al., 2020; Wang et al., 2020a; Yu et al., 2022). Dong et al. (2021) and Gao et al. (2022) argue that state shareholders can effectively monitor private shareholders and inhibit their tunneling behavior, which can improve business information disclosure credibility, reduce unusual cash expenditure and asset loss, lower investors' risk premium, and moderate the financing constraints of private enterprises. In summary, the introduction of state-owned equity strengthens the connection between the family business and the government, which can bring in more resources and opportunities for the former, thereby improving its operations.

When arguing that state-owned equity exerts negative effects on businesses, academics typically consider enterprise value, investment efficiency, and business performance. Shen et al. (2014) found that the participation of state-owned equity will diminish the quality of enterprise surplus and increase the risk of exposure. Political connections are random and uncertain. The underlying opportunism will jeopardize the entrepreneur's control over the company, thus lowering enterprise performance and inducing the risk of corporate zombification (Ge et al., 2019; Nguyen et al., 2022; Xiao et al., 2022). According to Bai et al. (2018), the participation of state-owned capital suppresses entrepreneurs' aspiration for innovation, fails to bring into full play the advantage of credit and loans, and harms the technological innovation of enterprises. Dong and Liu (2021) argued that, in the presence of policy burdens due to state-owned capital, the enterprise has to shoulder additional labor costs and fixed asset costs,

which adversely affects its profitability. In this sense, because of the political nature of state-owned capital, the management costs of the enterprise increase, productivity is lowered, and long-term investment gets squeezed.

Some scholars argue that the positive effect of state-owned equity is applicable only when the shareholding proportion is maintained within a certain range. Li et al. (2017) found that excessive shareholding proportion of state-owned equity exerts a reverse U influence. This negative impact can only be mitigated when the shareholding proportion of the state-owned equity exceeds the supervision cost threshold. Yang et al. (2018) empirically found a reverse U relationship between the degree of state-owned capital participation and enterprise value capacity. Therefore, a diversified equity structure does not apply to all private enterprises. The state shareholding proportion should be set within a reasonable range. Although Li et al. (2017) and Yang et al. (2018) made breakthroughs by proposing a non-linear effect of state-owned equity, they targeted all private enterprises. They failed to verify that a non-linear effect also exists in family firms. In addition, they did not examine the influence of state-owned equity on innovation. An increase in innovation investment by family firms can promote growth of the private economy. Therefore, it is essential to explore the influence of the state-owned equity participation on family firms' innovation investment.

Family businesses' innovation investment

Most Chinese private enterprises are family-owned. Family businesses have long been subjected to a complex and volatile environment, experiencing many twists and turns. Given the special characteristics of family businesses in China, in this study, we define a family business as "an enterprise controlled and operated by the family" (Chen & Li, 2008; Tobak & Nabradi, 2020). Meanwhile, it must satisfy the following conditions. First, the actual controller of an enterprise can be traced back to the family or the natural person who established it. Second, the actual controller is the largest shareholder of the enterprise, holding at least 10% of its shares. Third, relatives of the controller assume positions as directors, supervisors, senior managers, or shareholders.

Thus far, research on innovation investment by family businesses has not reached a consensus. One school holds that family businesses invest significantly in innovation. High innovation investment is attributed to long-term development orientation, low agency costs, and flexible organizational structure. First, unlike non-family businesses pursuing short-term economic benefits, family businesses have a long-term development vision and orientation, including investment (Xu et al., 2013; Islam et al., 2022). To guarantee smooth succession and maintain steady prosperity, family businesses are bound to scale up their investments in technological innovation (Sunder et al., 2017; Chen et al., 2018b). Second, the joint participation of family members in business operations is conducive to coordinating internal objectives and interests, which, to some extent, reduces agency costs and minimizes information asymmetry and moral risks, therefore being relevant to long-term investment (Wu et al., 2012; Islam et al., 2022). Finally, family businesses usually have a flexible organizational structure, which enables them to engage in business, make decisions in unconventional ways, and respond to environmental changes (Li et al., 2020b). Therefore, family businesses usually target innovation projects with high levels of investment uncertainty.

The second school holds the opposite opinion; that is, family businesses invest little in innovation. This concept focuses on agency problems within the family, enterprise resources, and risk-taking capabilities. Although the agency cost of family businesses is low, there are agency conflicts within the holding family (Chrisman et al., 2004), mainly the struggle for control of the business and a low sense of second-generation altruism. Meanwhile, the major shareholders of

a family business may take advantage of their dominant status to seek private benefits at the expense of minor (non-family) shareholders' interests. This may cause a second type of agent problem within the family business (Li et al., 2021). When exposed to such agency conflicts, family businesses may pursue short-term profits (Chang et al., 2010; Block, 2012; Su & Lee, 2013). Family businesses have limited resources (Chaudhary et al., 2021). To maintain tight control, family businesses seldom recruit external senior managerial personnel, which impedes innovation investment (Zhu et al., 2016). In terms of financial resources, family businesses tend to raise funds internally (Kim et al., 2022). Now that the agency cost of debt is high and financing channels are scarce, costly investment may not be favored (Si et al., 2021). In terms of risk undertaking, families usually concentrate the majority of their assets in one business. Thus, family businesses are risk averse to highly uncertain innovation projects.

The relationship between state-owned equity participation and family businesses' innovation investment

Innovation is a high-investment, uncertain, and long-term activity (Brockova et al., 2021). As stated previously, because of internal agency issues, inadequate enterprise resources, and a lack of risk-taking capability, family businesses are not sufficiently motivated to make innovation investments (Di & Bu, 2021). According to the agency theory, the holding family is highly risk-averse (Brune et al., 2019; Chaudhary et al., 2021). The potential loss of control triggered by innovation investment may prevent family businesses from investing in highly risky R&D projects (Kim et al., 2022). With the introduction of state-owned capital to family businesses, a community between family businesses and the government is formed. This alters the identity of the family business. To some extent, it will effectively safeguard the private ownership of family businesses and reinforce their risk-undertaking capabilities to drive innovation investment (Yang et al., 2020; Deng & Wang, 2020; Du et al., 2022; Li et al., 2022).

The most striking feature of family businesses is that their decision-making is based primarily on socioemotional wealth (Zhou et al., 2022; Yang et al., 2022). While conducting routine operations, family businesses tend to circumvent strategies that may impair their socioemotional wealth (Zhu et al., 2016). Innovation investment may help accumulate socioemotional wealth for the future. Nevertheless, socioemotional wealth may be eroded due to significant uncertainties during the R&D stage, and the weakened family control caused by the introduction of external human resources and financial capital (Zhu et al., 2012; Islam et al., 2022). Miller and Le Breton-Miller (2014) divided socioemotional wealth into constraint and extended types. The former values family control, which renders family businesses too shortsighted to invest sufficiently in innovation. The latter values family inheritance and sustainability, and maintains sound relationships with internal and external stakeholders, which helps scale up enterprises' innovation investment. Luo and Qin (2019) found that the increase in the socioemotional wealth by the introduction of state-owned capital surpassed the constraint caused by decline in socioemotional wealth owing to weakened family control due to state-owned equity participation. To some extent, this strengthened the capability of the enterprise to withstand risks, boosting its aspiration for long-term investment.

Additionally, innovation is connected with funding support. However, banking institutions tend to discriminate among family businesses. With monotonous and inadequate financing channels, family businesses are inferior to state-owned enterprises, which have access to government subsidies and resources (De Massis et al., 2018; Yan et al., 2019; Li et al., 2020a; Si et al., 2021). The introduction of state-owned equity to family businesses can align the interests and objectives of the government with those of family businesses (Li et al., 2021; Diaz-Moriana et al., 2020). It helps moderate the financing

constraints of family businesses, thereby promoting technological innovation (Fang et al., 2017; Harris & Li, 2019; Yu et al., 2022). The government issue of transfer payment and tax break policies for enterprises is a signal to financing institutions that enterprises can access more credit resources (Liu et al., 2018; He et al., 2022; Li et al., 2022). State-owned equity symbolizes the will of governments at all levels, which implicitly brings honor to family businesses (Chen, 2015; Guan & Qu, 2012; Zhang & Guo, 2019; Zhang et al., 2022a). The government will prefer to provide more resources to family businesses with state-owned equity (Peng et al., 2021; Wei & Zhao, 2021). When family businesses are in trouble, the government will provide assistance for the sake of maintaining and increasing value (Wang et al., 2016; Ren et al., 2019). Additionally, to a certain extent, the introduction of state-owned capital can check and balance the composition of controlling shareholders in a family business, preventing family managers from manipulating their dominance and access to information to encroach profits. Further, it cushions the internal and external agent problems of family businesses, protects the interests of small and intermediate shareholders, and encourages enterprises to invest more in research and development, especially in innovation (Dong et al., 2021; Di & Bu, 2021; Gao et al., 2022).

However, when the proportion of state-owned shareholding in family businesses is excessive, it may negatively influence innovation investment through excessive monitoring (Gao et al., 2022). There are significant differences between state-owned shareholders and family-business controlling shareholders in institutional logic, management objectives, and decision-making patterns (Zhang et al., 2022a). State-owned enterprises are subject to low management efficiency and owner absence, and there is a redundant chain between the initial principal and ultimate agent (Yang et al., 2018; Di & Bu, 2021; Gao et al., 2022). Once their shareholding proportion becomes too high, state-owned shareholders are not able to play their role, with their monitoring and incentive mechanisms becoming ineffective. The principal-agent problem between family business managers and shareholders will worsen (Wang et al., 2020b; Xiao et al., 2022). Additionally, with conflicting interests between state-owned shareholders and family managers, internal control will be weakened, and the managers will pursue short-term interests and, accordingly, will become reluctant to invest in innovation.

Moreover, apart from the role of an external shareholder, state-owned capital stands for governmental will. The increasing proportion of state-owned shares will further raise the administration level of family businesses, weaken the decision-making power of family businesses and impair their socioemotional wealth (Li et al., 2020a; Wehrheim et al., 2020). In an enterprise, state-owned shareholders mainly act as national agents and tend to pursue social objectives (Liu et al., 2018; Hong & Gui, 2021; Yu et al., 2022). To fulfill their political objectives, state-owned shareholders will make certain political interventions in the operational decisions of the family businesses (Chen et al., 2018b; Di & Bu, 2021; Wang et al., 2021). For example, state-owned shareholders may require family businesses to undertake extra corporate social responsibility (CSR) by shifting the governmental objectives of environmental protection, employment rates, and pay hikes to politically connected family businesses (Liang & Feng, 2010; Bendell, 2022; Ye et al., 2022; Yu et al., 2022), which will increase the management costs of family businesses, lower innovation investments. Under the pressure of regular assessment and promotion competition, government officials are shortsighted. For the sake of policy objectives and political performance, they tend to indulge enterprises, covering, and even harboring their misconduct (Jiang & Kim, 2020; Nguyen et al., 2022). Consequently, family business agents may adopt reverse selection when lobbying for allowance and may suffer from moral hazard after winning it. As this is likely to decelerate its pace of development, the family firm may be reluctant to engage in innovation (Dong & Liu, 2021; Huang et al., 2021b). Meanwhile, if the participating state-owned shareholder misbehaves,

it will erode the interests of the family businesses through rent-seeking behaviors, such as excessive consumption and bribery, thereby influencing its long-term investment decision-making adversely (Xiao et al., 2022; Gao et al., 2022). However, once the proportion of state-owned equity becomes excessive, it suppresses innovation investment in family businesses. Based on the above analysis, we propose the following hypothesis:

Hypothesis 1. The participation of state-owned equity has a significant impact on family businesses' innovation investment, showing a reverse U relationship between shareholding proportion and innovation investment.

The regulation role of business succession

Succession symbolizes the transition between family fortune and power. For long-term consideration, family businesses are more inclined to transfer ownership to the next generation (Qiu & Freel, 2020). During intergenerational succession, children receive certain human and social capital from their parents (Huang et al., 2021b). With vastly different educational backgrounds and growth environments than those of their predecessors, second-generation successors are more inclined to make long-term investments (Zhou, 2014; Zybura et al., 2021). However, during the succession stage, family successors find it challenging to completely inherit the previous generation's talent and social capital (Zhao & Wu, 2022), so compared to first-generation managers, they tend to invest less in innovation (Duran et al., 2016; Zhao et al., 2020). Due to the lack of authority and legitimacy, second-generation successors face the challenge of earning the trust of senior officers and other employees (Zhao & Li, 2018; Wang & He, 2020; Liu et al., 2021). To this end, second-generation successors are prone to pursuing short-term benefits by investing in projects that can produce a quick effect and are less resource-dependent or risk-averse. Given the considerably uncertain and risky nature of innovation, second-generation successors also tend to be conservative and cautious, and, in order to circumvent risks, reduce R&D costs (Zhu et al., 2021).

The impact of state-owned capital on the innovation investment of family businesses varies with differences in the shareholding proportion. This is also applicable in the business succession phase. Second-generation managers are inclined to enhance their legitimacy by delivering impressive short-term performance. Such objectives are inconsistent with those of state-owned shareholders, which have political ambitions. In addition, the withdrawal of first-generation managers breaks the original balance between state-owned and family shareholders. Consequently, conflicts between second-generation managers and state-owned shareholders tend to intensify (Yang et al., 2022). For the sake of controlling business, there will be internal agency problems between second and first generation managers (Qiu & Freel, 2020). As the proportion of state-owned equity increases, state-owned shareholders are prone to conflict with second-generation successors (Yan et al., 2021). This is expected to further complicate agency relations and increase agency costs, thereby impeding R&D (Huang et al., 2018). State-owned capital results in more resources for family businesses, thereby moderating financing constraints. However, such positive effects are offset by negative effects on innovation investment caused by the increase in agency costs. This suggests that, along with the increase in shareholding proportion, business succession inhibits the positive effect of state-owned equity participation on family businesses' innovation investment.

In the context of excessive state-owned equity, once the shareholding proportion reaches a certain level, family businesses undergoing succession will become more united to maintain their socioemotional wealth than those that are not. In this case, the internal agency costs between business successors and predecessors will

reduce, thus revealing the positive effects of business succession. The second-generation successor becomes a member of the board of directors and serves as a business supervisor, which is conducive to strengthening the long-term orientation of the business (Huang et al., 2018; Wang et al., 2019). The participating state-owned shareholders can help second-generation managers get informed of local policies, assist them in building legitimacy, and minimize information asymmetry, which will encourage the latter to increase their investment in innovation (Yang et al., 2021). To maintain the long-term development of the business, second-generation successors must adapt to new, changing, and uncertain environments (Zhao et al., 2020; Liu et al., 2021). Such adaptability helps family businesses solve management problems caused by excessive state-owned capital, monitor state-owned shareholders, and minimize the negative impact of political connections (Wang et al., 2019). Hence, once the proportion of state-owned capital exceeds a certain limit, business succession buffers the negative effect of state-owned equity on innovation investment by family businesses. Based on the above, we propose the following hypothesis:

Hypothesis 2. Business succession has a negative moderating effect on state-owned equity participation and innovation investment, cushioning the reverse U relationship between the two.

Research methodology

Sample and data

Our research sample comprises family businesses listed on the Shenzhen and Shanghai A-share markets from 2007 to 2019. The sample contains R&D expenditures of the companies listed above since 2007.¹ To ensure the reliability of the data, we screened the initial sample according to the following standards: (1) Remove ST-listed companies to eliminate the possibility of unusual results caused by financial plight, (2) remove financial and insurance industries to ensure comparable data, and (3) remove missing values. After processing the data in accordance with the above rules and regulations, we obtained 13,552 records for 1364 family businesses, including 694 with state-owned equity and 552 in the business succession stage. China Stock Market and Accounting Research (CSMAR) and Chinese Research Data Services (CNRDS) provide the relevant data. To test the accuracy and scientific nature of the data used in this study, we supplemented it with the Wind Economic Database and data from the annual reports of family businesses. The data were processed using STATA version 16.0. To exclude interference from abnormal values, we winsorized the continuous variables.

Measures

Dependent variable

Innovation investment is the dependent variable. R&D indicators can be divided into absolute and relative. Compared with the absolute indicator, the relative indicator is more robust in measuring the R&D investment of an enterprise. Referring to Luo and Qin (2019), Bozec and Di Vito (2019), and Saunila (2020), this study adopts the R&D investment-to-revenue ratio as an important indicator to measure investment by enterprises in technological innovation.

Independent variable

The independent variable is state-owned equity participation. Referring to the method proposed by Hao and Gong (2017), we define the concrete range of state-owned equity to central governmental agencies, state-owned enterprise legal persons, and four major asset

¹ The annual interval starts from 2007 because listed companies have fully disclosed data related to R&D expenses since 2007.

supervision companies. Financial shareholders such as social security funds and trust banks were completely removed. In this study, we used the following two indicators to measure state-owned equity participation: (1) If one or more of the top 10 shareholders of a family business involve state-owned equity, the family business can be defined as state-owned (S1). (2) The sum of the shareholding proportion of state-owned capital held by the top ten shareholders is defined as the state-owned equity shareholding proportion (S2).

Moderator variable

The moderating variable in this study is business succession. Referring to Hu and Wu (2017), once the children of a business founder, including son, daughter, son-in-law, and daughter-in-law, serve the posts of directors, supervisors, and senior managers, it is defined as a family business undertaking succession.

Control variables

Referring to Li et al. (2018), Luo and Qin (2019), and Medase and Abdul-Basit (2020), we select the effect of state-owned equity participation on the innovation investment of a family business, as the control variables. Specific definitions of the variables are listed in Table 1. In addition, we set dummy variables for industry and year in the model.

Model design

To test the influence of state-owned equity participation and business succession on innovation investment in family businesses, we established the following three empirical regression models:

$$Rd_{i,t} = \alpha + \beta_1 S1_{i,t} + \beta_2 \sum Controls_{i,t} + \varepsilon_{i,t} \tag{1}$$

$$Rd_{i,t} = \alpha + \beta_1 S2_{i,t} + \beta_2 S2 * S2_{i,t} + \beta_3 \sum Controls_{i,t} + \varepsilon_{i,t} \tag{2}$$

$$Rd_{i,t} = \alpha + \beta_1 S2_{i,t} + \beta_2 S2 * S2_{i,t} + \beta_3 Succession_{i,t} + \beta_4 S2 * S2 * Succession_{i,t} + \beta_5 \sum Controls_{i,t} + \varepsilon_{i,t} \tag{3}$$

Where Rd denotes the degree of innovation investment by family businesses, S1 denotes whether state-owned equity participates, S2 denotes the shareholding ratio of state-owned shares, succession denotes whether family businesses are in the business succession stage, α denotes the intercept, β_i denotes the coefficient, and ε denotes the residual. Formulas (1) and (2) are used to test the impact of state-owned equity participation on the innovation investment of family businesses. When β_1 in Formula (1) is significant, it indicates that participation by state-owned shareholders will have a significant

impact on innovation by family businesses. In Formula (2), we added the square term of the shareholding proportion of state-owned equity to examine the non-linear relationship between the shareholding proportion of state-owned equity and innovation investment by family businesses, and predicted that the regression coefficient β_2 would be significantly negative. Formula (3) tests the moderating role of business succession. In Formula (3), we added the cross-product term between the square of the shareholding proportion of state-owned and intergenerational equity. The regulatory effect was significant when β_2 and β_4 were significant.

Results

Descriptive statistics and correlation test

In this study, we provide descriptive statistics and conduct correlation analyses on the major variables. As Table 2 shows, from 2007 to 2019, innovation investment by family businesses accounted for 4.84% of their operating revenue on average, which was lower than that by non-family businesses during the same period (5.67%). The values range from 0.03 to 25.8%, indicating that expenditure by family businesses on innovation is generally low, and varies significantly between different enterprises. The mean of the indicator of state-owned equity participation (S1) is 0.154, indicating that state-owned equity participation is present in 15.4% of the family businesses. Thus, state-owned equity participation is no longer exceptional, and it has gradually become a common phenomenon. The maximum value of the indicator of the shareholding proportion of participating state-owned capital (S2) is 0.201, indicating that the proportion of state-owned capital has increased in some family businesses, rendering it an essential force in their regular operation. The mean of succession is 0.258, indicating that over one-quarter of the family businesses are in the business succession stage.

As we further analyze the correlation coefficients, we find that the Pearson coefficient of the state-owned equity proportion is insignificant, which partly supports the curve relationship hypothesis proposed in this paper. By contrast, innovation investment is significantly correlated with the Pearson coefficient of most control variables, which, to a great extent, shows that the selection of control variables in this study makes sense.

Results of hierarchical multiple regression

This study normalizes the major variables and adopts a cluster-robust Pooled OLS regression to verify the relationship between

Table 1
Variable definition.

Variable category	Variable name	Variable code	Meaning and calculation description
Dependent variable	Innovation investment	Rd	R&D investment / operating income
Independent variable	State-owned equity participation	S1	If the top ten shareholders include state-owned equity, the value is 1, otherwise, it is 0.
		S2	The sum of the shareholding ratios of the top ten shareholders in China
Moderator variable	Business succession	Succession	When the founder's children (including son, daughter, daughter-in-law and son-in-law) hold the positions of director, supervisor and senior manager of the company, the value is 1, otherwise it is 0.
Control variables	Asset-liability ratio	Lev	Total liabilities / total assets
	Cash flow	Cash	Monetary funds / total assets
	Enterprise scale	Size	Natural logarithm of total assets
	Tobin Q value	Tq	Market value of total assets / total assets
	Enterprise age	Age	Observed year minus year of company establishment plus 1 to take natural logarithm
	Board size	Boardsize	Natural logarithm of total assets
	Proportion of independent directors	Inde	Proportion of independent directors to the board of directors of the company
	Dual position as chairman and general manager	Dual	1 for dual posts, otherwise 0
	Equity balance degree	Balancedegree	No. 2–5 sum of major shareholders / the ratio of the largest shareholders

Source: The variable definition in this table is based on previous literature.

Table 2
Descriptive statistics of major variables.

Variable	Mean	Sd	Min	Max	Rd	S1	S2	Succession
Rd	0.048	0.045	0.000	0.258	1			
S1	0.154	0.361	0.000	1.000	0.031***	1		
S2	0.009	0.031	0.000	0.201	-0.008	0.689***	1	
Succession	0.258	0.438	0.000	1.000	-0.139***	-0.022**	-0.040***	1
Lev	0.346	0.183	0.041	0.799	-0.298***	0.127***	0.077***	0.011
Cash	0.107	0.926	0.025	0.865	-0.046***	0.026***	0.010	-0.010
Size	21.613	0.989	19.801	24.579	-0.189***	0.121***	0.039***	0.106***
Tq	2.147	1.249	0.959	8.178	0.211***	-0.004	0.040***	-0.057***
Age	2.686	0.403	1.386	3.401	-0.032***	0.101***	0.099***	0.065***
Dual	1.604	0.489	1.000	2.000	-0.103***	0.063***	0.029***	0.094***
Boardsize	2.093	0.183	1.609	2.485	-0.086***	0.112***	0.098***	0.038***
Inde	0.376	0.052	0.333	0.571	0.081***	-0.087***	-0.076***	-0.058***
Balancedegree	0.845	0.627	0.051	2.970	0.112***	0.014*	0.103***	-0.059***

Note: N = 13,552,
* $p < 0.1$,
** $p < 0.05$,
*** $p < 0.01$.

state-owned equity participation and innovation investment by family businesses. Table 3 presents the results of the hierarchical multiple regression analysis. As shown in the first column of the table, state-owned equity participation has a significantly positive impact on innovation investment by family businesses. Its regression coefficient is 0.003, which indicates that, in the case of state-owned equity participation, innovation investment increases by 6.25% on average (= regression coefficient/innovation investment mean). We used the method proposed by Haans et al. (2016) to test the inverted U-shaped relationship. We found that the quadratic coefficient of the independent variable was significantly negative ($\beta = -0.693$), and the slope

of the curve was significantly positive towards the left end of the S2 range and significantly negative at the right end. According to the calculation, its inflection point is 0.104, which falls within the range [0.000, 0.201]. Thus, there is a reverse U-shaped relationship between the state-owned equity proportion in total shareholding, and innovation investment by family businesses, which proves Hypothesis 1.

Innovation is a highly risky activity that requires large investments. Due to their monopolized equity structure, family businesses are not motivated to invest in innovation. The introduction of state-owned equity has a significant impact on innovation investment by family businesses. When the proportion of state-owned equity in total shareholding makes sense, the introduction of state-owned capital can stimulate the aspirations of family businesses for long-term investment, which is conducive to improving their innovation investment. Once the proportion surpasses a certain level, the introduction of state-owned equity will weaken the innovation investment by family businesses.

The regulating role of business succession

Table 4 shows the regulating role of business succession in the reverse U relationship between state-owned equity participation and innovation investment by family businesses. The first column in the table shows the inhibitory role of business succession on the relationship between the proportion of state-owned equity in total shareholding and investment in innovation by family businesses ($\beta = -0.007, p < 0.001$); it indicates that business succession moderates the impact of the state-owned equity shareholding proportion on innovation investment. The square terms of the state-owned equity shareholding proportion and its product with succession are added to the second column of the table. The cross-product term is significantly positive. Compared to the results in Table 3, in the absence of succession, the regression coefficient of the shareholding proportion of state-owned equity is 0.144, and the regression coefficient of the square term is -0.693. These regression coefficients are larger than those in the succession stage. These findings prove that family business succession can moderate the reverse U impact of the state-owned equity shareholding proportion on innovation investment, thus playing a negative regulatory role. Therefore, Hypothesis 2 is supported.

During the transition stage, second-generation successors, who are anxious to establish legitimacy and authority, tend to favor conservative strategic decision-making to obtain short-term benefits. The introduction of state-owned equity is likely to conflict with the strategy of the second-generation successor, thus increasing agency costs and diluting the positive effect of state-owned equity on

Table 3
Stratified regression analysis of state-owned equity participation and innovation input of family firms.

Variables	Independent variable (Rd)	
	(1)	(2)
S1	0.003*** (3.191)	
S2		0.144*** (4.760)
S2 × S2		-0.693*** (-3.791)
Lev	-0.055*** (-26.839)	-0.055*** (-26.929)
Cash	-0.000 (-0.351)	-0.000 (-0.387)
Size	-0.000 (-0.085)	-0.000 (-0.027)
Tq	0.005*** (18.455)	0.005*** (18.310)
Age	-0.008*** (-8.732)	-0.008*** (-8.859)
Dual	-0.005*** (-7.618)	-0.005*** (-7.708)
Boardsize	0.006*** (2.739)	0.006*** (2.616)
Inde	0.045*** (5.830)	0.046*** (5.878)
Balancedegree	0.002*** (4.006)	0.002*** (3.752)
Constant	0.007 (0.635)	0.007 (0.651)
Year & Ind	Control	Control
N	13,552	13,552
R ²	0.362	0.362
adj. R ²	0.360	0.360

Note: * $p < 0.1$; ** $p < 0.05$;
*** $p < 0.01$; T values are in parentheses.

Table 4
Regression analysis of the moderating effect of business succession.

Variables	Independent variable (Rd)	
	(1)	(2)
S2	0.031*** (3.085)	0.136*** (4.539)
Succession	-0.007*** (-9.699)	-0.007*** (-9.848)
S2 × S2		-0.731*** (-3.954)
Succession × S2 × S2		0.305* (1.927)
Lev	-0.056*** (-27.462)	-0.056*** (-27.557)
Cash	-0.000 (-0.228)	-0.000 (-0.234)
Size	0.000 (0.930)	0.000 (0.826)
Tq	0.005*** (18.211)	0.005*** (18.225)
Age	-0.008*** (-8.269)	-0.008*** (-8.352)
Dual	-0.004*** (-6.762)	-0.004*** (-6.879)
Boardsize	0.006*** (2.647)	0.006** (2.500)
Inde	0.042*** (5.456)	0.042*** (5.446)
Balancedegree	0.002*** (3.316)	0.002*** (3.362)
Constant	0.002 (0.132)	-0.047*** (-4.152)
Year & Ind	Control	Control
N	13,552	13,552
R ²	0.366	0.367
adj. R ²	0.364	0.365

Note:

- * $p < 0.1$;
- ** $p < 0.05$;
- *** $p < 0.01$; T values are in parentheses.

innovation investment. In the case of excessive state-owned capital participation, the family business strengthens its internal cohesion to mitigate the business agency problem. In this context, succession has a positive effect. Succession reduces the reverse U-influence of state-owned capital on innovation investment.

Robustness test

Instrumental variable regression

Given that family businesses with significant innovation investment will attract state-owned capital, in this study, by referring to Jiang et al. (2012) and Luo and Qin (2019), we select the mean state-owned equity shareholding proportion of the same industry in the same region in the same year as the instrumental variable to address the reverse cause-effect problem between state-owned equity participation and innovation investment. In general, state-owned equity participation of other companies in the same industry in the same region seldom affects the innovation investment by a company. Therefore, the selection of the instrumental variable is representative to some extent. Based on the first-stage regression results shown in Table 5, the regression coefficient of instrumental variable S2 is significant. However, weak instrumental variables do not exist. In the second-stage regression results, the regression coefficient of the square term is significantly negative, indicating that the reverse U relationship between the state-owned equity shareholding proportion and innovation investment proposed in this study still holds.

Table 5
Analysis of regression results of the instrumental variable.

Variables	Stage 1 S2	Stage 2 Rd
Instrumental variable S2	0.965*** (63.408)	0.112*** (2.881)
Instrumental variable S2 × S2		-0.939*** (-3.238)
Lev	0.010*** (6.662)	-0.054*** (-26.693)
Cash	0.000 (1.250)	-0.000 (-0.303)
Size	0.001*** (2.602)	0.000 (0.226)
Tq	0.002*** (8.262)	0.005*** (18.668)
Age	0.007*** (10.544)	-0.008*** (-8.553)
Dual	-0.000 (-0.525)	-0.005*** (-7.578)
Boardsize	0.004** (2.221)	0.006*** (2.775)
Inde	-0.021*** (-3.672)	0.045*** (5.776)
Balancedegree	0.004*** (11.155)	0.002*** (4.036)
Constant	-0.044*** (-5.267)	0.005 (0.407)
Year & Ind	Control	Control
N	13,552	13,552
R ²	0.268	0.362
adj. R ²	0.266	0.360

Note:

- * $p < 0.1$;
- ** $p < 0.05$;
- *** $p < 0.01$; T values are in parentheses.

The explanatory variable is stage delayed

Considering that the effect of state-owned capital participation on innovation investment is somewhat delayed, this study employs one-stage delayed explanatory variables to conduct a robustness test. As the first two columns of Table 6 show, the regression coefficients of state-owned equity participation (S1), state-owned equity shareholding proportion (S2), and its square term are still significant, although the explanatory variables are delayed by one stage. It indicates the conclusion that there exists a reverse U relationship between state-owned equity and family businesses' innovation investment. The last two columns show the regulatory role of family business succession. The results of all the robustness tests are significant below 1% and 5%, proving the reliability of the conclusions of this study.

Indicator substitution test

In the regression above, innovation investment is measured mainly by the ratio of R&D investment to operating revenue. To guarantee the reliability of the research results, we choose the percentage of R&D investment to gross assets as a substitute variable for innovation investment to conduct regression analyses, as shown in Table 7. The regression coefficients of state-owned equity participation (S1) and state-owned equity shareholding proportion (S2) are both significantly positive, and the regression coefficient of the square term of the state-owned equity shareholding proportion is significantly negative, indicating that the reverse U-effect of the state-owned equity shareholding proportion is tested. Similarly, after the indicator of innovation investment is substituted, the negative regulating role of succession still exists, proving that the regression model is robust.

Table 6
Analysis of one-stage lag regression results of explanatory variables.

Variables	Independent variable (Rd)			
	(1)	(2)	(3)	(4)
S1	0.002** (2.420)			
S2		0.144*** (4.225)	0.027** (2.367)	0.140*** (4.134)
S2 × S2		-0.721*** (-3.514)		-0.806*** (-3.877)
Succession			-0.007*** (-8.383)	-0.007*** (-8.694)
Succession × S2 × S2				0.456*** (2.591)
Lev	-0.055*** (-24.129)	-0.056*** (-24.215)	-0.056*** (-24.649)	-0.057*** (-24.780)
Cash	-0.000 (-0.974)	-0.000 (-1.010)	-0.000 (-0.885)	-0.000 (-0.879)
Size	-0.000 (-0.574)	-0.000 (-0.549)	0.000 (0.297)	0.000 (0.223)
Tq	0.005*** (15.712)	0.005*** (15.592)	0.005*** (15.557)	0.005*** (15.592)
Age	-0.007*** (-7.487)	-0.007*** (-7.594)	-0.007*** (-7.103)	-0.007*** (-7.170)
Dual	-0.004*** (-6.280)	-0.005*** (-6.385)	-0.004*** (-5.509)	-0.004*** (-5.610)
Boardsize	0.007*** (2.778)	0.007*** (2.671)	0.007*** (2.731)	0.006** (2.562)
Inde	0.054*** (6.407)	0.055*** (6.472)	0.051*** (6.107)	0.051*** (6.068)
Balance degree	0.002*** (3.740)	0.002*** (3.556)	0.002*** (3.162)	0.002*** (3.194)
Constant	0.005 (0.379)	0.005 (0.391)	-0.001 (-0.093)	-0.049*** (-3.981)
Year & Ind	Control	Control	Control	Control
N	10,727	10,727	10,727	10,727
R ²	0.369	0.370	0.374	0.375
adj. R ²	0.367	0.368	0.371	0.372

Note:
* $p < 0.1$;
** $p < 0.05$;
*** $p < 0.01$; T values are in parentheses.

Table 7
Analysis of regression results of index replacement test.

Variables	Independent variable (Rd)			
	(1)	(2)	(3)	(4)
S1	0.002* (1.667)			
S2		0.174*** (4.125)	0.026* (1.882)	0.172*** (4.074)
S2 × S2		-0.916*** (-3.622)		-0.991*** (-3.856)
Succession			-0.007*** (-6.894)	-0.007*** (-7.080)
Succession × S2 × S2				0.370* (1.758)
Lev	-0.060*** (-21.278)	-0.060*** (-21.415)	-0.061*** (-21.654)	-0.061*** (-21.804)
Cash	-0.000 (-0.314)	-0.000 (-0.347)	-0.000 (-0.218)	-0.000 (-0.245)
Size	0.002*** (2.577)	0.002*** (2.588)	0.002*** (3.228)	0.002*** (3.199)
Tq	0.006*** (16.149)	0.006*** (16.028)	0.006*** (15.985)	0.006*** (16.011)
Age	-0.005*** (-4.530)	-0.005*** (-4.681)	-0.005*** (-4.261)	-0.005*** (-4.352)
Dual	-0.004*** (-4.883)	-0.004*** (-4.995)	-0.004*** (-4.255)	-0.004*** (-4.367)
Boardsize	0.009*** (2.909)	0.009*** (2.763)	0.009*** (2.892)	0.008*** (2.693)
Inde	0.061*** (6.043)	0.062*** (6.114)	0.059*** (5.837)	0.058*** (5.786)
Balance degree	0.003*** (3.876)	0.003*** (3.762)	0.002*** (3.356)	0.002*** (3.419)
Constant	-0.027* (-1.736)	-0.026* (-1.699)	-0.032** (-2.109)	-0.084*** (-5.451)
Year & Ind	Control	Control	Control	Control
N	13,552	13,552	13,552	13,552
R ²	0.361	0.363	0.365	0.367
adj. R ²	0.358	0.359	0.362	0.363

Note:
* $p < 0.1$;
** $p < 0.05$;
*** $p < 0.01$; T values are in parentheses.

Further analysis: group tests based on different types of family businesses

In light of the heterogeneity of family businesses, they exhibit varying behaviors (De Massis et al., 2013, 2014). In the context of mixed-ownership reform, before being listed on the market, many family businesses were state-owned absolute holding companies. After being listed in the market, they gradually transformed into private relative holding companies, in accordance with China’s reform of state-owned enterprises. According to Zulfiqar et al. (2021) and Ye et al. (2022), family businesses can be divided into two categories, created and transformed. Created family business refers to an enterprise founded and managed by family members upon going public. A transformed family business refers to an enterprise that is gradually transformed into a family-held business from a state-held or non-natural family-held business through merging, reorganization, or state-owned enterprise reform.

These two types of family businesses are diametrically different. Created family businesses value long-term prosperity and are, therefore, more inclined to make long-term investments. Transformed family businesses cling to the organizational structure, management patterns, and corporate governance of state-owned enterprises. Family members are not entirely involved in this type of business. The business owner is not well-informed about the enterprise. Such businesses typically pursue short-term performance. They may seek self-interest and neglect long-term investment. Therefore, it is essential to study these factors separately.

The first four columns of Table 4 show the grouped regression results for state-owned equity participation in different types of family businesses. It can be seen that the regression coefficient of the square term of state-owned equity shareholding proportion and that of innovation investment in created family businesses are significantly negative, which proves the reversed U-shaped relationship. Transformed family businesses have strong state-owned stamps and special backgrounds. Once state-owned capital is introduced into the transformed family business, it may produce a substitution effect. Thus, state-owned equity participation does not have a significant effect on innovation investment in this type of enterprise. Further, to verify that the differences in the group coefficients between the two types of family firms are significant, we introduce a test based on a seemingly unrelated regression model. According to the results in the first four columns of Table 8, the p-values are 0.042 and 0.079, respectively, indicating a significantly different effect of state-owned equity participation on the innovation inputs of the different family firms.

This study introduces a cross-product term between family firm type and the square of state-owned equity ownership to verify the moderating effect of the former between state-owned equity participation and innovation investment. The regression coefficients of the square term of the state-owned equity shareholding proportion and cross-product term of the family business category are significantly negative. The research proves that an increase in created family businesses can strengthen the reversed U-shaped impact of the state-owned equity shareholding proportion on innovation investment.

Table 8
Grouping tests based on different types of family firms.

Variables	Independent variable (Rd)					
	Created firms (1)	Transformed firms (2)	Created firms (3)	Transformed firms (4)	All (5)	All (6)
S1	0.005*** (4.965)	0.001 (0.666)				
S2			0.218*** (5.921)	0.074 (1.414)	0.049*** (4.732)	0.169*** (5.555)
Famstyle					-0.008*** (-8.113)	-0.008*** (-7.672)
S2 × S2			-0.990*** (-4.324)	-0.359 (-1.197)		-0.512* (-1.932)
Famstyle × S2 × S2						-0.257* (-1.803)
Lev	-0.054*** (-23.390)	-0.036*** (-7.945)	-0.054*** (-23.406)	-0.036*** (-7.948)	-0.053*** (-25.582)	-0.052*** (-25.567)
Cash	-0.000 (-1.207)	0.000 (0.315)	-0.000 (-1.223)	0.000 (0.290)	-0.000 (-0.559)	-0.000 (-0.572)
Size	-0.000 (-0.140)	0.003*** (2.659)	-0.000 (-0.035)	0.003*** (2.677)	0.000 (0.781)	0.000 (0.611)
Tq	0.006*** (18.167)	0.005*** (7.994)	0.006*** (18.096)	0.005*** (7.941)	0.006*** (19.309)	0.006*** (19.328)
Age	-0.006*** (-5.775)	-0.011*** (-3.403)	-0.006*** (-5.827)	-0.011*** (-3.500)	-0.006*** (-6.514)	-0.006*** (-6.580)
Dual	-0.005*** (-6.636)	-0.004** (-2.407)	-0.005*** (-6.679)	-0.004** (-2.448)	-0.005*** (-7.027)	-0.005*** (-7.173)
Boardsize	0.007*** (2.867)	-0.007 (-1.344)	0.007*** (2.779)	-0.008 (-1.458)	0.005** (2.295)	0.005** (2.144)
Inde	0.050*** (5.938)	0.001 (0.044)	0.050*** (6.010)	0.000 (0.016)	0.043*** (5.569)	0.044*** (5.656)
Balance degree	0.002*** (4.076)	0.001 (0.982)	0.002*** (3.753)	0.001 (0.795)	0.002*** (3.430)	0.002*** (3.494)
Constant	-0.005 (-0.426)	0.001 (0.025)	-0.006 (-0.471)	0.002 (0.086)	0.006 (0.573)	-0.049*** (-4.338)
Year & Ind	Control	Control	Control	Control	Control	Control
N	11,636	1916	11,636	1916	13,552	13,552
R ²	0.371	0.256	0.372	0.257	0.365	0.366
adj. R ²	0.369	0.240	0.370	0.240	0.363	0.364
chi ²	4.140		3.100		/	/
Prob > chi ²	0.042**		0.079*		/	/

Note:
* $p < 0.1$;
** $p < 0.05$;
*** $p < 0.01$; T values are in parentheses. The last two rows of the table are the results of the seemingly unrelated regression model, "Prob > chi²" is used to test the significance of the difference in coefficients between groups.

Conclusions and implications

Research conclusions

The comprehensive promotion of mixed-ownership reform is conducive to the improvement of China's basic economic system and the institutional mechanism of economic operations. The introduction of state-owned capital has had a profound effect on the management and corporate governance of private enterprises (Nguyen et al., 2022). However, existing studies have paid more attention to the context in which private capital participates in state-owned enterprises (Zhang et al., 2020; Yuan et al., 2022). Governmental control behind state-owned equity has both, a "predatory" and a "supportive" hand, generating resource advantages for the enterprise while also imposing policy burdens on it (Gao et al., 2022). Some studies on the relationship between state-owned equity participation and technological innovation have concentrated on the linear relationship between the two. Moreover, no consensus has been reached so far (Bai et al., 2018; Luo & Qin, 2019; Deng & Wang, 2020; Li et al., 2021). Due to differences in research targets and sample limitations, extant studies did not explore the optimal range of the proportion of state-owned equity in a family firm. This study expands the research range and considers listed family firms from 2007 to 2019 as the study sample to analyze the double-edged sword effect of state-owned equity and identify the threshold of the positive and excessive monitoring

effects. Our study enriches theoretical research on the relationship between state-owned equity shareholding proportions and innovation investment. So far, the research on family business succession has not considered the impact of complex equity structures on innovation investment (Huang et al., 2018; Diaz-Moriana et al., 2020; Yan et al., 2021; Zhu et al., 2021). This study was a creative attempt. We integrated state-owned equity participation, innovation investment, and succession, revealing the regulatory role of succession in the relationship between the other two. The study supplements the research on family business succession. Some studies have divided family businesses into the following two categories, based on their sources: created and transformed. These studies have focused on comparing and contrasting these two types of enterprises (Zulficar et al., 2021; Ye et al., 2022). Against the backdrop of mixed-ownership reform, this study further investigates the influence of different types of family businesses with state-owned equity participation on innovation investment, which sheds new light on optimizing technological innovation strategies in the context of family business heterogeneity. The following conclusions were drawn.

- (1) A reverse U relationship exists between the proportion of state-owned equity shareholding and innovation investment by family businesses. A proportion that is too low or too high is not conducive to long-term investment by family businesses. Only a sound proportion can boost innovation investment in family businesses.

This finding differs from previous findings on the shareholding proportion of state-owned equity (Zhao et al., 2020; Bendell, 2022; Yuan et al., 2022). Due to research time limitations, the proportion of state-owned equity in the selected sample of family businesses in existing studies is observed to be low (Luo & Qin, 2019; Deng & Wang, 2020). Consequently, they could not explore the relationship between the equity proportion and innovation investment in the context of an increase in the state-owned shareholding proportion. Our study has the advantage of using a sample data interval. We studied the data on all family businesses listed in the A-share market from 2007 to 2019. We found that the promotion role of the state-owned equity participation proportion on innovation investment does not improve with an increase in the shareholding proportion. When the shareholding proportion exceeds 10.4%, innovation investment decreases along with an increase in the shareholding proportion. This study further explores the mechanism behind the positive and excessive monitoring effects of state capital in family firms. We reveal a reversed U-shaped relationship between state-owned equity participation and innovation investment, which moderates the conflict arising in existing linear research. By identifying the threshold between the positive effect and the excessive supervision effect, we find the optimal range of the proportion of state-owned equity, which theoretically defines its role and helps family firms to consider state-owned capital in a dialectical manner for its effective utilization.

- (2) Family succession negatively regulates the relationship between the shareholding proportion of state-owned equity and innovation investment, which weakens the reversed U-shaped relationship. Family business succession in China has reached its peak. Existing studies on family business succession focus on business operations and performance (De Massis et al., 2018; Zhao & Li, 2018; Wang & He, 2020). In addition, research findings concerning the relationship between intergenerational succession and innovation investment are inconsistent (Amore et al., 2021; Zybura et al., 2021; Zulfiqar et al., 2021; Ye et al., 2022). The influence of family business succession on innovation investment in the context of a mixed equity structure has been neglected. In this study, we found that when an SOE participates in the family business, the family business successor, to establish legitimacy and authority, is exposed to agency conflicts with the predecessor and state-owned shareholders, thus cutting long-term R&D investment. On the other hand, once the shareholding proportion of state-owned capital exceeds a certain limit, the successor reduces internal family agency costs while maintaining corporate socioemotional wealth and lasting prosperity. In this context, family business succession offsets the negative effect of state-owned equity participation on the family business' innovation investment. This study proves that intergenerational succession is a contextual factor affecting the relationship between state-owned equity participation and innovation investment. This finding will guide the innovation decisions of family firms undergoing mixed-ownership reform to realize smooth intergenerational succession.
- (3) Given its heterogeneity, there are obvious differences between different family businesses in investment decision-making and management modes. Although existing studies have investigated the difference between a transformed family business and a created family business (Zulfiqar et al., 2021; Ye et al., 2022), they have not investigated the influence of the external institutional environment on business heterogeneity. Due to the historical background of overlap in state-owned enterprise reform and function, there exists a substitution effect between the innovation investment by transformed family businesses and state-owned equity participation. This study empirically reveals that the positive effect of state-owned equity participation on

transformed family businesses is weakened. By contrast, the participation of state-owned equity will further stimulate family businesses to invest in innovation, as such businesses develop a long-term vision. We categorize family firms based on their origin, and conduct an in-depth analysis of the impact of state-owned equity participation on the innovation investment of different types of firms, which enriches the research on the heterogeneity of family businesses.

Managerial implications

- (1) The introduction of state-owned capital to family businesses, to some extent, will encourage family businesses to invest in innovation, energize their internal innovation vitality and improve their business operations. As an indispensable part of the private economy, family businesses play an important role in promoting the long-term stability of the national economy. China has reached a critical point in its economic transition. Currently, well-established state-owned capital is encouraged to participate in family businesses. The positive and external effects of state-owned capital should be given full play so that businesses can develop in a well-coordinated manner by drawing on the strengths of their own and state-owned capital. Meanwhile, the government is expected to launch property rights institutions to protect family businesses, provide policy support for technological innovation, and create a fair and just environment for the development of family businesses.
- (2) The government and the supervisor should ensure that the shareholding proportion of state-owned equity should make sense. A very high or very low proportion would adversely affect the development of the firm. Governments should consider the heterogeneity of family businesses to promote mixed-ownership reform through classification and stratification, realizing rational advances and withdrawals. For created family firms, state-owned capital can be appropriately introduced to give full play to their resource advantages and protect private property rights. For transformed family firms, state-owned capital should reduce shareholding. Instead, other alternatives, such as policy subsidies, should be employed to spur innovation.
- (3) During the succession stage, family businesses tend to circumvent risk. As they are conservative, they seldom invest in innovation. Prior to the succession stage, family enterprises should make adequate preparations to cultivate family successors' abilities, help them accumulate social resources, and gain the trust and recognition of enterprise members in advance. This reduces the differences between the two generations of owners in terms of legitimacy and authority. Meanwhile, first-generation owners should appropriately empower their successors, especially when the proportion of state-owned capital is high. This will reinforce the successors' decision-making power to enable them to give due regard to both long-term and short-term objectives. Thus, family businesses can avoid short-term practices, even during the succession stage, instead, develop a long-term vision to seize opportunities and realize innovative developments.

Shortcomings and prospect

Given the current research conditions, our paper needs improvement in the following aspects:

- (1) In this study, we selected innovation investment as the dependent variable to conduct an empirical analysis. As innovation activities are highly uncertain, innovation output may not be high (Li et al., 2022; Brockova et al., 2021). In the future, relevant research is expected to extend the action chain to further

investigate the interaction between state-owned equity participation, innovation investment, and innovation output.

- (2) In this study, we selected family businesses listed in the Shanghai and Shenzhen A-share markets as the sample. The ownership and management rights of family businesses in China are highly concentrated. Family businesses exist in small- and medium-sized, unlisted forms. Consequently, the scope of our research remains to be expanded. So far, data on family businesses in transition for power handover remain scarce, and the exposure of family businesses' R&D expenditure remains insufficient. In the future, data can be supplemented by field trips, questionnaires, and interviews.
- (3) In this paper, we highlighted the heterogeneity of family businesses (Zulfiqar et al., 2021; Ye et al., 2022). We discovered the replacement effect between the existing resources of transformed family businesses and state-owned equity in terms of their impact on innovation investment. Future research could explore how the replacement effect of state-owned equity in transformed family businesses emerges.

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Data availability statement

The data used to support the findings of this study are included within the article.

Declaration of Competing Interest

The authors declare that they have no competing interest.

CRediT authorship contribution statement

Kanghong Li: Conceptualization, Funding acquisition, Writing – original draft, Writing – review & editing. **Yuyan Xiang:** Writing – original draft, Methodology, Formal analysis. **Changbao Zhou:** Conceptualization. **Runhui Lin:** Supervision, Project administration.

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